Northwest Training Range Complex

Environmental Impact Statement/ Overseas Environmental Impact Statement

Draft EIS/OEIS | December 2008
Volume 1: EIS/OEIS

Commander
United States Pacific Fleet
c/o Pacific Fleet Environmental Office
1101 Tautog Circle
Silverdale, WA 98315

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COVER SHEET
DRAFT ENVIRONMENTAL IMPACT STATEMENT/
OVERSEAS ENVIRONMENTAL IMPACT STATEMENT
NORTHWEST TRAINING RANGE COMPLEX

Lead Agency for the EIS:	U.S. Department of the Navy
Title of the Proposed Action:	Northwest Training Range Complex (NWTRC)
Affected Jurisdiction:	Washington, Oregon, California
Designation:	Draft Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS)

Abstract

This draft EIS/OEIS has been prepared by the Department of the Navy in compliance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code § 4321 et seq.); the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations [C.F.R.] §§ 1500-1508); Department of the Navy Procedures for Implementing NEPA (32 C.F.R. § 775); and Executive Order 12114, Environmental Effects Abroad of Major Federal Actions. The Navy has identified the need to support and conduct current, emerging, and future training and research, development, test, and evaluation (RDT&E) activities (unmanned aerial systems only) in the NWTRC. Three Alternatives are analyzed in this EIS/OEIS. The No Action Alternative will continue training and RDT&E activities of the same types, and at the same levels of training intensity as currently conducted, without change in the nature or scope of military activities in the EIS/OEIS Study Area. Alternative 1, in addition to accommodating training activities addressed in the No Action Alternative, would support an increase in training activities. Alternative 1 also proposes training and RDT&E required by force structure changes to be implemented for new weapons systems, instrumentation, and technology as well as new classes of ships, submarines, and new types of aircraft. Alternative 2 would include all elements of Alternative 1, in addition, under Alternative 2, training activities would be increased over levels identified in Alternative 1, and certain range enhancements would be implemented, to include new electronic combat threat simulators/targets, development of a small scale underwater training minefield, development and use of the portable undersea tracking range, and development of air and surface target services.

This EIS/OEIS addresses the potential environmental impacts that result or could result from activities under the No Action Alternative, Alternative 1, and Alternative 2. Environmental resource topics evaluated include geology and soils, air quality, hazardous materials and wastes, water quality, acoustic environment-airborne sound, marine plants and invertebrates, fish, sea turtles, marine mammals, sea birds, terrestrial biological resources, cultural resources, traffic, socioeconomics, environmental justice and the protection of children, and public safety.

Prepared by: Department of the Navy

Point of Contact: Kimberly Kler, Environmental Planner
Naval Facilities Engineering Command Northwest
1101 Tautog Circle, Suite 203
Silverdale, WA 98315-1101
(360) 396-0927

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ES 1 EXECUTIVE SUMMARY

ES 1.1 INTRODUCTION

This Environmental Impact Statement (EIS) / Overseas Environmental Impact Statement (OEIS) analyzes the potential environmental impacts to the human environment that may result from the United States (U.S.) Navy's Proposed Action and Alternatives, which address ongoing and proposed naval activities within most of the Navy's existing Northwest Training Range Complex (NWTRC).

This Draft EIS/OEIS (hereafter referred to as "EIS/OEIS") has been prepared by the Department of the Navy in compliance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code [U.S.C.] § 4321 et seq.); the Counsel on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations [CFR] §§ 1500-1508); Department of the Navy Procedures for Implementing NEPA (32 CFR § 775); and Executive Order (EO) 12114 *Environmental Effects Abroad of Major Federal Actions* (EO No. 12114, 44 Fed. Reg. 1957, Jan 4, 1979). This EIS/OEIS satisfies the requirements of NEPA and EO 12114, and will be filed with the U.S. Environmental Protection Agency (USEPA) and made available to appropriate Federal, State, local, and private agencies, organizations, and individuals for review and comment.

The Navy is the lead agency for the EIS/OEIS; the National Marine Fisheries Service (NMFS) is a cooperating agency, pursuant to 40 C.F.R. Section 1508.5.

The NWTRC consists of two primary components: the Offshore Area and the Inshore Area. The Range Complex includes ranges, operating areas (OPAREAs), and airspace that extend west to 250 nautical miles (nm) (463 kilometers [km]) beyond the coast of Washington, Oregon, and Northern California; and east to the Washington/Idaho border. The components of the NWTRC encompass 122,440 square nautical miles (nm^2) (420,163 square kilometers [km^2]) of surface/subsurface ocean OPAREAs, 46,048 nm^2 (157,928 km^2) of special use airspace[1] (SUA), 367 nm^2 (1,258 km^2) of Restricted Airspace and 875 acres (354 hectares) of land. For range management and scheduling purposes, the NWTRC is divided into numerous sub-component ranges or training areas used to conduct training and Research, Development, Test, and Evaluation (RDT&E) activities (Unmanned Aerial Systems [UASs] only), as described in detail in Chapter 2 of this EIS/OEIS. Figures ES-1 and ES-2 depict the training areas to be analyzed in this EIS/OEIS.

The Navy's mission is to organize, train, equip, and maintain combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. This mission is mandated by Federal law (Title 10 U.S. Code (U.S.C.) § 5062), which charges the Chief of Naval Operations (CNO) with responsibility for ensuring the readiness of the Nation's naval forces.[2] The CNO meets that directive, in part, by establishing and executing training programs, including at-sea training and exercises, including mid-frequency active (MFA) sonar activities, and ensuring naval forces have access to the ranges, OPAREAs, and airspace needed to develop and maintain skills for conducting naval activities. Activities involving RDT&E for naval systems are an integral part of this readiness mandate.

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[1] Special use Airspace (SUA) is airspace of defined dimensions wherein activities, such as military aircraft activities, must be confined because of their nature. Restrictions or limitations are typically imposed on non-participants. SUA includes restricted areas, alert areas, military operating areas (MOAs), and over-water warning areas.

[2] Title 10, Section 5062 of the United States Code provides: "The Navy shall be organized, trained, and equipped primarily for prompt and sustained combat incident to operations at sea. It is responsible for the preparation of Naval forces necessary for the effective prosecution of war except as otherwise assigned and, in accordance with Integrated Joint Mobilization Plans, for the expansion of the peacetime components of the Navy to meet the needs of war."

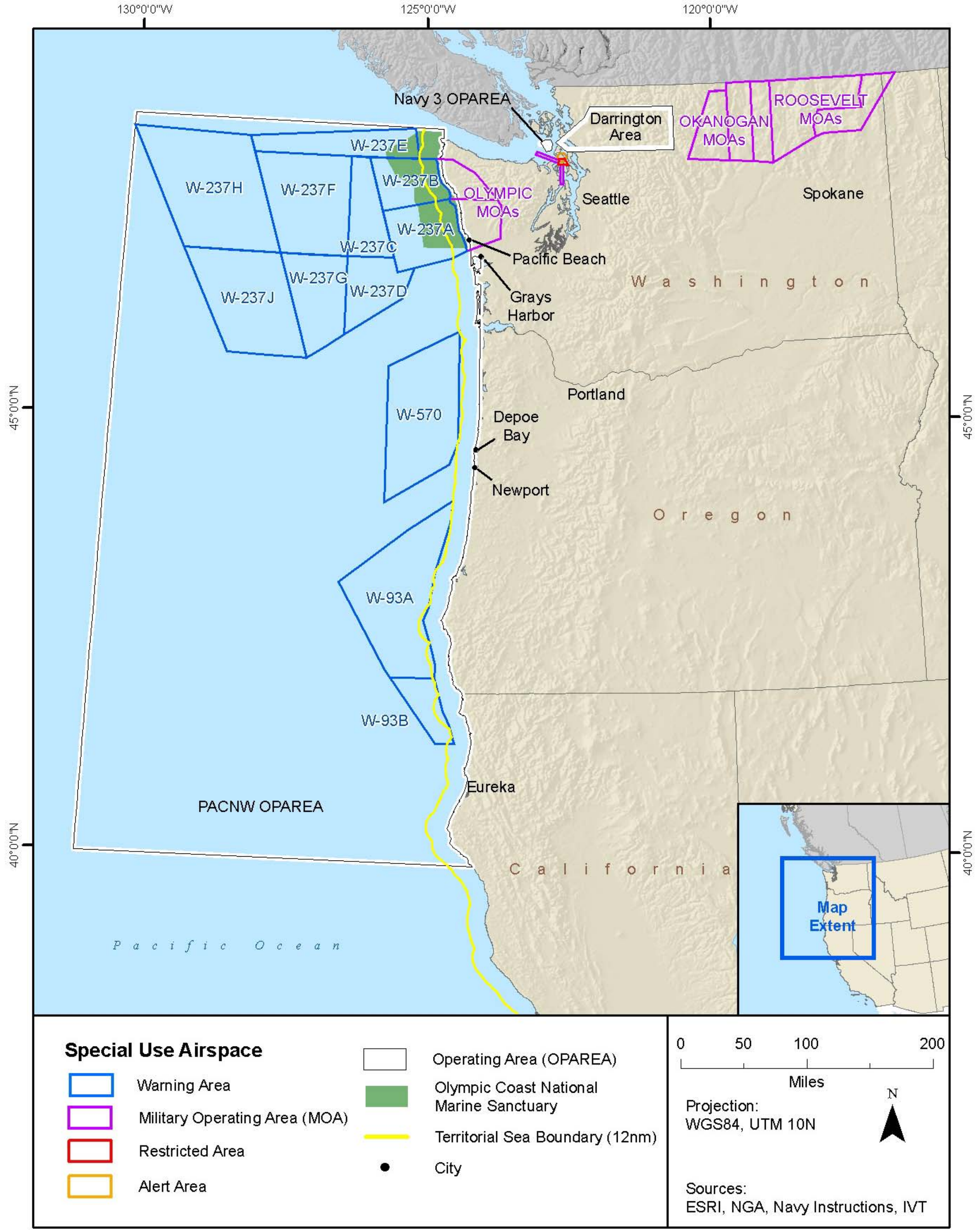

Figure ES-1: NWTRC EIS/OEIS Study Area

The NWTRC plays a vital part in the execution of this naval readiness mandate. The NWTRC serves as the principle "backyard" training range for those units homeported in the Pacific Northwest area, including those aviation, surface ship, submarine, and Explosive Ordnance Disposal (EOD) units homeported at Naval Air Station (NAS) Whidbey Island, Naval Station (NAVSTA) Everett, Puget Sound Naval Shipyard, and Naval Base Kitsap (NBK) Bremerton, NBK-Bangor, formerly known as Submarine Base (SUBASE) Bangor. Additionally, the NWTRC supports other non-resident users and their training requirements to include Naval Special Warfare (NSW) units. The Navy's Proposed Action is a step toward ensuring the continued vitality of this essential naval training resource.

ES 1.2 PURPOSE AND NEED FOR THE PROPOSED ACTION

The NWTRC provides a unique training environment for naval forces (see Section 1.2.3[3] for a detailed discussion of the strategic importance of the NWTRC). Nevertheless, shortfalls exist in the Range Complex that affect the quality of training (see Section 1.3.3). The Navy proposes to take actions for the purposes of:

- Achieving and maintaining Fleet readiness using the NWTRC to support and conduct current, emerging, and future training and RDT&E activities (primarily Unmanned Aerial Systems [UASs]);
- Expanding warfare missions supported by the NWTRC, consistent with the requirements of the Fleet Response Training Plan (FRTP), described in Section 1.2.1; and
- Upgrading and modernizing existing range capabilities to address shortfalls and deficiencies in current training areas and operating areas.

The Proposed Action is needed to provide a training environment consisting of ranges, training areas, and range instrumentation with the capacity and capabilities to fully support required training tasks for operational units and military schools such as the Electronic Attack Weapons School, located at NAS Whidbey Island. The Navy has developed alternatives criteria based on this statement of the purpose and need for the Proposed Action (see Section 2.3.1).

The NWTRC supports and promotes the Navy's execution of its roles and responsibilities under Title 10 (Title 10 U.S. Code [USC] § 5062). To comply with its Title 10 mandate, the Navy needs to:

- Maintain current levels of military readiness by training in the NWTRC;
- Accommodate future increases in operational training tempo in the NWTRC and support the rapid deployment of individual naval units or Strike Groups;
- Achieve and sustain readiness of ships, submarines, aviation squadrons, and other units using the NWTRC so that the Navy can quickly surge significant combat ready forces in the event of a national crisis or contingency operation, consistent with the FRTP;
- Support the acquisition and implementation into the Fleet of advanced military technology using the NWTRC to conduct training events for new platforms and associated weapons systems (EA-18G Growler aircraft, Guided Missile Submarines [SSGN], P-8 Multimission Maritime Aircraft [MMA], and RDT&E for several types of UASs;

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[3] In this Executive Summary, cross-references are to sections of the EIS/OEIS.

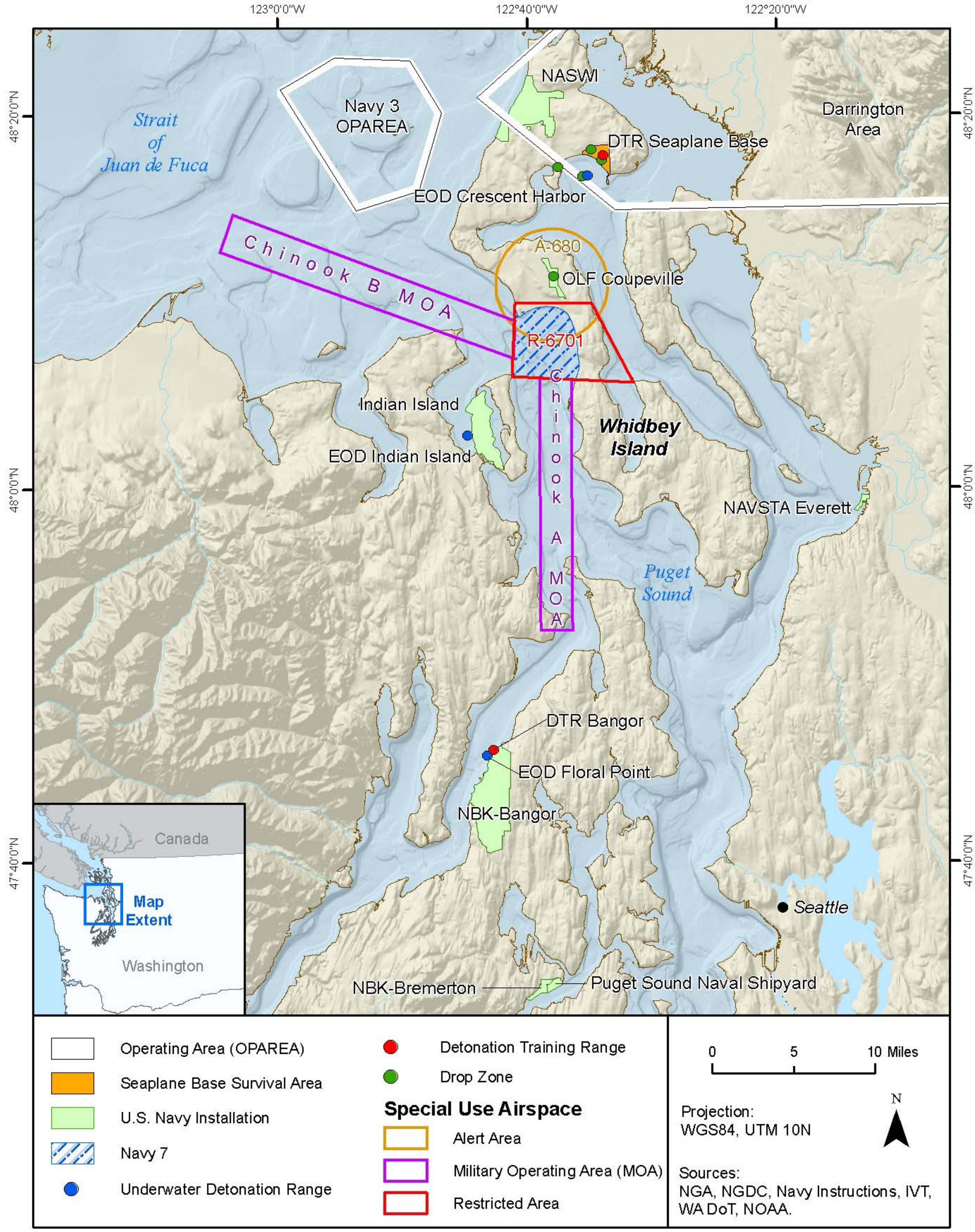

Figure ES-2: Puget Sound Training Areas of the NWTRC

- Identify shortfalls in range capabilities, particularly training infrastructure and instrumentation, and address corrective options through range enhancements; and
- Maintain the long-term viability of the NWTRC as a premiere Navy training and testing area while protecting human health and the environment, and enhancing the quality, capabilities, and safety of the Range Complex.

ES 1.3 SCOPE AND CONTENT OF THE EIS/OEIS

The Navy includes areas of the NWTRC that lie within 12 nm (22 km), or the territorial seas, in its analysis under NEPA [Proclamation No. 5928, 54 C.F.R. 777 (1989)]. Environmental effects in the areas outside of U.S. territorial seas are analyzed under EO 12114 and associated implementing directives. The basis for extending the coverage of EO 12114 inside of 12 nm (22 km) is described in Section 1.5 of this EIS/OEIS. The Navy is the lead agency for the EIS/OEIS; NMFS is a cooperating agency, pursuant to 40 C.F.R. Section 1508.5.

This EIS/OEIS provides an assessment of environmental effects associated with current and proposed training activities, changes in force structure (to include new weapons systems and platforms), and range enhancements in the Range Complex.

The first step in the NEPA process is the preparation of a notice of intent (NOI) to develop the EIS/OEIS. The NOI provides an overview of the Proposed Action, Alternatives, and the scope of the EIS/OEIS. The NOI for this project was published in the *Federal Register* on July 27, 2007, and in seven (7) local newspapers (*Seattle Times, Kitsap Sun, Whidbey News-Times, Peninsula Daily, Daily World, The News Guard, Times-Standard*). The NOI and newspaper notices included information regarding the procedure for submitting comments, a list of information repositories (public libraries), the project website address (http://www.NWTRangecomplexEIS.com), and the dates and locations of the scoping meetings.

Scoping is an early and open process for developing the "scope" of issues to be addressed in the EIS/OEIS and for identifying significant issues related to a Proposed Action. The five scoping meetings for this EIS/OEIS (held in Oak Harbor, WA; Pacific Beach, WA; Grays Harbor, WA; Depoe Bay, OR; and Eureka, CA) helped to define, prioritize, and convey issues and concerns from the public to the Navy. As a result of the scoping process, the Navy received comments from the public (see Appendix F), as well as agencies, special interest groups, and federally recognized Native American Tribes and Nations which have been considered in the preparation of this EIS/OEIS.

Incorporating public input from the scoping process, this EIS/OEIS was prepared to assess the potential effects of the Proposed Action and Alternatives on the human environment. It was then provided to the U.S. EPA for review and comment. A notice of availability was published in the *Federal Register* and notices were placed in the aforementioned newspapers announcing the availability of the EIS/OEIS. The EIS/OEIS is now available for general review and is being circulated for review and comment (available at: Jefferson County Rural Library, P.O. Box 990 620 Cedar Ave, Port Hadlock, WA 98399-0990; Kitsap Regional Library, 1301 Sylvan Way, Bremerton, WA 98310; Oak Harbor Public Library, 1000 SE Regatta Dr., Oak harbor, WA 98277; Timberland Regional Library, 420 7th St., Hoquiam, WA 98550; Port Townsend Public Library, 1220 Lawrence St., Port Townsend, WA 98368-6528; Lincoln City Public Library, 801 SW Highway 101, Lincoln City, OR 97367; and Humboldt County Library, 1313 3rd St., Eureka, CA 95501). Public meetings will be advertised and held in the same geographic locations as the scoping meetings to receive public comments on the EIS/OEIS.

A Final EIS/OEIS will be prepared that responds to all public comments received on the Draft EIS/OEIS. Responses to public comments may take various forms such as, including correction of data, clarifications of and modifications to analytical approaches, and inclusion of additional data or analyses. The Final EIS/OEIS will then be made available for public review.

Finally, a Record of Decision (ROD) will be issued no less than 30 days after the Final EIS/OEIS is made available to the public. The ROD will summarize the Navy's decision and identify the selected alternative, describe the public involvement and agency decision-making processes, and include commitments to specific mitigation measures.

Comments received from the public during the scoping process are categorized and summarized in Table ES-1 below. This summary is not intended to provide a complete listing, but to show the extent of the scope of comments and the variety of parties making comments. A more thorough summary of the public scoping process is presented in Appendix F of this EIS/OEIS.

Table ES-1: Summary of Comments Received During Scoping

Category	Commentator	Comment Summary
Alternatives	Olympic Coast National Marine Sanctuary (OCNMS) Advisory Council Private Citizens Olympic Coast Alliance	Concerns about: • Navy consideration of a broader analysis of alternatives within the OCNMS and outside the Study Area. • Alternatives to clean up Puget Sound. • Alternative that includes reducing training.
Marine Life	Private Citizens California Coastal Commission	Concerns about: • Potential impacts to marine life and habitat from sound, hazardous materials, pollution. • Endangered Species Act (ESA)-listed species.
Airborne Noise	Private Citizens	Concerns about: • Noise from aircraft.
Sonar, Sound in the Water	California Coastal Commission Private Citizens	Concerns about: • Mid- and low-frequency sound sources, ranges, power settings, etc. • Underwater detonations.
Birds and Terrestrial Species	OCNMS Advisory Council California Coastal Commission Environmental Protection Agency (EPA)	Concerns about: • Noise disturbance of nesting or migratory waterfowl, shore birds, or other avian species within the OCNMS. • Bird strike hazards. • Habitat fragmentation from land use.
Cultural Resources	OCNMS Advisory Council EPA, Olympic Coast Alliance	Concerns about: • Damage to cultural and historical resources, interference with tribal fishing and tribal ceremonial harvesting. • Consultation with native tribes.
Economic Impacts	Private Citizens	Concerns about: • Potential impacts to commercial and recreational fishing.

ES 1.3.1 Executive Order (EO) 12114

EO 12114 directs Federal agencies to provide for informed decision-making for major Federal actions outside the U.S. territorial sea. This includes actions within the Exclusive Economic Zone (EEZ) of a foreign nation, but excludes the territorial sea of a foreign nation. For purposes of this EIS/OEIS, areas outside U.S. territorial sea are areas beyond 12 nm (22.2 km) from shore. This EIS/OEIS satisfies the requirements of EO 12114, analysis of training activities or impacts occurring, or proposed to occur, beyond the U.S. territorial sea border of 12 nm.

For the majority of resource sections addressed in this EIS/OEIS, projected impacts outside of U.S. territorial waters would be similar to those within territorial waters. The 12 nm (22 km) distinction is simply a jurisdictional boundary and is not delineated for purposes of scheduling or management of military training activities. In addition, the baseline environment and associated impacts to the various resource areas analyzed in this EIS/OEIS are not substantially different within or outside the 12 nm (22 km) jurisdictional boundary. Therefore, for these resource sections, the impact analyses contained in the main body of the EIS/OEIS is comprehensive and follow both NEPA and EO 12114 guidelines. The description of the affected environment addresses areas both within and beyond U.S. territorial sea.

ES 1.3.2 Coastal Zone

The *Coastal Zone Management Act* (CZMA) of 1972 (16 U.S.C. § 1451) encourages coastal States to be proactive in managing coastal uses and coastal resources in the coastal zone. The CZMA is a voluntary program; participating States submit a Coastal Management Plan (CMP) to the National Oceanographic and Atmospheric Administration (NOAA) for approval. Activities of Federal agencies affecting the coastal zone are consistent to the maximum extent practicable with the enforceable policies of NOAA-approved CMPs. Washington, Oregon, and California participate in the CZMA through approved CMPs. The coastal zone is defined in the CZMA (at 16 U.S.C. § 1453) as extending 3 nm (5.5 km) seaward from the shoreline (i.e., "to the outer limit of State title and ownership under the Submerged Lands Act"). The coastal zone extends inland from the shorelines only to the extent necessary to control the shorelines; however, excluded from the coastal zone are lands the use of which is by law subject solely to the discretion of or which is held in trust by the Federal Government (16 U.S.C. § 1453).

Washington became the first State to achieve a federally-approved State coastal management program in 1976. As defined by the Washington Department of Ecology (DOE) (Washington Administrative Code 173- 18; 20; 22; 27), Washington's coastal zone is comprised of the following fifteen counties: Clallam, Grays Harbor, Island, Jefferson, King, Kitsap, Mason, Pacific, Pierce, San Juan, Skagit, Snohomish, Thurston, Wahkiakum, and Whatcom. Each of these counties is bounded by saltwater, either by the Pacific Ocean, Strait of Juan de Fuca, or Puget Sound. Because the Columbia River contains measurable quantities of salt water upstream to Pillar Rock, Wahkiakum County is included as a coastal zone county. The coastal zone includes all non-federal lands and waters from the coastline seaward for 3 nm (5.5 km). For the areas that abut the ocean, the coastline is defined as the position of ordinary low water. The coastline along the inland marine waters is located at the seaward limit of rivers, bays, estuaries, or sound (Washington State Department of Ecology 2001).

The Oregon Coastal Management Program (OCMP) was federally-approved in 1977 (Oregon Revised Statutes 197.628- 197.650; Oregon Administrative Rules Chapter 660). The Oregon Department of Land Conservation and Development (DLCD) is the State's designated coastal management agency and is responsible for reviewing projects for consistency with the OCMP and issuing coastal management decisions. DLCD's reviews involve consultation with local governments, State agencies, Federal agencies, and other interested parties in determining project consistency with the OCMP.

As defined by the OCMP, Oregon's coastal zone extends from the Washington border on the north to the California border on the south, seaward to the extent of State jurisdiction as recognized by Federal law (the Territorial Sea, extending 3 nm [5.5 km] offshore), and inland to the crest of the coastal mountain range. There are three exceptions where the coastal boundary is different. These are where the basins of the Columbia, Umpqua, and Rogue Rivers lie predominantly inland of the crest of the coastal mountains.

In these cases the coastal zone boundary crosses these rivers and extends to Bradwood, Scottsburg, and Agness, respectively.

Per the CZMA, Federal agencies are required to comply with the State of Oregon's "mandatory enforceable policies," including goal requirements, various State authorities, and local comprehensive plan and zoning ordinance requirements. The enforceable policies of the OCMP include the following:

- Oregon's 19 Statewide Planning Goals. Goal 19-Ocean Resources is the primary goal that is applicable to the proposed action (Oregon Administrative Rule [OAR] 660-015-0014[4]). Other goals potentially applicable to the proposed action include: Goal 16-Estuarine Resources (OAR 660-015-010[1]), Goal 17-Coastal Shorelands (OAR 660-015-010[2]), and Goal 18-Beaches and Dunes (OAR 660-015-010[3]).
- Land use plans by cities and counties approved by DLCD. Most are not likely to be applicable to the proposed action based on lack of land-based activities in Oregon's coastal zone. DLCD consults with local government during the Federal Consistency Review process.
- State laws such as Oregon Beach Bill and Removal/Fill Law. Most are not likely to be applicable to the proposed action based on lack of land-based activities in Oregon's coastal zone.
- Oregon Territorial Sea Plan (1987 c.576 §6; 1991 c.501 §2; 2003 c.744 §1).

The California Coastal Act (CCA) of 1976 (California Public Resources Code, § 30000 et seq.) implements California's CZMA program. The CCA includes policies to protect and expand public access to shorelines, and to protect, enhance and restore environmentally sensitive habitats including intertidal and nearshore waters, wetlands, bays and estuaries, riparian habitat, certain wood and grasslands, streams, lakes, and habitat for rare or endangered plants or animals.

Coastal zones that fall under the CCA include that land and water area of the State of California from the Oregon border to the border of the Republic of Mexico, extending seaward to the State's outer limit of jurisdiction (out to 3 nm [5.5 km]), including all offshore islands, and extending inland generally 1,000 yards from the mean high tide line of the sea. In significant coastal estuarine, habitat, and recreational areas it extends inland to the first major ridgeline paralleling the sea or five miles from the mean high tide line of the sea, whichever is less, and in developed urban areas the zone generally extends inland less than 1,000 yards.

For the activities covered in this EIS/OEIS, the Navy will initiate the Federal consistency process under the CZMA with the States of Washington, Oregon, and California. For the State of Washington, the Navy has determined that its Proposed Action may have coastal effects but is consistent, to the maximum extent practicable, with the States' enforceable policies, and accordingly will submit its consistency determination to the States in due course. For the States of Oregon and California, the Navy has determined that its Proposed Action will have no coastal effects. The coastal consistency determination process, by law, requires the States to afford public comment and involvement on Federal consistency determinations.

ES 1.3.3 Other Environmental Requirements Considered

The Navy must comply with a variety of other Federal environmental laws, regulations, and EOs. These include (among other applicable laws and regulations):

- Marine Mammal Protection Act (MMPA);
- Endangered Species Act (ESA);
- Migratory Bird Treaty Act (MBTA);

- Federal Bald and Golden Eagle Protection Act of 1940
- Rivers and Harbors Act (RHA);
- Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) for Essential Fish Habitat (EFH);
- Clean Air Act (CAA);
- National Marine Sanctuaries Act (NMSA);
- Federal Water Pollution Control Act (Clean Water Act);
- National Historic Preservation Act (NHPA);
- EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations; and
- EO 13045, Environmental Health and Safety Risks to Children.

In addition, laws and regulations of the States of Washington, Oregon, and California appropriate to Navy actions are identified and addressed in this EIS/OEIS. This EIS/OEIS will facilitate compliance with applicable, appropriate State laws and regulations.

ES 1.4 PROPOSED ACTION AND ALTERNATIVES

ES 1.4.1 Alternatives Development

NEPA implementing regulations provide guidance on the consideration of alternatives in an EIS. These regulations require the decision-maker to consider the environmental effects of the Proposed Action and a range of alternatives to the Proposed Action (40 C.F.R. § 1502.14). The range of alternatives includes reasonable alternatives, which must be rigorously and objectively explored, as well as other alternatives that are eliminated from detailed study. To be “reasonable,” an alternative must meet the stated purpose of and need for the Proposed Action.

The purpose of including a No Action Alternative in environmental impact analyses is to ensure that agencies compare the potential impacts of the proposed Federal action to the known impacts of maintaining the status quo. The current level of range management activity is used as a benchmark. By using the status quo as the No Action Alternative here, the Navy compares the impacts of the original proposal and preferred alternative to the impacts of continuing to operate, maintain, and use the NWTRC in the same manner and at the same levels as for current activities.

For the purposes of this EIS, the No Action Alternative serves as the baseline level of activities on the NWTRC, representing the regular and historical level of training and testing activity necessary to maintain Navy readiness. Consequently, the No Action Alternative stands as no change from current levels of training and testing usage. This interpretation of the No Action Alternative is consistent with guidance provided by CEQ (40 Questions #3), which indicates that where ongoing programs continue, even as new plans are developed, "no action" is "no change" from current management direction or level of management intensity. The potential impacts of the current level of training and RDT&E activity on the NWTRC (defined by the No Action Alternative) are compared to the potential impacts of activities proposed under Alternative 1 and Alternative 2.

Alternatives considered in this EIS/OEIS were developed by the Navy after careful assessment by subject matter experts, including units and commands that utilize the ranges, range management professionals, and Navy environmental managers and scientists. The Navy has developed a set of criteria for use in assessing whether a possible alternative meets the purpose of and need for the Proposed Action. Each of these criteria assumes implementation of mitigation measures for the protection of natural resources as appropriate. Any alternative considered for future analysis should support or employ the following criteria:

1. All requirements of the FRTP as they apply to training conducted in the NWTRC;
2. Achievement of training requirements based on Fleet deployment schedules;
3. Joint training events;
4. Basic and Intermediate-level training[4] of Navy forces in a training environment that replicates the dynamic nature of modern naval warfare;
5. Training requirements of formal military schools located at Navy installations throughout the Pacific Northwest (PACNW) region;
6. Navy RDT&E activities associated with unmanned aerial systems (UASs);
7. Allied military training activities;
8. Alignment of the NWTRC infrastructure with Naval Force structure, including training with new weapons, systems, and platforms (vessels and aircraft) as they are introduced into the Fleet;
9. Sustainable range management practices that protect and conserve natural and cultural resources; and
10. Preservation of access to training areas for current and future training requirements, while addressing potential encroachments that threaten to impact range capabilities.

NEPA regulations require that the Federal action proponent study means to mitigate adverse environmental impacts by virtue of going forward with the Proposed Action or an alternative (40 C.F.R. § 1502.16). Additionally, an EIS is to include study of appropriate mitigation measures not already included in the Proposed Action or alternatives (40 C.F.R. § 1502.14 [h]). Each of the alternatives, including the Proposed Action considered in this EIS/OEIS, includes protective measures intended to reduce the environmental effects of Navy activities. Protective measures, such as current requirements and practices are discussed throughout this EIS/OEIS.

ES 1.4.2 Alternatives Considered

Three alternatives are analyzed in this EIS/OEIS: 1) The No Action Alternative – Current Level of Activities; 2) Alternative 1 – Increase Training Activities and Accommodate Force Structure Changes; and 3) Alternative 2 – Increase Training Activities, Accommodate Force Structure Changes, and Implement Range Enhancements. Alternative 2 is the Preferred Alternative

The purpose of the Proposed Action is to achieve and maintain Fleet readiness using the NWTRC to support current and future training activities. The Navy proposes to:

1) Conduct training and RDT&E (UASs only) activities of the same types, and at the same levels of training intensity as currently conducted, without change in the nature or scope of military activities in the EIS/OEIS Study Area;

2) Increase training activities from current levels as necessary in support of the FRTP;

3) Accommodate force structure changes (new platforms and weapons systems); and

[4] Training doctrine and procedures are based on operational requirements for deployment of naval forces. Training proceeds on a continuum, from teaching basic and specialized individual military skills, to intermediate skills or small unit training, to advanced, integrated training events, culminating in multi-service (Joint) exercises or pre-deployment certification events.

4) Implement range enhancements associated with the NWTRC.

The components that make up the Proposed Action are discussed in the following sections.

ES 1.4.3 No Action-Current Training Activities within the NWTRC

The Navy has been operating in the NWTRC since the early 1900's. Under the No Action Alternative, training activities and major range events would continue at current levels. The NWTRC would not accommodate an increase in training activities required to execute the FRTP or implement proposed force structure changes, nor would it implement range enhancements as necessary by the Navy. Evaluation of the No Action Alternative in this EIS/OEIS provides a baseline for assessing environmental impacts of Alternative 1 and Alternative 2 (Preferred Alternative).

Training activities currently conducted in the NWTRC are described in detail in Chapter 2 of this EIS/OEIS, including a description of each type of event, the number of events conducted or proposed to be conducted, and the location within the Range Complex where the events occur. Each military training activity described in this EIS/OEIS meets a requirement that can be ultimately traced to requirements from the National Command Authority[5]. Training activities in the NWTRC vary from basic individual or unit level training events of relatively short duration involving few participants to integrated training activities, which may involve hundreds of participants over several days.

Over the years, the tempo and type of activities have fluctuated within the NWTRC due to changing requirements, the dynamic nature of international events, the introduction of advances in warfighting doctrine and procedures, and force structure changes. Such developments have influenced the tempo, duration, intensity, and location of required training. The factors influencing tempo and types of activities are fluid in nature and will continue to cause fluctuations in training activities within the NWTRC. Accordingly, training activity data used throughout this EIS/OEIS are a representative baseline for evaluating impacts that may result from the proposed training activities.

With reference to criteria identified above in ES 1.4.1, the No Action Alternative supports criteria 3, 6, 7, and 9, while only partially satisfying criteria 1 and 5. The No Action Alternative does not support criteria 2, 4, 8, and 10.

ES 1.4.4 Alternative 1: Increase Training Activities and Accommodate Force Structure Changes

Alternative 1 is a proposal designed to meet Navy and Department of Defense (DoD) current and near-term operational training requirements. If Alternative 1 were to be selected, in addition to accommodating training activities currently conducted, the NWTRC would support an increase in most training activities to include force structure changes associated with the introduction of new weapon systems, vessels, and aircraft into the Fleet. Under Alternative 1, most baseline-training activities would be increased. In addition, training activities associated with force structure changes would be implemented for the EA-18G Growler, Guided Missile Submarine (SSGN), P-8 Multimission Maritime Aircraft (MMA), and unmanned aerial systems (UASs). Force structure changes associated with new weapons systems would include new air-to-air missiles, and new sonobuoys.

[5] National Command Authority (NCA) is a term used by the United States military and government to refer to the ultimate lawful source of military orders. The term refers collectively to the President of the United States (as Commander-in-Chief) and the United States Secretary of Defense.

While Alternative 1 would meet the Navy's purpose and need, it does not meet established Navy minimum range capability requirements nor does it optimize the training capabilities of the Range Complex. With reference to the criteria identified in ES 1.4.1, Alternative 1 supports criteria 3 and 6-9, while only partially satisfying criteria 1, 2, and 5. Alternative 1 does not support criteria 4 and 10.

ES 1.4.5 Alternative 2: Increase Training Activities, Accommodate Force Structure Changes, and Implement Range Enhancements (Preferred Alternative)

Implementation of Alternative 2 would include all elements of Alternative 1 (accommodating training activities currently conducted, increasing training activities, and accommodating force structure changes). In addition, under Alternative 2:

- Training activities of the types currently conducted would be increased over levels identified in Alternative 1;
- Range enhancements would be implemented, to include new electronic combat threat simulators/targets, development of a small scale underwater training minefield, development of a Portable Undersea Tracking Range (PUTR), and development of air and surface target services.

Alternative 2 is the preferred alternative, because it would optimize the training capability of the NWTRC and meet Navy minimum required capabilities as documented in the Navy Ranges Required Capabilities Document (RCD) of September 8, 2005. Alternative 2 fully meets the criteria identified in ES 1.4.1.

ES 1.5 SUMMARY OF EFFECTS ANALYSIS

Chapter 3 of the EIS/OEIS describes existing environmental conditions for resources potentially affected by the Proposed Action and Alternatives described in Chapter 2. This chapter also identifies and assesses the environmental consequences of the Proposed Action and Alternatives. The affected environment and environmental consequences are described and analyzed according to categories of resources. The categories of resources addressed in this EIS/OEIS and the location of the respective analyses are identified in the Table ES-2:

Table ES-2: Categories of Resources Addressed, and EIS/OEIS Chapter 3 Analysis Guide

Geology and Soils (3.1)	Air Quality (3.2)
Hazardous Materials (3.3)	Water Resources (3.4)
Acoustic Environment – Airborne Sound (3.5)	Marine Plants & Invertebrates (3.6)
Fish (3.7)	Sea Turtles (3.8)
Marine Mammals (3.9)	Birds (3.10)
Terrestrial Biological Resources (3.11)	Cultural Resources (3.12)
Traffic (3.13)	Socioeconomics (3.14)
Environmental Justice & Protection of Children (3.15)	Public Safety (3.16)

In the environmental impact analysis process, the resources analyzed are identified and the expected geographic scope of potential impacts for each resource, known as the resource's region of influence (ROI), is defined. The discussion and analysis, organized by resource area, covers the Offshore Area and the Inshore Area of the NWTRC, to the extent affected resources or potential impacts are present.

Analysis of potential impacts of Navy activities on marine mammals is particularly complex. Therefore, the Navy has provided a comprehensive discussion of the approach to and results of the impacts analysis relating to marine mammals in Section 3.9 Marine Mammals and Appendix D Marine Mammal Modeling.

ES 1.5.1 Geology and Soils

ES 1.5.1.1 Offshore Area

Marine water and sediment quality of the Offshore Area are discussed in ES Section 1.5.4. There is no analysis in Geology and Soils for the Offshore Area.

ES 1.5.1.2 Inshore Area

The most likely sources of impacts to soils under all alternatives arise from explosions, the by-products of exploded materials, and the movement of personnel and equipment. However, impacts from these activities under the Proposed Actions would be negligible. Therefore, no significant impacts would occur. Explosions are limited to land Demolition Training Ranges (DTRs), which are specifically designed to contain the debris from the explosions. As such, the amount of potentially hazardous by-products from such explosions is small and quickly evaporates or dissipates. Also, soils outside the DTRs are not disturbed, thus preventing soil run-off and erosion. Personnel and equipment movements are infrequent, the numbers of explosions and the net explosive weights involved are small, and the locations dispersed. A summary of impacts is provided in Table ES-3.

Table ES-3: Summary of Effects – Geology and Soils

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Activities would have temporary and spatially limited short-term impacts. • No significant impacts would occur.	• Not Applicable.
Alternative 1	• Impacts generally the same as No Action Alternative. • No significant impacts would occur.	• Not Applicable.
Alternative 2 (Preferred Alternative)	• Impacts generally the same as No Action Alternative. • No significant impacts would occur.	• Not Applicable.

ES 1.5.2 Air Quality

The EIS Study Area encompasses the Pacific Northwest Ocean surface and subsurface ocean operating area (PACNW OPAREA), over-ocean military airspace, the Darrington Area located within the Puget Sound, and onshore military operating areas (Okanogan, Roosevelt, and Olympic MOAs). The EIS Study Area includes areas that are under the jurisdiction of the Washington Department of Ecology (onshore MOAs and the Darrington Area). Coastal waters within 3 nautical miles (nm) (5.5 kilometers [km]) of a shoreline are part of the same air quality jurisdiction as the contiguous land area. Therefore, the waters within 3 nm (5.5 km) of the State of Washington are within the jurisdiction of the WDOE; the waters within 3 nm (5.5 km) of the State of Oregon are within the jurisdiction of the ODEQ, and the waters within 3 nm (5.5 km) of the State of California are within the jurisdiction of the CARB and the North Coast Unified Air Quality Management District. Portions of the OPAREAS that lie outside coastal waters and beyond 3 nm (5.5 km) of a coastline are not within any air quality jurisdiction.

ES 1.5.2.1 Offshore Area

Although the Offshore Area includes the coastal waters within 3 nm of the shoreline, air quality impacts for this area, as well as those onshore, will be discussed as Inshore Area impacts in the following section. Outside U.S. Territory, emission increases are mainly associated with increased surface vessel activities, with additional contributions from aircraft activities. Although Alternative 1 and Alternative 2 would result in increases in emissions of air pollutants above the No Action Alternative, associated emissions would not exceed air quality standards within U.S. Territory; therefore, no significant impacts would occur

ES 1.5.2.2 Inshore Area

As shown in Table ES-4 emissions associated with implementation of Alternatives 1 and 2 would result in increases in air emissions above baseline (No Action Alternative) conditions. Within U.S. Territory, emission increases are mainly associated with increased activities of aircraft, surface vessels, and ordnance use. In conclusion, although Alternatives 1 and 2 would result in increases in emissions of air pollutants, it is not anticipated that emissions would exceed air quality standards, as discussed in Section 3.2; therefore, no significant impacts would occur.

Table ES-4: Summary of Effects – Air Quality

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• The No Action Alternative involves maintaining activities at the baseline levels. Emissions for the No Action Alternative reflect baseline levels that are currently occurring. There is no increase in emissions above the baseline within U.S. Territory under the No Action Alternative. • No significant impacts would occur.	• The No Action Alternative involves maintaining activities at the baseline levels. Emissions for the No Action Alternative reflect baseline levels that are currently occurring. There is no increase in emissions above the baseline outside the U.S. Territory under the No Action Alternative. • No significant harm to air quality would occur.
Alternative 1	• Within U.S. Territory, emission increases are associated with increased marine vessel activities, aircraft activities, ground vehicles, and ordnance use. • Emission increases over baseline for Alternative 1 would result from increased activities. Emission increases would not be considered major and would not result in a significant impact on the air quality. Under Alternative 1, emissions within U.S. Territory would exceed air quality standards. • No significant impacts would occur.	• Outside U.S. Territory, emission increases are mainly associated with increased surface vessel activities, with additional contributions from aircraft activities. • Although Alternative 1 would result in increases in emissions of air pollutants over the No Action Alternative, emissions outside U.S. territorial waters would not be expected to adversely affect offshore air quality and emissions would not exceed air quality standards within U.S. Territory. • No significant harm to air quality would occur.
Alternative 2 (Preferred Alternative)	• Impacts generally the same as Alternative 1. • No significant impacts would occur.	• Impacts generally the same as Alternative 1. • No significant harm to air quality would occur.

ES 1.5.3 Hazardous Materials

ES 1.5.3.1 Offshore Area

Due to the increased number of training activities, the overall amount of hazardous materials used and generated during training under Alternatives 1 and 2 would be more than that used and generated under the No Action Alternative.

All hazardous materials would continue to be managed in compliance with applicable federal and state regulations, and DoD guidelines. No substantial changes in hazardous materials management practices are anticipated under any of the alternatives. The anticipated amounts of hazardous materials generated are well within the capacity of the Navy's afloat and ashore hazardous waste management systems.

Expended materials include the nonreactive materials that are not recovered following their use in a training activity. While these items represent persistent seabed litter, their strong resistance to degradation and their chemical composition mean that they do not chemically contaminate the surrounding environment by leaching heavy metals or organic compounds. Expended material that sinks to the sea floor would gradually degrade, be overgrown by marine life, or incorporated into the sediments. Floating nonhazardous expended material may be lost from targets and would either degrade over time or wash ashore as flotsam.

As summarized in Table ES-5, no significant harm to resources would occur under the No Action Alternative, Alternative 1, and Alternative 2 (the Preferred Alternative). Expended materials would be deposited in offshore areas or become buried in the sea floor sediments, and would have no substantial environmental effects. The overall volume of expended training items would increase in Alternative 1 and Alternative 2, the Preferred Alternative, in correlation to changes in training activities.

ES 1.5.3.2 Inshore Area

Activities involving expended hazardous materials include land demolition training conducted at DTR Seaplane Base and DTR Bangor, and underwater detonation training at EOD Crescent Harbor, EOD Floral Point, and EOD Indian Island. In the case of the land demolition training, the facilities for detonating explosives at these locations previously have been cleared of vegetation and combustible materials (i.e., disturbed). EOD training would not occur outside of the DTRs. The majority of blast debris is contained by the structure walls. All of the byproducts of detonations will dissipate or evaporate in the open air and would not be considered hazardous under those circumstances; therefore, no significant impacts would occur.

For underwater detonation training, high-order detonations result in almost complete conversion of explosives (99.997 percent). The majority of these byproducts (water, carbon dioxide, hydrogen, carbon monoxide, nitrogen, and ammonia), which represent 98 percent of all byproducts produced, are commonly found in seawater. The remaining byproducts are either gases or liquids that will dissipate, evaporate, or dilute to undetectable or insignificant levels, or they react with constituents of salt water in the existing currents to form harmless substances; therefore, no significant impacts would occur.

Table ES-5: Summary of Effects – Hazardous Material

Alternative and Stressor	Summary of Effects and Impact Conclusion	
	NEPA (Territorial Waters, 0 to 12 nm)	Executive Order 12114 (Non-territorial Waters, >12 nm)
No Action		
Expended Materials	• Long-term, minor, and localized accumulation of expended materials on the ocean floor. • No significant impacts would occur.	• Long-term, minor, and localized accumulation of expended materials on the ocean floor. • No significant harm to resources from hazardous materials would occur.
Hazardous Material Contamination	• No significant impacts would occur.	• No significant harm to resources from hazardous materials would occur.
Alternative 1		
Expended Materials	• Increase in expended materials compared to No Action. Long-term, minor, and localized accumulation of expended materials on the ocean floor. Most materials inert. • No significant impacts would occur.	• Increase in expended materials compared to No Action Alternative. Long-term, minor, and localized accumulation of expended materials on the ocean floor. Most materials inert. • No significant harm to resources from hazardous materials would occur.
Hazardous Material Contamination	• No significant impacts would occur.	• No significant harm to resources from hazardous materials would occur.
Alternative 2 (Preferred Alternative)		
Expended Materials	• Increase in expended materials compared to No Action. Long-term, minor, and localized accumulation of expended materials on the ocean floor. Most materials inert. • No significant impacts would occur.	• Increase in expended materials compared to No Action. Long-term, minor, and localized accumulation of expended materials on the ocean floor. Most materials inert. • No significant harm to resources from hazardous materials would occur.
Hazardous Material Contamination	• No significant impacts would occur.	• No significant harm to resources from hazardous materials would occur.

ES 1.5.4 Water Resources

In the Study Area, water bodies that could be affected by the Proposed Action include:

- marine waters off the coasts of Washington, Oregon, and northern California, the Strait of Juan de Fuca, coastal waters, and estuaries;
- northern portions of Puget Sound;
- freshwater streams, lakes, ponds and wetlands; and
- man-made impoundments, ditches, and storage facilities.

Activities under the Proposed Action that may affect water resources are those materials expended during training that may affect water and sediment quality, such as petroleum products, heavy metals, and combustion byproducts. Factors considered in evaluating impacts on marine water and sediment quality include the extent or degree to which:

- deposition of expended training materials would directly affect bottom sediment quality or indirectly affect water quality;

- concentrations of potentially hazardous materials produced by the Proposed Action or alternatives that exceed established standards or violate existing laws or regulations; or
- the alternative would affect existing or future beneficial uses of existing water resources.

ES 1.5.4.1 Offshore Area

Under the Proposed Action, a total of 191,102 items would be expended. Assuming an even distribution of these items within the PACNW OPAREA, the concentration of expended items would be less than 1.6 per nm^2 (0.46 per km^2). More than 60 percent of these materials would be small caliber rounds. Many of these items are inert, would settle to the sea bottom and become encrusted by chemical processes and marine organisms, and pose no hazard to ocean water resources. The number of vessel sinkings would also increase from one to two compared to the No Action Alternative. No significant harm to water resources would occur as a result of this level of deposition in the Offshore Area.

ES 1.5.4.2 Inshore Area

Under all alternatives, activities in nearshore habitats in Puget Sound would occur during mine countermeasure training at EOD Crescent Harbor, EOD Floral Point, and EOD Indian Island. Due to force structure changes that involve the move of EOD personnel out of the NWTRC, mine countermeasure training under Alternatives 1 and 2, underwater detonations would be reduced to four per year with a maximum charge size of 2.5 lb. Impacts from this level of activity would be negligible because of relatively low level of activity and standard site investigation and clean up procedures. The vast majority—98 percent—of explosion byproducts are normal constituents of seawater. Turbidity resulting from detonation would dissipate rather quickly depending on the site conditions at the time, such as wind speed and tidal currents.

None of the Proposed Action Alternatives would have long-term or significant impacts on marine or fresh water resources in the Study Area. Short-term effects on water quality would be related to ordnance use and expended materials, and would not be anticipated to be measurable given the large area over which activities occur and the dynamic nature of the marine environment of Puget Sound. Most residual materials that settle to the seafloor after their use in training activities will slowly dissolve and become diluted by ongoing ocean and tidal currents. Other materials are coated with plastic, which reduces corrosion and provides an effective barrier to water exchange. Given the mobility characteristics of the soluble constituents, and the plastic coatings of others components, there is low potential for substantial accumulation of constituents in sediments. Therefore, no significant impacts on water resources would occur in the Inshore Area. Table ES-6 summarizes the effects of the alternatives.

Table ES-6: Summary of Effects – Water Resources

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Releases of constituents from explosives and ordnance used during training exercises have no substantial impacts. • No long-term degradation of marine, surface, or ground water quality. • No significant impacts would occur.	• Constituents and other materials (batteries, fuel, and propellant) from training devices have minimal effect; are below standards; or result in local, short-term impacts. • No long-term degradation of marine water quality. • No significant harm to water resources would occur.

Table ES-6: Summary of Effects – Water Resources (continued)

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
Alternative 1	• Constituents (explosives, ordnance) from training devices and training exercises would have little effect or result in short-term impacts. • No long-term degradation of marine, surface, or ground water quality. • No significant impacts would occur.	• Constituents and materials (batteries, fuel, and propellant) from training devices would have minimal effect; would be below standards; or would result in local, short-term impacts. • No long-term degradation of marine water quality. • No significant harm to water resources would occur
Alternative 2 (Preferred Alternative)	• Impacts to Alternative 2 would be substantially the same as Alternative 1. • No significant impacts would occur.	• Impacts to Alternative 2 would be substantially the same as Alternative 1. • No significant harm to water resources would occur.

ES 1.5.5 Acoustic Environment – Airborne

Significant noise sources of the Proposed Action include aircraft activities and ordnance use.

ES 1.5.5.1 Offshore Area

Under the Proposed Action, the majority of Navy training and testing activities would increase, as discussed in Chapter 2. Activities that include or could include aircraft make up a large portion of Alternative 2 activities. Although a small proportion of flights and ordnance use would be inshore, many of these air activities take place far out to sea over the Pacific Ocean, out of range of human receptors. These activities will not result in significant harm resources from airborne noise.

ES 1.5.5.2 Inshore Area

Under the Proposed Action, approximately 109 annual aircraft activities would involve helicopters at low-altitude flight, typically between Naval Air Station Whidbey Island (NASWI), Crescent Harbor Seaplane Base, and OLF Coupeville. The Proposed Action also includes approximately 112 unmanned aerial system (UAS) aircraft activities, usually in the vicinity of R-6701 (see Figure ES-2). Finally, on land and underwater detonations will occur as a result of EOD training near Crescent Harbor, Naval Base Kitsap-Bangor, and Indian Island.

Airborne noise level impacts currently generated by the No-Action Alternative are less than significant and those proposed under Alternatives 1 and 2 would not result in significant impacts for the following reasons:

- Noise from training activities in the PACNW OPAREA would be dispersed and intermittent, which would not contribute substantially to long-term noise levels, and few or no sensitive receptors (non-participants) would be exposed to these noise events.
- Noise from aircraft training activities over-land in MOAs would typically take place at high altitude and over relatively lower populated areas. Few sensitive receptors (non-participants) would be exposed to these noise events.

- Noise associated with EOD on or near shore would take place in areas currently used for EOD training. Underwater explosives are not likely to impact the airborne noise environment.
- Noise would be generated in training areas that have been in similar use for more than 50 years, so no new public areas would be exposed to noise from training and testing activities.
- The incremental increases in the numbers of range events would not substantially increase long-term average noise levels; hourly average equivalent noise levels are, and would remain, relatively low.

Table ES-7 summarizes the airborne noise effects for the No Action, Alternative 1, and Alternative 2.

Table ES-7: Summary of Effects – Airborne Noise

Alternative and Stressor	Summary of Airborne Noise Effects	
	NEPA (On Land and Territorial Waters out to 12 nm)	Executive Order 12114 (Non-Territorial Waters, >12 nm)
No Action		
Surface ship noise	• Minor localized engine noise. Few to no sensitive receptors present.	• Minor at-sea noise. Few to no sensitive receptors present.
Aircraft noise	• Short-term noise impacts during transits to and from range areas.	• Short-term noise impacts, including sonic booms. Few to no sensitive receptors present.
Weapon and target noise	• Very short-term noise impacts. Few to no sensitive receptors present.	• Very short-term noise impacts. Few to no sensitive receptors present.
EOD	• Short-term minor noise impacts from on or near shore EOD activities which would occur infrequently. Underwater EOD would have no airborne noise effects.	• There are no EOD activities in non-territorial waters.
Summary	• No significant impacts would occur.	• No significant harm to resources from airborne noise would occur.
Alternative 1		
Surface ship noise	• Minor localized engine noise. Few to no sensitive receptors present.	• Minor at-sea noise. Few to no sensitive receptors present.
Aircraft noise	• Short-term noise impacts during transits to and from range areas.	• Short-term noise impacts, including sonic booms. Few to no sensitive receptors present.
Weapon and target noise	• Very short-term noise impacts. Few to no sensitive receptors present.	• Very short-term noise impacts. Few to no sensitive receptors present.
EOD	• Short-term minor noise impacts from on or near shore EOD activities which would occur infrequently. Underwater EOD would have no airborne noise effects.	• There are no EOD activities in non-territorial waters.
Summary	• No significant impacts would occur.	• No significant harm to resources from airborne noise would occur.

Table ES-7: Summary of Effects – Airborne Noise (continued)

Alternative and Stressor	Summary of Airborne Noise Effects	
	NEPA (On Land and Territorial Waters out to 12 nm)	Executive Order 12114 (Non-Territorial Waters, >12 nm)
Alternative 2 (Preferred Alternative)		
Surface ship noise	• Minor localized engine noise. Few to no sensitive receptors present.	• Minor at-sea noise. Few to no sensitive receptors present.
Aircraft noise	• Short-term noise impacts during transits to and from range areas.	• Short-term noise impacts, including sonic booms. Few to no sensitive receptors present.
Weapon and target noise	• Very short-term noise impacts. Few to no sensitive receptors present.	• Very short-term noise impacts. Few to no sensitive receptors present.
EOD	• Short-term minor noise impacts from on or near shore EOD activities which would occur infrequently. Underwater EOD would have no airborne noise effects.	• There are no EOD activities in non-territorial waters.
Summary	• No significant impacts would occur.	• No significant harm to resources from airborne noise would occur.

ES 1.5.6 Marine Plants and Invertebrates

Activities that may affect marine communities include materials expended during training and explosions.

ES 1.5.6.1 Offshore Area

Expended Materials

The effect of materials expended during training on open ocean communities in the Study Area is assessed by the number of expended items per unit area. Of approximately 190,000 items expended under Alternative 2 (the preferred alternative), more than 60 percent are small caliber gunnery rounds, all seven to 15 centimeters in size (smaller if broken apart during water or target impact). The remaining 40 percent include items ranging from 5 inch gun rounds to 2,000-lb bombs. Spread out over the entire Offshore Area, the annual level of expended materials in the NWTRC amounts to less than four items per square nautical mile for the No Action Alternative, less than five items for Alternative 1, and less than eight items for Alternative 2. Due to the widespread and sparse distribution of expended materials, no significant harm to marine plants and invertebrates are anticipated for the Proposed Action.

Explosions

The underwater explosions analyzed in the Proposed Action have the potential to kill or harm individual animals and plants in the immediate area of the explosion. The shock waves from such explosions attenuate quickly (see Section 3.6.2). Their distribution also tends to be patchy rather than uniform. In situations where an explosion occurred in an area with a high concentration of individuals, the extent of death or harm would be substantially greater than in a more barren area.

Because the explosions in the Offshore Area take place at or near the surface, the impacts are not expected to reach the deep benthic habitats (seafloor greater than 200 meters), therefore no significant harm to marine plans and invertebrates are expected. See discussion in Section 3.6.2.

ES 1.5.6.2 Inshore Area

Expended Materials

The only expended materials in the Inshore Area are from underwater detonations in which small pieces of simulated mine targets may separate from the target. Following underwater detonation training, EOD personnel retrieve larger pieces. The nonhazardous material that is not recovered settles to the seafloor and eventually becomes covered by sediment. No significant impacts would occur.

Explosions

In nearshore habitats, underwater explosions take place in designated training areas both near the water's surface and near the bottom. Under all alternatives, the only activities in the Inshore Area that involve explosions and impacts would occur at EOD Crescent Harbor, EOD Floral Point, and EOD Indian Island. Under both Alternative 1 and Alternative 2, the number of underwater detonations would decrease significantly from the No Action Alternative (from 60 to 4 annual detonations). Because eelgrass and kelp beds do not occur within the underwater detonation training areas, Alternatives 1 and 2 would not result in any adverse effects on these plants and the communities they support. Explosions at or near the surface or the bottom could harm invertebrates. The degree of harm, including death, would depend on the organism's proximity to the explosion. Given the generally disturbed nature of the training sites, the large decrease in the number of exercises and detonations, and the small area in which the exercises are concentrated, impacts would be negligible.

Because of these factors and the very low number of detonations that would be associated with the Proposed Action, no significant impacts would occur. Table ES-8 summarizes potential effects.

Table ES-8: Summary of Effects – Marine Plants and Invertebrates

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Releases of munitions constituents from explosives and ordnance used during training exercises have no substantial impacts. • No significant impacts would occur.	• Munitions constituents and other materials from training activities have minimal effects. • No significant harm to marine plants and invertebrates would occur.
Alternative 1	• Minimal impacts reduced further due to significant reduction in Inshore underwater detonations. • No significant impacts would occur.	• Minimal impacts reduced further due to significant reduction in Inshore underwater detonations. • No significant harm to marine plants and invertebrates would occur.
Alternative 2 (Preferred Alternative)	• Minimal impacts reduced further due to significant reduction in Inshore underwater detonations. • No significant impacts would occur.	• Minimal impacts reduced further due to significant reduction in Inshore underwater detonations. • No significant harm to marine plants and invertebrates would occur.

ES 1.5.7 Fish

ES 1.5.7.1 Offshore Area

Relatively small numbers of fish would be killed by shock waves from inert bombs, and intact missiles and targets hitting the water surface. These and several other types of activities common to many exercises or tests have minimal effects on fish: aircraft, missile, and target overflights; muzzle blast from

5 inch naval guns, release of munitions constituents, falling debris, and small arms rounds. Underwater explosions may result in disturbance, injury, or mortality to ESA-listed salmonid species, but any negative effect is considered unlikely, therefore the Proposed Action may affect, but is not likely to adversely affect ESA-listed salmonid species. However, no significant harm to fish populations or habitat would occur as a result of implementation of any of the alternatives.

Because only a few species of fish may be able to hear the relatively higher frequencies of mid-frequency sonar, effects of sonar used during Navy exercises on fish are minimal (see Section 3.7). The Proposed Action does not include the use of low-frequency sonar. Table ES-9 summarizes impacts to fish species and fish habitat.

ES 1.5.7.2 Inshore Area

The only stressor to fish in the Inshore Area results from underwater detonations, which are limited to a three specific training areas; Crescent Harbor Underwater EOD range, Floral Point Underwater EOD Range, and Indian Island Underwater EOD Range.

As discussed in Section 3.7.1.4, there are several species of ESA-designated salmonids with known or potential occurrence in the NWTRC. As part of the EIS/OEIS process, Navy has prepared a Biological Evaluation (BE) for the NWTRC for use, as appropriate, in consultation with NMFS and U.S. Fish and Wildlife Service (USFWS). The BE provides detailed descriptions and analysis of the potential impacts to all threatened or endangered species and critical habitats protected under the ESA.

Explosive Ordnance Disposal training is conducted in the NWTRC under a current Biological Opinion (NMFS 2008).

The Crescent Harbor Underwater EOD Range is outside the major migration corridor for river systems in the area. The Indian Island Underwater EOD Range lies on a migration corridor for Chinook, chum, and other salmon species in the Hood Canal system. As such, the Indian Island Underwater EOD Range area is expected to support larger numbers of adult salmon than Crescent Harbor Underwater EOD Range area. Resident Chinook (blackmouth) may occur in low densities. At any time of the year, small numbers of adult salmon are expected to occur within the injury distances of the detonation sites at the time of detonation. Therefore, juvenile and adult salmon could be injured or killed by EOD detonations. Effects to steelhead or bull trout would be similar to those described for salmon.

Impacts to fish from explosions would be possible, but have a low potential for occurrence. While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of underwater detonations and high explosive ordnance use, explosions under the No Action Alternative would not result in impacts to fish populations based on the low number of fish that would be affected. Due to force structure changes that involve the move of EOD personnel out of the NWTRC, annual underwater detonations are decreasing from 60 to 4, and the likelihood of harm to any fish species is even further reduced.

Table ES-9: Summary of Effects – Fish and Essential Fish Habitat

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Aircraft overflight, weapons firing disturbance, and expended materials associated with the No Action Alternative would result in minimal effects to EFH and would not affect ESA-listed salmonid species. • Because only a few species of fish may be able to hear the relatively higher frequencies of mid-frequency sonar, effects of sonar used in Navy exercises on fish and EFH are minimal, and would not affect ESA-listed salmonid species. • Effects of non-explosive ordnance use on fish populations or EFH would be minimal. • Explosive ordnance use may result in injury or mortality to individual fish but would not result in impacts to fish populations. Baseline environmental conditions of critical habitat would remain the same. The No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. • Underwater explosions may affect, but are unlikely to adversely affect ESA-listed salmonid species. • No significant impacts would occur.	• Aircraft overflight, weapons firing disturbance, and expended materials would result in minimal effects to EFH and would not affect ESA-listed salmonid species. • Because only a few species of fish may be able to hear the relatively higher frequencies of mid-frequency sonar, sonar used in Navy exercises would not affect ESA-listed salmonid species. • Non-explosive ordnance use would not affect ESA-listed salmonid species and would result in minimal harm to EFH. • Explosive ordnance use may result in injury or mortality to individual fish but would not result in impacts to fish populations. Baseline environmental conditions of critical habitat would remain the same. • No effect to threatened and endangered species or critical habitat. • No significant harm to fish populations or habitat would occur.
Alternative 1	• Impacts similar to those described in the No Action Alternative. Environmental conditions of critical habitat would be improved compared to current baseline conditions, since underwater detonations would be reduced from current conditions by greater than 90 percent. • Alternative 1 activities may affect, but are not likely to adversely affect ESA-listed salmonid species. • No significant impacts would occur.	• Impacts similar to those described in the No Action Alternative. • No significant harm to fish populations or habitat would occur.
Alternative 2 (Preferred Alternative)	• Impacts similar to those described in the No Action Alternative. Environmental conditions of critical habitat would be improved compared to current baseline conditions, since underwater detonations would be reduced from current conditions by greater than 90 percent. • Alternative 2 activities may affect, but are not likely to adversely affect ESA-listed salmonid species. • No significant impacts would occur.	• Impacts similar to those described in the No Action Alternative. • No significant harm to fish populations or habitat would occur.

ES 1.5.8 Sea Turtles

ES 1.5.8.1 Offshore Area

There are no formal density studies for sea turtles in the PACNW OPAREA, but use of the area by sea turtles other than the leatherback are extremely unlikely to occur due to temperature restrictions. Leatherbacks have been reported in the Study Area, but their occurrence is not common. This EIS/OEIS analyzes potential effects to the leatherback sea turtle in the context of the ESA, NEPA, and EO 12114. For purposes of ESA compliance, effects of the action were analyzed to make the Navy's determination of effect for listed species (that is 'no effect' or 'may affect'). The Navy is working with NMFS through the ESA Section 7 consultation process to ensure that unavoidable significant effects to sea turtles do not result from implementation of the proposed action. The low occurrence of turtles, limited number of stressors from Navy activities and routine implementation by the Navy of current requirements and practices combine to produce a low potential for effects to sea turtles under all the alternatives. Impacts from the Proposed Action may affect, but are not likely to adversely affect sea turtles in the NWTRC Study Area. However, no significant harm to sea turtles would occur. Table ES-10 summarizes the effects of the alternatives.

ES 1.5.8.2 Inshore Area

All discussion of sea turtle impacts in this Executive Summary is contained in the Offshore Area section above.

Table ES-10: Summary of Effects – Sea Turtles

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Activities would have temporary and spatially limited short-term impacts. • No long-term effect would occur. • No Action Alternative activities may affect but are not likely to adversely affect Federally listed leatherback turtles. • No significant impacts would occur.	• Activities would have temporary and spatially limited short-term impacts. • No long-term effect would occur. • No Action Alternative activities may affect but are not likely to adversely affect Federally listed leatherback turtles. • No significant harm to sea turtles would occur.
Alternative 1	• Impacts generally the same as No Action Alternative. • Alternative activities may affect but are not likely to adversely affect Federally listed leatherback turtles. • No significant impacts would occur.	• Impacts generally the same as No Action Alternative. • Alternative 1 activities may affect but are not likely to adversely affect Federally listed leatherback turtles. • No significant harm to sea turtles would occur.
Alternative 2 (Preferred Alternative)	• Impacts generally the same as No Action Alternative. • Alternative 2 activities may affect but are not likely to adversely affect Federally listed leatherback turtles. • No significant impacts would occur.	• Impacts generally the same as No Action Alternative. • Alternative 2 activities may affect but are not likely to adversely affect Federally listed leatherback turtles. • No significant harm to sea turtles would occur.

ES 1.5.9 Marine Mammals

The ESA and MMPA prohibit the unauthorized harassment of marine mammals and endangered species, and provide the regulatory processes for authorizing any such harassment that might occur incidental to an otherwise lawful activity. These two acts establish the context for determining potentially adverse impacts to marine mammals from military activities. Because acoustic modeling and analysis of impacts to marine mammals made no distinction between effects within territorial waters and those outside territorial waters, this section does not structure the analysis based on Offshore and Inshore Areas.

Endangered Species Act

The Navy is consulting with NMFS under Section 7 of the ESA regarding its determination of effect for federally-listed marine mammals and critical habitat. Table ES-11 provides a summary of the Navy's determination of acoustic effects for federally-listed marine mammals that potentially occur in the Study Area.

The analysis presented in Section 3.9.2 indicates that all seven ESA-listed species of marine mammals may be affected by one or more stressors resulting from Alternative 2 (Preferred Alternative) training activities. All species may be affected by exposures to sonar emissions.

The Study Area contains designated critical habitats for the southern resident killer whale population in the Puget Sound and Straits of Juan de Fuca areas of northwest Washington and breeding rookeries for Steller sea lion at several locations along the coast of Oregon and northern/central California. The critical habitat analysis examined the potential effects of training and testing activities on the primary constituent elements of critical habitat considered essential to the conservation of each species. None of the Navy activities were determined to either destroy or adversely modify critical habitat for either species. Therefore, it was concluded that training and testing activities under the proposed action would have no effect on either species' habitat.

This assessment focused on four aspects of the proposed NWTRC exercises — ship traffic, mid-frequency sonar, aircraft overflights, and underwater detonations. Potential risks associated with the ship traffic were assessed by estimating the probability of a ship striking a marine mammal. Potential risks associated with sonars that are likely to be employed during anti-submarine warfare exercises were assessed by treating the acoustic energy produced by those sonar as a pollutant introduced into the ocean environment. The sonar analysis evaluated the likelihood of listed species being exposed to sound pressure levels associated with mid-frequency sonar, which includes estimating the intensity, duration, and frequency of exposure. The analysis assumed that mid-frequency sonar posed no risk to listed species if they were not exposed to sound pressure levels from the mid-frequency sound sources. The analysis assumed that the potential consequences of exposure to mid-frequency sonar on individual animals would be a function of the intensity (measured in both sound pressure level in decibels and frequency), duration, and frequency of the animal's exposure to the mid-frequency transmissions.

Potential risks associated with underwater explosions that are likely to be employed during warfare exercises were assessed by treating the impulse energy produced by underwater explosions as an energy force introduced into the ocean environment. The underwater explosion analysis evaluated the likelihood of listed species being exposed to sound pressure levels associated with underwater detonations, which includes estimating the intensity, duration, and frequency of exposure. The analysis assumed that underwater detonations posed no risk to marine mammal species if they were not exposed to sound pressure levels from the detonations.

Aircraft overflights are not expected to result in stress to marine mammals because it is extremely unlikely that individual animals would be repeatedly exposed to low altitude overflights. Limited research in this area has been primarily focused on aerial scientific surveys in which aircraft fly low and slow. In these studies, whale reactions have been inconsistent (Smultea et al 2001). Most aircraft flights proposed in the alternatives are at high altitudes where the sound is greatly reduced at the surface of the ocean.

Marine Mammal Protection Act

The analysis presented above indicates that several species of marine mammals could be exposed to impacts associated with underwater detonations and explosive ordnance use under the No-Action Alternative, Alternative 1, or Alternative 2 (Preferred Alternative) that could result in Level A or Level B harassment as defined by MMPA provisions that are applicable to the Navy (16 U.S.C. §§1361). Exposure estimates are provided in Section 3.9.2. Other stressors associated with the Proposed Action are not expected to result in Level A or Level B harassment. Accordingly, the Navy is working with NMFS through the MMPA permitting process to ensure compliance with the MMPA.

National Environmental Policy Act and Executive Order 12114

As summarized in Table ES-12, statements regarding impacts on marine mammals under the No Action Alternative, Alternative 1, and Alternative 2 are provided in accordance with both NEPA and EO 12114. Based on acoustic modeling and analysis, impacts to marine mammals in non-territorial waters were not discernable from those in territorial waters.

ES 1.5.10 Birds

The NWTRC encompasses important foraging and breeding habitats for birds. Migratory birds utilize the productive offshore waters associated with the Pacific coast upwelling to forage during wintering and migratory movements. Coastal developments, loss of habitat, commercial fishing, and introduced species have caused populations of many seabird species to decline in recent decades. Navy activities in the NWTRC would not be expected to increase effects to bird populations. Based on the analysis of the proposed alternatives, it is thought that effects to protected and migratory birds would be minimal. The sheer size of the Range Complex, as well as the temporal and spatial variability of activities, in combination with temporal and seasonal distributions of seabird species poses minimal effect potential to seabird populations. Therefore no significant impact and no significant harm to birds would occur.

As part of the EIS/OEIS process, Navy has prepared a BE for the NWTRC for use, as appropriate, in agency consultations. The BE provides detailed descriptions and analysis of the potential impacts to all threatened and endangered species and critical habitats protected under the ESA. Navy has initiated consultation with USFWS in accordance with Section 7 of the ESA.

In accordance with ESA, under the No Action Alternative, Alternative 1, or Alternative 2 (Preferred Alternative) at the NWTRC, vessel movements, aircraft overflight, ordnance use, underwater detonations and military expended materials (entanglement) may affect individual short-tailed albatross; however, these activities would not have community or population level effects. Vessel movements, aircraft overflights and underwater detonations may affect individual marbled murrelets (*Brachyramphus marmoratum*) and individual California brown pelicans (*Pelecanus occidentalis californicus*). Aircraft overflights and underwater detonations may affect individual western snowy plovers (*Charadrius alexandrinus nivosus*), but would not have community or population level effects. Proposed No Action Alternative, Alternative 1, or Alternative 2 (Preferred Alternative) NWTRC activities would not destroy or adversely modify critical habitat for the marbled murrelet or the western snowy plover. Activities associated with any of the alternatives will have no significant adverse effect to these birds.

Table ES-11: Summary of the Navy's Determination of Effect for Federally Listed Marine Mammals that May Occur– Preferred Alternative (Alternative 2)

Stressor	Blue Whale	Fin Whale	Humpback Whale	North Pacific Right Whale	Sei Whale	Sperm Whale	Southern Resident Killer Whale (SP/CH)[b/]	Steller Sea Lion (SP/CH)[b/]	Sea Otter
Vessel Movements									
Vessel Disturbance	MA[a/]	MA	MA	MA	MA	MA	MA/NE	MA/NE	MA
Vessel Collisions	MA	MA	MA	MA	MA	MA	NE/NE	NE/NE	NE
Aircraft Overflights									
Aircraft Disturbance	MA	MA	MA	MA	MA	MA	MA/NE	MA/NE	MA
Non-Explosive Practice Munitions									
Weapons Firing Disturbance	NE	NE	NE	NE	NE	NE	NE/NE	NE/NE	NE
Non-Explosive Ordnance Strikes	NE	NE	NE	NE	NE	NE	NE/NE	NE/NE	NE
High Explosive Ordnance									
Underwater Detonation	MA	MA	MA	MA	MA	MA	MA	MA	MA
Explosive Ordnance	MA	MA	MA	MA	MA	MA	MA	MA	MA
Active Sonar									
Mid- and High-Frequency Sonar	MA	MA	MA	MA	MA	MA	MA	MA	MA
Expended Materials									
Ordnance Related Materials	NE	NE	NE	NE	NE	NLA	NE/NE	NE/NE	NE
MK-58 Marine Markers	NLA	NLA	NLA	NLA	NLA	NLA	NLA/NE	NLA/NE	NLA
Target Related Materials	NE	NE	NE	NE	NE	NE	NE/NE	NE/NE	NE
Sonobuoys	NLA	NLA	NLA	NLA	NLA	NLA	NLA/NE	NLA/NE	NLA

a/ MA = May Affect; NE = No Effect; NLA = May affect, but not likely to adversely affect.
b/ SP/CH = Species effect/critical habitat effect determination made only for species with listed critical habitat

Table ES-12: Summary of Effects – Marine Mammals

Alternative and Stressor	Summary of Effects and Impact Conclusion NEPA and Executive Order 12114
No Action	
Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or ortality from vessel collisions.
Aircraft Overflights	Potential for short-term behavioral responses to overflights. No long-term population-level effects.
Non-Explosive Practice Munitions	No effect based on extremely low probability of direct strikes.
High-Explosive Ordnance	Short-term behavioral responses or Temporary Threshold Shift (TTS) from ordnance use and underwater detonations. Modeling of underwater explosions indicated 170 annual exposures of potential behavioral harassment (76 pinnipeds, 94 cetaceans), 116 exposures of potential Level B harassment (56 pinnipeds, 60 cetaceans), 11 exposures of potential slight injury (5 pinnipeds, 6 cetaceans), and 1 exposure of potential severe injury to a harbor seal (pinniped).
Active Sonar	Short-term behavioral responses or TTS from sonar use. Except for one exposure to harbor seal (pinniped), sonar exposure modeling indicated no potential for Permanent Threshold Shift (PTS) from active sonar. Modeling indicated 108,807 annual exposures (1,875 pinnipeds, 106,932 cetaceans) that exceed the SPL dose response curve and potentially results in behavioral harassment and 443 annual exposures (207 pinnipeds, 236 cetaceans) that exceed the TTS threshold.
Expended Materials	Low potential for ingestion of ordnance related materials.
Summary	No significant impact and no significant harm to marine mammals would occur.
Alternative 1	
Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions. Slight increase compared to No Action.
Aircraft Overflights	Potential for short-term behavioral responses to overflights. Slight increase compared to No Action. No long-term population-level effects.
Non-Explosive Practice Munitions	No effect based on extremely low probability of direct strikes.
High-Explosive Ordnance	Short-term behavioral responses or TTS from ordnance use and underwater detonations. Modeling of underwater detonations and explosive ordnance use indicated 217 annual exposures of potential behavioral harassment (76 pinnipeds, 141 cetaceans), 144 exposures of potential Level B harassment (58 pinnipeds, 86 cetaceans), 14 exposures of potential slight injury (4 pinnipeds, 10 cetaceans), and 0 exposures of potential severe injury. Reductions in underwater EOD training would result in no effects to marine mammals from EOD activities.
Active Sonar	Short-term behavioral responses or TTS from sonar use. Except for one exposure to harbor seal (pinniped), sonar exposure modeling indicated no potential for PTS from active sonar. Modeling indicated 117,354 annual exposures (2,021 pinnipeds, 115,333 cetaceans) that exceed the SPL dose response curve and potentially results in behavioral harassment and 480 annual exposures (224 pinnipeds, 256 cetaceans) that exceed the TTS threshold.
Expended Materials	Low potential for ingestion of ordnance related materials. Slight increase compared to No Action.
Summary	No significant impact and no significant harm to marine mammals would occur.

Table ES-12: Summary of Effects – Marine Mammals (continued)

Alternative and Stressor	Summary of Effects and Impact Conclusion
	NEPA and Executive Order 12114
Alternative 2 (Preferred Alternative)	
Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions. Slight increase compared to No Action.
Aircraft Overflights	Potential for short-term behavioral responses to overflights. Slight increase compared to No Action. No long-term population-level effects.
Non-Explosive Practice Munitions	No effect based on extremely low probability of direct strikes.
High-Explosive Ordnance	Short-term behavioral responses or TTS from ordnance use and underwater detonations. Modeling of offshore explosive ordnance use and underwater detonations indicated 262 annual exposures of potential behavioral harassment (84 pinnipeds, 178 cetaceans), 199 exposures of potential Level B harassment (89 pinnipeds, 110 cetaceans), 14 exposures of potential slight injury (4 pinnipeds, 10 cetaceans), and 1 exposure of potential severe injury. Reductions in underwater EOD training would result in no effects to marine mammals from EOD activities.
Active Sonar	Short-term behavioral responses or TTS from sonar use. Except for one exposure to harbor seal (pinniped), sonar exposure modeling indicated no potential for PTS from active sonar. Modeling indicated 117,615 annual exposures (2,217 pinnipeds, 126,366 cetaceans) that exceed the SPL dose response curve and potentially results in behavioral harassment and 480 annual exposures (246 pinnipeds, 282 cetaceans) that exceed the TTS threshold.
Expended Materials	Low potential for ingestion of ordnance related materials. Slight increase compared to No Action.
Summary	No significant impact and no significant harm to marine mammals would occur.

Implementation of the No Action Alternative, Alternative 1, or Alternative 2 (Preferred Alternative) would not adversely affect the bald eagle as defined by the Bald and Golden Eagle Protection Act (see Section 3.10.1.3), or MBTA regulations (see Section 3.10.3.1) applicable to military readiness activities. In accordance with the NEPA, the No Action Alternative, Alternative 1, or Alternative 2 would have no significant adverse effects on the bald eagle or migratory birds on land or in territorial waters. In accordance with EO 12114, harm to bald eagles from the No Action Alternative, Alternative 1, or Alternative 2 would be unlikely in non-territorial waters. The No Action Alternative, Alternative 1, or Alternative 2 is not expected to disturb, or result in take of bald eagles as defined by the Bald and Golden Eagle Protection Act. Table ES-13 summaries effects of the alternatives.

ES 1.5.11 Terrestrial Biological Resources

Terrestrial areas within the NWTRC that may be affected by activities include the eastern portion of the NAS Whidbey Island Seaplane Base, Indian Island, Naval Outlying Landing Field (OLF) Coupeville, and NBK-Bangor. Activities within these areas may affect resources that occur on-land and in near-shore areas. Activities under the Proposed Action and Alternatives that may affect the terrestrial resources discussed in this section are those that are most likely to result in land disturbance, such as explosions, personnel training, and materials expended during training. There are no federally-listed threatened and endangered plant or wildlife species associated exclusively with the terrestrial environment.

Table ES-13: Summary of Effects – Birds

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Vessel movements could result in short-term behavioral responses and low potential for injury/mortality from collisions. No long-term population-level effects. • Short-term behavioral response to overflights. Low potential for bird injury/mortality from aircraft strikes. No long-term or population-level effects. • Minor, short-term, and localized disturbance due to land based training and land demolition activities. No long-term or population-level effects. • Low potential for direct and indirect effects to birds from ordnance use. No long-term or population-level effects. • Potential for direct and indirect effects to birds from underwater detonations and explosives use. • Low potential for ingestion or entanglement impacts to birds resulting from military expended materials. No long-term or population-level effects. • No significant adverse effects to migratory birds or bald eagles. • Not expected to disturb, or result in take of, bald eagles as defined by the Bald and Golden Eagle Protection Act. • May affect threatened and endangered birds (short-tailed albatross, Western snowy plover, marbled murrelet, and California brown pelican); would not destroy or adversely modify critical bird habitat. • No significant impacts would occur.	• Vessel movements could result in short-term behavioral responses and low potential for injury/mortality from collisions. No long-term population-level effects. • Short-term behavioral response to overflights in non-territorial water areas. Low potential for harm to birds from aircraft strikes. • Low potential for harm to birds from ordnance use in non-territorial water areas. • Low potential for harm to birds from explosives use in non-territorial water areas. • Low potential for harm from military expended materials in non-territorial water areas. • No significant adverse effects or harm to migratory birds or bald eagles in non-territorial water areas. • Not expected to disturb, or result in take of, bald eagles in non-territorial water areas. • May affect threatened and endangered birds in non-territorial water areas (short-tailed albatross); would not destroy or adversely modify critical bird habitat. • No significant harm to birds would occur.
Alternative 1	• Impacts slightly higher than the No Action Alternative. • No significant impacts would occur .	• Impacts slightly higher than the No Action Alternative. • No significant harm to birds would occur.
Alternative 2 (Preferred Alternative)	• Impacts slightly higher than Alternative 1. • No significant impacts would occur.	• Impacts slightly higher than Alternative 1. • No significant harm to birds would occur.

ES 1.5.11.1 Plant Species

Only one federally-listed threatened species is known to occur in the NWTRC; the golden Indian paintbrush (*Castilleja levisecta*). Based on species distribution information provided in the Naval Air Station Whidbey Island Integrated Natural Resources Management Plan, golden Indian paintbrush is known to occur at Forbes Point on Seaplane Base.

Vehicle and equipment use and foot traffic associated with the continued use of the existing Demolition Training Range (DTR) at Seaplane Base and Bangor by personnel would have a negligible effect on vegetation. These sites have been and continue to be used for demolition training and the areas are considered to be disturbed. There are no significant communities present in these areas and no potential habitat for threatened and endangered plant species.

Naval Special Warfare training on Indian Island could affect terrestrial vegetation because of off-road foot traffic. However, because the covert nature of Special Forces activities requires small numbers of personnel conducting special training and having an overall light footprint, effects on vegetation would be comparatively minimal.

Foot traffic in undisturbed areas has the potential to cause damage to individual plants from trampling or crushing in localized areas. However, there would not be any loss of populations and areas of trampling would be expected to recover in a short time period.

Insertion/extraction activities at OLF Coupeville and Seaplane Base, with additional SAR activities occurring at Seaplane Base Survival Area, occur predominantly in defined drop zones or insertion points. In these designated areas, vegetation would be impacted because of crushing, trampling, and uprooting. In areas such as grasslands and scrub-shrub habitats vegetation could experience long-term effects as soils become compacted and vegetation is removed. However, given the low frequency of these actions and relatively low number of personnel participating, impacts would less than significant.

At Seaplane Base, helicopter rope suspension training activities occur monthly and involve approximately eight participants. At OLF Coupeville, these covert activities generally consist of four to six people walking through an area and activities occur infrequently; for two to three weeks twice a year. Given the low frequency of these actions and relatively low number of personnel participating, impacts would less than significant.

Demolition practice on land takes place in the existing DTR Seaplane Base and DTR Bangor, where little vegetation is present. Because of the long-term use of the DTRs and repeated disturbances in these areas, little vegetation is present and the areas are considered disturbed. There would be no significant impacts to vegetation in these areas.

ES 1.5.11.2 Animal Species

As summarized in Table ES-14, the No Action Alternative, Alternative 1, and Alternative 2 would have negligible to minor short-term impacts on terrestrial vegetation, wetlands, and wildlife. In addition, there are no federally-listed terrestrial wildlife species that would be affected by land-based NWTRC activities.

During EOD training activities, the presence of personnel and vehicles and equipment use at established DTRs on Seaplane Base and NBK-Bangor to conduct training would have no effect on wildlife as these areas are disturbed from prior use and provide poor quality habitat for wildlife. They do provide minimal habitat for some small mammals, snakes, and perching birds. Individuals of species present in these areas would be disturbed from feeding, nesting, or resting while personnel were present and equipment were in use. Some may leave the area to more suitable adjacent available habitats. Individual animals may also adjust to the disturbance of equipment noise and people with minimal effect. There would be no change in populations of animals and no significant impacts to wildlife because of vehicle and foot traffic associated with EOD training activities.

NSW training on Indian Island could affect terrestrial vegetation which could affect shelter, nesting, and roosting areas. Because of the covert nature of Special Operations Forces, they generally use a small number of personnel, have a light footprint, and cause little noise disruption. As a result, the effects of this training would potentially result in temporary displacement of animals and may cause only brief disruptions to foraging, nesting, and/or roosting activities. The effects would be limited predominantly to wildlife that are typically found on the ground such as mammals, amphibians, reptiles, and ground nesting birds. As these activities are short-term and infrequent, there would not be any population level effects to wildlife. Overall these activities would have no significant impact on wildlife species.

Insertion/extraction activities would occur at Seaplane Base and OLF Coupeville that may affect terrestrial wildlife. Movements of personnel during these training activities would not have significant impact on vegetation or wetlands on the base that provide wildlife habitat. Personnel movements for insertion/extraction activities would not prohibit the use of habitats by birds, mammals, and reptiles once the disturbance ceased. There is significant marsh habitat at Seaplane Base and forest habitat at Seaplane Base and OLF Coupeville for neotropical migratory birds. Although some damage would occur to individual plants because of personnel movement through these areas, there would not be significant impact to these habitats that would interfere with neotropical migratory bird use.

Demolition training on land takes place in the existing DTRs at Seaplane Base and NBK-Bangor. Animals such as small mammals and reptiles in the immediate vicinity of an explosion could be susceptible to lethal injury and birds and mammals on the outer edges of the zone of influence could exhibit a short-term behavioral response. Under the Proposed Action, DTR Seaplane Base would host approximately 6 training events per month. Because of the frequent level of human presence and activity that occurs in this disturbed habitat, animals are most likely to avoid the area or flee prior to detonation. Under the Proposed Action, the number of detonations at Bangor DTR would be much less than at DTR Seaplane Base, approximately 6 per year. The wildlife in the vicinity may elicit a stronger physiological response as the activity is infrequent. While the effects of detonations in the Study Area on wildlife cannot be quantified, lethal injury because of detonations is not expected to mammals and birds that can flee the area. Mortality may occur to reptiles that are less mobile or are found underground. Given the prior use of the DTRs and the poor wildlife quality of the disturbed habitat, there may be loss of individuals with little or no effect at the population level.

ES 1.5.12 Cultural Resources

In this EIS/OEIS, cultural resources are divided into three groups: archaeological resources (both historic and prehistoric), architectural resources, and traditional cultural resources.

ES 1.5.12.1 Archeological Resources

Prehistoric and historic archaeological resources are locations (sites) where human activity measurably altered the earth or left deposits of physical remains. Prehistoric sites in the NWTRC consist of evidence of human activities that spanned the time from perhaps 8,000 years ago until the time of the first European contact in the late 18th century. Most frequently, such sites contain both surface and subsurface elements. Historic archaeological resources are those resources from after European contact. They may include subsurface features such as wells, cisterns, or privies or artifact concentrations and building remnants, such as foundations. Underwater archaeological resources are submerged sites that have some cultural affiliation. These may be prehistoric sites or isolated prehistoric artifacts, or they can consist of submerged historic shipwrecks, airplanes, or pieces of ship components, such as cannons or guns.

Table ES-14: Summary of Effects – Terrestrial Biological Resources

Alternative and Stressor	Summary of Effects and Impact Conclusion
No Action	
Land Based Training	Minor, short-term, and localized disturbance to terrestrial vegetation and wildlife from foot traffic, light vehicular use, and ordnance and pyrotechnics. No long-term population-level effects. Wetlands would not be affected.
Land Demolitions	Temporary displacement and minor disturbance of terrestrial wildlife in the areas adjacent to DTRs. Wildlife would exhibit short-term physiological response but would return to normal behaviors shortly after disturbance. No long-term population level effects. Vegetation and wetlands would not be affected by EOD actions in established DTRs.
Aircraft Overflights	Short-term behavioral responses of wildlife particularly from helicopters. Due to the infrequent occurrence and short-duration of activities, there would be no long-term population-level effects.
Summary	No significant impacts would occur.
Alternative 1	
Land Based Training	Minor, short-term, and localized disturbance to terrestrial vegetation and wildlife from foot traffic, light vehicular use, and ordnance and pyrotechnics. No long-term population-level effects. Wetlands would not be affected.
Land Detonations	Temporary displacement and minor disturbance of terrestrial wildlife in the areas adjacent to DTRs. Wildlife would exhibit short-term physiological response but would return to normal behaviors shortly after disturbance. No long-term population level effects. Vegetation and wetlands would not be affected by EOD actions in established DTRs.
Aircraft Overflights	Short-term behavioral responses of wildlife particularly from helicopters. Although activities would increase over the No Action Alternative, they would occur relatively infrequently and for short-durations which would not result in long-term population-level effects.
Summary	No significant impacts would occur.
Alternative 2 (Preferred Alternative)	
Land Based Training	Minor, short-term, and localized disturbance to terrestrial vegetation and wildlife from foot traffic, light vehicular use, and ordnance and pyrotechnics. No long-term population-level effects. Wetlands would not be affected.
Land Detonations	Temporary displacement and minor disturbance of terrestrial wildlife in the areas adjacent to DTRs. Wildlife would exhibit short-term physiological response but would return to normal behaviors shortly after disturbance. No long-term population level effects. Vegetation and wetlands would not be affected by EOD actions in established DTRs.
Aircraft Overflights	Short-term behavioral responses of wildlife particularly from helicopters. Although activities would increase over the No Action Alternative, they would occur relatively infrequently and for short-durations which would not result in long-term population-level effects.
Summary	No significant impacts would occur.

ES 1.5.12.2 Architectural Resources

Architectural resources are elements of the built environment, such as existing buildings, dams, bridges, and other structures of historic, engineering, or artistic significance. Factors in determining a resource's significance are its age, integrity, design, and association with important events or persons. To receive protection under Federal cultural resources laws, architectural resources generally must be at least 50 years old or be of exceptional importance. Cold War-era military facilities may meet the exception criteria.

ES 1.5.12.3 Traditional Cultural Resources

Traditional cultural resources are resources associated with cultural practices and beliefs of a living community that are rooted in its history and are important in maintaining the continuing cultural identity of the community. Traditional cultural resources may include archaeological sites, locations of historic events, sacred areas, sources of raw materials used to produce tools and sacred objects, traditional hunting or gathering areas, and usual and accustomed tribal fishing grounds. The traditional community may consider these resources essential for the persistence of their culture. Those traditional resources that are listed in or eligible for listing in the National Register of Historic Places (NRHP) are known as “traditional cultural properties.”

ES 1.5.12.4 Summary of Proposed Action Potential Effects on Cultural Resources

Because of the continued use of protective measures currently in place, such as identification of cultural sites, shipwrecks, and submerged resource locations prior to exercises, and avoidance of known cultural sites, EOD training and explosions from bombing, missiles, and gunnery exercises would have few if any direct adverse effects on shipwrecks or other archaeological resources. Land-based training and nearshore activities would increase and could disturb archaeological resources, but effects would be minor due to the small number of activities and/or covert nature of the activities that limit the amount of disturbance. Slight increase in land-based EOD training would have minimal impact on historic sites or archaeological resources due to the confined nature of the detonations and the distance of activities from historic sites. There would be a substantial decrease in underwater EOD activities that would reduce the potential for impacts to archaeological resources and historic sites. There would be few, if any, effects to shipwrecks or other archaeological resources from a slight increase in explosions at sea from bombing, missile, and gunnery exercises with implementation of mitigation measures. Small quantities of expended materials that sink to the ocean bottom would not affect the historic properties of the shipwreck, and eventually all such expended materials would be covered by sediments. The Proposed Action would have a negligible to minor adverse effect and negligible effects to historic structures.

Under the Proposed Action, two of the range enhancements have the potential to cause a negative impact to usual and accustomed fishing; the Portable Undersea Tracking Range (PUTR) and the underwater training minefield.

- Portable Undersea Tracking Range. The PUTR involves the temporary placement of seven electronics packages (sensors) on the seafloor, each approximately 3 ft long by 2 ft in diameter. Although no candidate locations have yet been identified, the electronic packages would be placed in water depths greater than 600 ft, at least 3 nm from land. Because this is a temporary installation—to be recovered once training is complete—no permanent restricted areas would be designated. While use of the range by Fleet ships and aircraft would have no direct impact to fishing, the gear placement on the seafloor could be incompatible with certain usual and accustomed fishing activities. The Navy would have to establish a temporary restricted area which would limit any activity that could damage or disturb the sensors. This could negatively impact Native American Tribes and Nations’ fishing activities if the range is deployed in a viable fishing area. Because this is a temporary installation—to be recovered once training is complete—no permanent restricted areas would be designated.
- Underwater training minefield. An underwater minefield would be permanently installed on the seafloor in a location not yet determined. Although the location for this minefield has not yet been determined, it would not be installed within the boundaries of the Olympic Coast

National Marine Sanctuary (Figure ES-1). The minefield, approximately 15 mine-like shapes anchored to the seafloor in a 2-nm by 2-nm area, would be used by submarines for mine location and avoidance training. Requirements for the minefield training dictate that the mine shapes would be tethered to the ocean floor in water depth of 500 to 600 ft (150 to 185 m) and rising to within 400 to 500 ft (120 to 150 m) of the ocean surface. While use of the range by Navy submarines would have no direct impact to fishing, the mine shapes' placement on the seafloor could be incompatible with certain usual and accustomed fishing activities. The Navy would have to establish a permanent restricted area which would limit any activity that could damage or disturb the sensors. This could negatively impact Native American Tribes and Nations' fishing activities if the range is deployed in a viable fishing area.

With consultation and coordination, effects on traditional cultural practices and archaeological and ethnographic sites and resources valued by tribes would change very little from those described for the No Action Alternative. Table ES-15 summarizes the potential impacts to cultural resources.

Table ES-15: Summary of Effects – Cultural Resources

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative		
Small Boat Activities	Minor, short-term, and localized disturbance to archaeological resources are possible, but unlikely due to low number and covert nature of small boat activities.	Small boat activities would have no effect on cultural resources beyond 12 nm.
Land-based Training	Helicopter landings at OLF Coupeville and the Seaplane Base Survival Area could potentially disturb soils in the vicinity of archaeological resources, but any effects would be minor.	Land-based activities would have no effect on cultural resources beyond 12 nm.
Land and Underwater Demolition	Confined explosives would have limited concussive or noise impacts to archaeological sites. Nearest historic sites are distant from detonations and are unlikely to suffer effects. Noise effects on traditional cultural resources are possible, but not likely due to current protective measures in place during all detonations.	These land-based and inshore activities would have no effect on cultural resources beyond 12 nm.
Weapons Firing At Sea	Weapons fired at sea have the potential to cause fragments to settle on shipwrecks. However, the small quantities of expended material would not affect the historic properties of any shipwrecks.	Potential impacts would be minor due to the low density of munitions and shipwrecks beyond 12 nm.
Summary	No significant impact to cultural resources would occur.	No significant harm to cultural resources would occur.
Alternative 1		
Small Boat Activities	Alternative 1 small boat activities that could impact cultural resources are the same as the No Action Alternative, with no increase in number of activities. Therefore, potential for impact would be the same.	Impacts generally the same as for the No Action Alternative.
Land-based Training	Helicopter landings at OLF Coupeville and the Seaplane Base Survival Area would increase only slightly over No Action levels. No additional impacts are expected.	

Table ES-15: Summary of Effects – Cultural Resources (continued)

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
Alternative 1 (continued)		
Land and Underwater Demolition	Alternative 1 land demolition training will increase, and underwater demolition training will decrease significantly, from 54 annual detonations, to 4. These changes in the level of training activity are expected to have no net effect on impacts to cultural resources.	Impacts generally the same as for the No Action Alternative.
Weapons Firing At Sea	Weapons firings will increase under Alternative 1. However, more than half of all rounds that enter the ocean are small caliber. Many of the rest are fragments of their original shells. The resulting increase in small objects entering the water is not likely to affect the historic properties of any shipwrecks.	
Summary	No significant impact to cultural resources would occur.	No significant harm to cultural resources would occur.
Alternative 2 (Preferred Alternative)		
Small Boat Activities	Alternative 2 small boat activities that could impact cultural resources are the same as the No Action Alternative, with no increase in number of activities. Therefore, potential for impact would be the same.	Impacts generally the same as for the No Action Alternative.
Land-based Training	Helicopter landings at OLF Coupeville and the Seaplane Base Survival Area would increase only slightly over No Action levels. No additional impacts are expected.	
Land and Underwater Demolition	Alternative 2 land and underwater demolition training is the same as Alternative 1, therefore, the potential for impacts will be the same.	
Weapons Firing At Sea	Weapons firings will increase from the No Action Alternative under Alternative 2. However, more than half of all rounds that enter the ocean are small caliber. Many of the rest are fragments of their original shells. The resulting increase in small objects entering the water is not likely to affect the historic properties of any shipwrecks.	
Summary	No significant impact to cultural resources would occur.	No significant harm to cultural resources would occur.

ES 1.5.13 Traffic

The majority of training and test activities are located within the charted, designated military operations boundaries; hence, there would be minimal potential for conflict with non-military air and ship traffic. Air and shipping traffic within the offshore areas is sparse enough that Navy ships and aircraft can conduct their activities far from non-participants if required. Therefore, no significant impacts to traffic would occur as a result of implementation of the No Action Alternative, Alternative 1, or Alternative 2. Table ES-16 summarizes the potential impacts to traffic.

Table ES-16: Summary of Effects – Traffic

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Hazardous air operation effects are minimal and any possible effects are limited by confining military aircraft to the warning areas to prevent accidental contact. • Activities at Explosive Ordnance Disposal (EOD) locations do not have an appreciable effect on traffic concerns due to the temporary dispersal of traffic and current requirements and practices of safety vessels. • Military use of the offshore ocean does not create a considerable risk to impact traffic because Navy aircraft and vessels are confined to operating areas (OPAREAs) away from shipping lanes and other recreational use areas. • No significant impacts would occur.	• Impacts would be similar to those described for the No Action Alternative for territorial waters.
Alternative 1	• Hazardous air operation effects would be minimal and any possible effects are limited by confining military aircraft to warning areas to prevent accidental contact. • Activities at EOD locations do not have an appreciable effect on traffic concerns due to the temporary dispersal of traffic and current requirements and practices of safety vessels. (Significant reduction in EOD underwater detonation activities from No Action Alternative.) • Military use of the offshore ocean would not create a considerable risk to impact traffic because Navy aircraft and vessels are confined to OPAREAs away from shipping lanes and other recreational use areas. • No significant impacts would occur.	• Impacts would be similar to those described for the No Action Alternative for territorial waters.
Alternative 2 (Preferred Alternative)	• Hazardous air operation effects would be minimal and any possible effects are limited by confining military aircraft to the warning areas to prevent accidental contact. • Activities at EOD locations do not have an appreciable effect on traffic concerns due to the temporary dispersal of traffic and current requirements and practices of safety vessels. (Significant reduction in EOD underwater detonation activities from No Action Alternative.) • Military use of the offshore ocean would not create a considerable risk to impact traffic because Navy aircraft and vessels are confined to OPAREAs away from shipping lanes and other recreational use areas. • No significant impacts would occur.	• Impacts would be similar to those described for the No Action Alternative for territorial waters.

ES 1.5.14 Socioeconomics

ES 1.5.14.1 Offshore Area

Civilian activities currently conducted in the NWTRC include commercial shipping, commercial fishing, sport fishing/diving, and tourist-related activities. These activities make an appreciable contribution to the Pacific Northwest regional economy (See Section 3.14.1). The Navy's procedures for temporarily clearing an area of non-participants for safety purposes will not adversely affect these economic activities because displacement is of short duration. The Navy has performed military training activities within this region since World War II and has not precluded fishing or recreational uses in the NWTRC, even during peak fishing seasons. When hazardous training needs to be conducted in the Offshore Area, a Notice to Mariners (NOTMAR) is issued or the activity is conducted within Warning Areas designated for hazardous activities. This measure provides mariners with Navy use areas in advance, which allows non-participants to select an alternate destination without appreciable affect to their activities. To help manage competing demands and maintain public access in the NWTRC, the Navy conducts its offshore activities in a manner that minimizes restrictions to commercial fisherman (U.S. Navy 2007). Similarly, activities performed within the OPAREAs rarely affect divers due to the infrequency of diving in these areas. See Section 3.14.2 for additional information. Table ES-17 summarizes the potential impacts to socioeconomics.

Under Alternative 2, two of the range enhancements have the potential to cause a negative socioeconomic impact to the Offshore Area; the Portable Undersea Tracking Range (PUTR) and the underwater training minefield.

- Portable Undersea Tracking Range. The PUTR involves the temporary placement of seven electronics packages (sensors) on the seafloor, each approximately 3 ft long by 2 ft in diameter. Although no candidate locations have yet been identified, the electronic packages would be placed in water depths greater than 600 ft, at least 3 nm from land. Because this is a temporary installation—to be recovered once training is complete—no permanent restricted areas would be designated. While use of the range by Fleet ships and aircraft would have no socioeconomic impact to the region, the gear placement on the seafloor could be incompatible with commercial fishing activities that involve towing nets in the water column where the sensor packages are located. The Navy would have to establish a temporary restricted area which would limit any activity that could damage or disturb the sensors. This could place an economic hardship on commercial fishing enterprises if the range is deployed in a viable fishing area. Because this is a temporary installation—to be recovered once training is complete—no permanent restricted areas would be designated and no limitations would be placed on commercial or civilian use, thus limiting impacts.
- Underwater training minefield. An underwater minefield would be permanently installed on the seafloor in a location not yet determined. The minefield, approximately 15 mine-like shapes anchored to the seafloor in a 2-nm by 2-nm area, would be used by submarines for mine location and avoidance training. Requirements for the minefield training dictate that the mine shapes would be tethered to the ocean floor in water depth of 500 to 600 ft (150 to 185 m) and rising to within 400 to 500 ft (120 to 150 m) of the ocean surface. While use of the range by Navy submarines would have no socioeconomic impact to the region, the mine shapes' placement on the seafloor could be incompatible with commercial fishing and some research activities if those activities required towing equipment through the water column where the mine shapes are tethered. The Navy would have to establish a permanent restricted area which would limit any activity that could damage or disturb the sensors. If the Navy determined that a new restricted area would have to be created, the analysis for that process would occur through separate documentation, not as part of this EIS/OEIS. This could place an economic hardship on commercial fishing enterprises if the range is deployed in a viable fishing area.

The Electronic Combat (EC) threat simulators/targets would be part of the Proposed Action in the offshore areas as well. This activity consists of a fixed radio transmitter on land and would not have any effect on socioeconomic interests in the OPAREAs. Additionally, the proposal for commercial air and surface target services would bring some economic benefit to businesses hired to haul targets.

ES 1.5.14.2 Inshore Area

Navy activities in the Inshore Area entail scheduling procedures and temporary civilian inconvenience during activities. The Navy temporarily limits public access to areas where there is a risk of injury or property damage. Locations of all popular dive sites are well documented and the Navy restricts access to certain areas within the range by notifying divers of hazardous activities through the use of NOTMARs. Navy training activities temporarily prevent civilian activities but are not expected to have a significant effect on socioeconomic interests. Only one specific area around Whidbey Island is deemed a Restricted Area. The MOAs entail overflight traffic which has only an aesthetic impact to the areas. The counties of Okanogan, Ferry, Stevens, and Pend Orielle do not have socioeconomic effects associated with Navy activities.

Under the Proposed Action, EOD underwater activities would decrease from 60 to 4. Otherwise, activities would increase by approximately 31 percent over the No Action Alternative. Activities associated with the Proposed Action would not have any new effects on socioeconomic interests; as a result, socioeconomic impacts would not occur.

Table ES-17: Summary of Effects – Socioeconomics

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Navy activities in the areas around Whidbey Island, the EOD ranges, nearshore OPAREAs, and inland OPAREAs entail range clearance procedures and temporary civilian inconvenience during activities. Only one specific area around Whidbey Island is deemed a Restricted Area. Activities do not have an effect on socioeconomic interests. • Limitations on recreational use of areas on a regular basis have been chosen as the least restrictive area possible for Navy activities to be conducted. • Fish and marine wildlife populations are currently at healthy population levels; commercial and recreational fishing is not affected by current Navy action. • No significant impacts would occur.	• Impacts would be similar to those described for the No Action Alternative for territorial waters.
Alternative 1	• Impacts generally the same as No Action Alternative. • EOD activities involving underwater demolitions will be decreasing from 60 to 4 activities per year. • No significant impacts would occur.	• Impacts would be similar to those described for the No Action Alternative for territorial waters.
Alternative 2 (Preferred Alternative)	• Impacts generally the same as No Action Alternative. • EOD activities involving underwater demolitions will be decreasing from 60 to 4 activities per year. • Portable Undersea Tracking Range (temporary installation) and the permanent underwater training minefield could have negative economic impacts to commercial fishing. • No significant impacts would occur.	• Impacts would be similar to those described for the No Action Alternative for territorial waters.

ES 1.5.15 Environmental Justice and Protection of Children

The Navy is required to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies and activities on minority populations and low-income populations in the United States and its territories and possessions. The Navy is also required to identify and assess environmental health risks and safety risks that may disproportionately affect children. These analyses are conducted in this EIS/OEIS in Section 3.15 – Environmental Justice and Protection of Children. Activities associated with the Proposed Action will have no significant impacts associated with environmental justice and protection of children. Potential impacts are summarized in Table ES-18.

ES 1.5.15.1 Offshore Area

No permanent human populations exist in the Offshore Area. Therefore, no disproportionate high and adverse human health or environmental effects on children or minority or low-income populations currently occur under the No Action Alternative, nor would occur under Alternative 1 or Alternative 2.

ES 1.5.15.2 Inshore Area

Navy activities occurring in Washington State have possible effects to individuals within a number of nearby counties but no disproportionate effects to minority/low-income populations or populations of children. In addition, no public health or safety impacts have been identified with regard to ongoing activities within the Inshore Area. Navy land activities account for a small percentage of total activities within the NWTRC. Activities within Puget Sound include EOD sites at Crescent Harbor, Indian Island, and NBK-Bangor. None of these activities have impacts which disproportionately affect minority/low-income populations or populations of children. The remaining activities within the Puget Sound areas are air activities, RDT&E activities, and support activities. As previously stated, Navy aircraft conduct training over much of the State of Washington in MOAs. Although the airspace floor in these areas is as low as 300 ft above the ground, most of the activities are conducted at higher altitudes with no discernable impact to the public. Therefore, the counties that lie beneath these areas are not considered for analysis in this EIS/OEIS. Based on these activities, there would be no disproportionately high and adverse human health or environmental effects of the Navy's programs, policies, or activities on minority/low-income populations or populations of children.

Under Alternative 1, the overall increase in activities from baseline (no action) to Alternative 1 would be less than 20 percent. Navy land activities account for a small percentage of total activities within the NWTRC. Activities within Puget Sound include EOD sites at Crescent Harbor, Indian Island, and NBK-Bangor. Operational tempo from underwater EOD training would decrease significantly (from 60 to 4 annual activities) and no new activities will be added.

Under Alternative 2 (Preferred Alternative), Inshore activities would have all the components of the No Action Alternative, but the training tempo would increase. However, the increases would occur in existing areas, with no disproportionate effect on any population groups or children.

ES 1.5.16 Public Safety

Public safety issues include potential hazards inherent in flight activities, vessel movements, underwater detonations, offshore use of sonar, and onshore explosives training. It is Navy policy to prevent personal injury or property damage by observing every possible precaution in the planning and execution of all activities that occur onshore or offshore.

Table ES-18: Summary of Effects – Environmental Justice and Protection of Children

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	**Environmental Justice** • No permanent human populations exist in the NWTRC Ocean OPAREAs. Therefore, no disproportionate effects on minority or low-income populations currently occur. • Navy activities occurring within Puget Sound OPAREAs have possible effects to populations within a number of nearby counties. Land activities account for a small percentage of total activities within the NWTRC. Activities conducted consist of air activities, undersea EOD activities, RDT&E, and support activities. None of these activities have a disproportionate effect on populations of minority or low-income populations. • Navy activities occurring within Inland OPAREAs have possible effects to populations within a number of nearby counties. None of the proposed activities have a disproportionate effect on populations of minority or low-income populations. • No significant impacts would occur. **Protection of Children** • No human populations exist in the NWTRC OPAREAs. Therefore, no disproportionate risks to children currently occur. • There are no populations of children disproportionately affected by Navy activities within the Puget Sound OPAREAs. Land activities account for a small percentage of total activities within the NWTRC. Activities conducted consist of air activities, undersea EOD activities, RDT&E, and support activities. None of these locations are near populations of children that are disproportionately affected. • There are no populations of children disproportionately affected by Navy activities within the Inland OPAREAs. None of these locations are near populations of children that are disproportionately affected. • No significant impacts would occur.	• No permanent human populations exist in the NWTRC OPAREAs outside of territorial waters. Therefore, no disproportionate effects on minority or low-income populations or health and safety risks to children would occur.
Alternative 1	• Impacts to Environmental Justice and Protection of Children would be the same as in the No Action Alternative • No significant impacts would occur.	• Impacts to Environmental Justice and Protection of Children would be the same as in the No Action Alternative
Alternative 2 (Preferred Alternative)	• Impacts to Environmental Justice and Protection of Children would be the same as in the No Action Alternative • No significant impacts would occur.	• Impacts to Environmental Justice and Protection of Children would be the same as in the No Action Alternative

Impacts to public health and safety are assessed in terms of the potential of Navy training activities to injure or compromise civilians in any way. Impacts may arise from physical injury directly from hazardous activities or as an indirect result of hazardous materials expended from a training event. Stressors that would likely impact public health and safety include surface and subsurface ship movements, aircraft movements, use of explosives, torpedoes, missiles and various ordnance, lasers, expended materials, radio frequencies, aircraft noise, and use of offshore sonar that may affect divers. These stressors were identified by conducting a detailed analysis of the warfare areas, geographic location, and specific activities included in the alternatives. Several factors were considered in evaluating the effects of the Navy's activities on public safety, including proximity to the public, ownership, access control, scheduling, public notification of events, frequency of events, duration of events, range safety procedures, operational control of training events, and safety history. Based on all of these factors, the activities associated with the Proposed Action will have no significant impacts on public safety.

ES 1.5.16.1 Offshore Area

Military, commercial, institutional, and recreational activities take place in the NWTRC. The Federal Aviation Administration (FAA) has established Warning Areas (W-) for military aircraft activities; however, most of the airspace and seaspace is available for co-use most of the time. The PACNW Ocean Surface/Subsurface OPAREA is the only range in the Northwest available for naval surface ship live firing. The PACNW OPAREA also hosts aircraft bombing exercises (not authorized in the Olympic Coast National Marine Sanctuary), several of which involve the use of laser-guided weapons. The PACNW OPAREA is used for the full range of naval ordnance. Only hazardous activities require exclusive use of an area, and these are scheduled and broadcast by the Navy through NOTMARs and Notices to Airmen (NOTAMs).

The public typically accesses the offshore ocean areas for recreational purposes such as sport fishing, sailing, boating, tourist-related activities (sightseeing and whale watching), diving, and swimming. Public access to offshore marine areas is a safety concern for the Navy because its activities occur primarily in international waters. Warning Areas 237, 570, and 93 (W-237, W-570, and W-93) are SUA lying over international waters and special use surface and subsurface training ranges where the Navy conducts hazardous activities, including missile firings, naval gunfire, and air-to-surface ordnance delivery. Commercial and recreational vessels generally are allowed to operate in the OPAREAs. During training events or exercises in these offshore areas, weapons delivery events are delayed or cancelled if range areas are not clear. Prior to issuing a "Green Range," Navy personnel must ensure that the hazard footprint of the ordnance being fired is clear of non-participating surface vessels, divers, and aircraft.

ES 1.5.16.2 Inshore Area

The Inshore Area includes air, surface, and land ranges. Several MOAs, alert areas (A-), and restricted areas (R-) exist throughout the Inshore Area of the NWTRC (Figure 3.16-1, Table 3.16-1). These areas have been identified and described in 33 CFR Parts 110, 165, and 334 as restricted to naval aircraft or vessels (as appropriate) only or as presenting a significant hazard to mariners or aviators.

Other designated surface zones within Puget Sound are not continuously restricted. When not in use by the Navy, these areas are accessible by boaters, divers, and fisherman, with nearshore anchorages available. NOTMARs and NOTAMs are issued about hazards of the operation of vessels and aircraft in the vicinity of the NWTRC. Among the surface ranges used by the Navy are those in which EOD personnel conduct underwater demolition training. This training takes place at Crescent Harbor Underwater EOD Range, Indian Island Underwater EOD Range, and Floral Point Underwater EOD Range.

In addition to the air and surface areas, several land ranges are in use in the Inshore Area. On-land DTRs are located at Seaplane Base and at NBK–Bangor.

ES 1.5.16.3 Summary of Potential Public Safety Effects

All of the Proposed Action activities, whether resulting from the new range enhancements or an increase of existing activities, have either been conducted previously in the NWTRC, or have been conducted for years in other Navy range complexes. As such, they present no unique safety hazards. The complete analysis of potential public safety issues is presented in Section 3.16 – Public Safety.

Table ES-19: Summary of Effects – Public Safety

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Range clearance procedures are implemented prior to activities for both land and water range areas. Activities will not proceed unless the range is clear of non-participants. Therefore, there is no risk to public safety. • No significant impacts would occur.	• Range clearance procedures are implemented prior to activities for range areas in non-U.S. territorial waters. Activities will not proceed unless the range is clear of non-participants. Therefore, there is no risk to public safety. • No significant harm to public health and safety would occur.
Alternative 1	• Impacts to public safety would be the same as the No Action Alternative. • No significant impacts would occur.	• Impacts to public safety would be the same as the No Action Alternative. • No significant harm to public health and safety would occur.
Alternative 2 (Preferred Alternative)	• Impacts to public safety would be the same as the No Action Alternative. • No significant impacts would occur.	• Impacts to public safety would be the same as the No Action Alternative. • No significant harm to public health and safety would occur.

ES 1.6 CUMULATIVE IMPACTS

The analysis of cumulative impacts considers the effects of the Proposed Action in combination with other past, present, and reasonably foreseeable future actions taking place in the project area, regardless of what agency or person undertakes these actions. This EIS/OEIS analyzes cumulative impacts associated with implementation of Navy-sponsored activities and other non-Navy activities in the region. Other activities included fishing, commercial and recreational marine traffic, ocean pollution, scientific research, and commercial and general aviation. Potential cumulative impacts resulting from other relevant projects (such as those listed above) combined with the Proposed Action addressed in this EIS/OEIS were determined to be less than significant.

ES 1.7 MITIGATION MEASURES

NEPA regulations require an EIS to include appropriate mitigation measures not already included in the Proposed Action or alternatives (40 C.F.R. § 1502.12(f)). Each of the alternatives, including the Proposed Action considered in this EIS/OEIS, already includes protective or mitigation measures intended to reduce environmental effects of Navy activities. Measures, such as current requirements and practices, are discussed in the resource-by-resource analysis, and also are addressed in detail in Chapter 5 – Mitigation Measures.

As part of its commitment to sustainable use of resources and environmental stewardship, the Navy incorporates measures that are protective of the environment into all of its activities. These include employment of current requirements and practices, adoption of conservation recommendations, and other protective measures that mitigate the impacts of Navy activities on the environment. Some of these measures are generally designed to apply to certain geographic areas during certain times of year or for specific types of Navy training. Conservation measures covering habitats and species occurring in the NWTRC have been developed through various environmental analyses conducted by the Navy for land and sea ranges and adjacent coastal waters. The discussion in Chapter 5 describes mitigation measures applicable to Navy activities in the NWTRC.

ES 1.8 OTHER REQUIRED CONSIDERATIONS

ES 1.8.1 Possible Conflicts with Objectives of Federal, State, and Local Plans Policies and Controls

Based on an evaluation with respect to consistency with statutory obligations, the Navy's alternatives including the Proposed Action for the NWTRC EIS/OEIS do not conflict with the objectives or requirements of Federal, State, regional, or local plans, policies, or legal requirements. Chapter 6, Table 6-1 provides a summary of environmental compliance requirements that may apply.

ES 1.8.2 Relationship between Short-term Uses and Long-term Productivity

The Proposed Action would result in both short-term and long-term environmental effects. However, the Proposed Action would not be expected to result in any impacts that would reduce environmental productivity, permanently narrow the range of beneficial uses of the environment, or pose long-term risks to health, safety or the general welfare of the public. The Navy is committed to sustainable range management, including co-use of the NWTRC with the general public and commercial interests to the extent practicable consistent with accomplishment of the Navy mission and in compliance with applicable law. This commitment to co-use enhances the long-term productivity of the the NWTRC.

ES 1.8.3 Irreversible or Irretrievable Commitment of Resources

For the alternatives including the Proposed Action, most resource commitments are neither irreversible nor irretrievable. Most impacts are short-term and temporary. However, implementation of the Proposed Action would require the use of fuels by aircraft, ships, and ground-based vehicles. Total fuel consumption would increase and this nonrenewable resource would be considered irreversibly lost.

ES 1.8.4 Energy Requirements and Conservation Potential

Increased training and testing activities in the NWTRC for the Alternatives, including the Proposed Action, would result in an increase in energy demand over the No Action Alternative. Energy requirements would be subject to established energy conservation practices. The use of energy sources has been minimized wherever possible without compromising safety, training, or testing activities. No additional conservation measures related to direct energy consumption by the proposed activities are identified.

ES 1.8.5 Natural or Depletable Resource Requirements and Conservation Potential

Resources that will be permanently and continually consumed by project implementation include water, electricity, natural gas, and fossil fuels. Pollution prevention is an important component of mitigation of the alternatives' adverse impacts. To the extent practicable, pollution prevention considerations are included. Sustainable range management practices are in place that protect and conserve natural and cultural resources, and allow for preservation of access to training areas for current and future training requirements, while addressing potential encroachments that threaten to impact range capabilities.

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Acronyms and Abbreviations

ACRONYMS/ABBREVIATIONS LIST

A-A	Air-to-Air
A-G	Air-to-Ground
A-S	Air-to-Surface
AAMEX	Air-to-Air Missile Exercise
AAW	Anti-Air Warfare
ACM	Air Combat Maneuvering
ADAR	Air Deployed Active Receiver
ADC	Acoustic Device Countermeasures
ADLFP	Air Deployable Low Frequency Projector
AESA	Active Electronically Scanned Array
AESO	Aircraft Emission Support Office
AMRAAM	Advanced Medium-Range Air-to-Air Missile
AMSP	Advanced Multi-static Processing Program
AMW	Amphibious Warfare
APPS	Act to Prevent Pollution from Ships
ARS	Advanced Ranging Source
ARTCC	Air Route Traffic Control Center
ASUW	Anti-Surface Warfare
ASW	Anti-Submarine Warfare
ATC	air traffic control
ATCAA	Air Traffic Control Assigned Airspace
BA	Biological Assessment
BAMS	Broad Area Maritime Surveillance
BDA	Battle-Damage Assessment`
BDU	Bomb Dummy Unit
BE	Biological Evaluation
BFM	Basic Fighter Maneuvering
BMP	Best Management Practice
BO	Biological Opinion
BOMBEX	Bombing Exercise
BUD/S	Basic Underwater Demolition/SEAL
CAA	Clean Air Act
CAAQS	California Ambient Air Quality Standards
CARB	California Air Resources Board
CCA	California Coastal Act
CEQ	Counsel on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIWS	Close-in-Weapon System
CMP	Coastal Management Plan
CNO	Chief of Naval Operations
CNRNW	Commander, Navy Region Northwest
CO	Carbon Monoxide
COMNAVSURFPAC	Commander, Naval Surface Force, U.S. Pacific fleet
COMPACFLT	Commander, U.S. Pacific Fleet
COMPTUEX	Composite Training Unit Exercise
COMSUBPAC	Commander, Submarine Force U.S. Pacific Fleet
CPF	Commander, Pacific Fleet
CPRW-10	Commander, Patrol and Reconnaissance Wing TEN
CPS	Coastal Pelagic Species
CSG	Carrier Strike Group
CUPA	Certified Unified Program Agency
CV	Coefficient of Variation
CVTS	Cooperative Vessel Traffic Service
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
dB	Decibel
dB/km	Decibel Per Kilometer
DDT	Dichloro-Diphenyl-Trichloroethane
DFOC	Department of Fisheries and Oceans, Canada
DICASS	Directional Command Activated Sonobuoy System
DIFAR	Directional Frequency and Ranging
DLCD	Department of Land Conservation and Development
DO	Dissolved Oxygen
DOC	Department of Commerce
DoD	Department of Defense
DoN	Department of Navy
DOPAA	Description of Proposed Action and Alternatives
DPU	Distinct Population Unit
DTR	Detonation Training Range
DU	Depleted Uranium
DZ	Drop Zone
E	East
EA	(1) Electronic Attack (2) Environmental Assessment
EC	Electronic Combat
EDMS	Emission and Dispersion Modeling System
EER	Extended Echo Ranging
EEZ	Exclusive Economic Zone
EFD	Energy Flux Density
EFH	Essential Fish Habitat
EFSEC	Energy Facility Site Evaluation Council
EIS	Environmental Impact Statement
EMATT	Expendable Mobile ASW Training Target
EMR	Electromagnetic Radiation
EO	Executive Order
EOD	Explosive Ordnance Disposal
EODMU-11	Explosive Ordnance Disposal Mobile Unit Eleven
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ES	(1) Executive Summary (2) Electronic Support
ESA	Endangered Species Act
ESG	Expeditionary Strike Group
ESU	Evolutionary Significant Unit
EXTORP	Running Torpedo Exercise
°F	Degrees Fahrenheit
FAA	Federal Aviation Administration
FACSFAC	Fleet Area Control and Surveillance Facility
FAST	Floating At-Sea Target
FCLP	Field Carrier Landing Practice
FDNF	Forward Deployed Naval Forces
FONSI	Finding of No Significant Impact
FRP	Fleet Response Plan
FRTP	Fleet Response Training Plan
ft	Feet
f^{t2}	Square Feet
FWPCA	Federal Water Pollution Control Act
GIS	Geographic Information Systems
GSE	Ground Support Equipment

GUNEX	Gun Exercise
HARMEX	High-Speed Anti-Radiation Missile Exercise
HAZMINCEN	Hazardous Material Minimization Center
HLX	cyclotetramethylenetetranitramine
HP	Historic Property
HRST	Helicopter Rope Suspension Training
HSMST	High Speed Maneuverable Surface Target
Hz	Hertz
I MEF	I Marine Expeditionary Force
ICAP	Improved Capability
ICRMP	Integrated Cultural Resources Management Plan
IED	Improvised Explosive Device
IEER	Improved Extended Echo Ranging
IFR	Instrument Flight Rules
IMPASS	Integrated Maritime Portable Acoustic Scoring and Simulator Systems
INRMP	Integrated Natural Resources Management Plan
IOC	Initial Operational Capability
ISR	Intelligence, Surveillance, and Reconnaissance
ISTT	Improved Surface Tow Targets
IUPAC	International Union of Pure and Applied Chemistry
JATO	Jet Assisted Take-Off
JTFEX	Joint Task Force Exercise
kHz	Kilohertz
Km	Kilometer
kts	Knots
lb	Pound
LMRS	Long-term Mine Reconnaissance System
LOA	Letter of Authorization
LOP	Letter of Procedure
LQG	Large Quantity Generator
LZ	Landing Zone
m	Meter
m^2	Square Meter
MBTA	Migratory Bird Treaty Act
MCM	Mine Countermeasures
METOC	Meteorological and Oceanographic Operations
MEU	Marine Expeditionary Unit
MFA	Mid-Frequency Active
min	Minute
MINEX	Mine Laying Exercise
MIW	Mine Warfare
MMA	Multi-mission Maritime Aircraft
MMPA	Marine Mammal Protection Act
MMR	Military Munitions Rule
MOA	Military Operating Area
MPA	Maritime Patrol Aircraft
MRA	Marine Resource Assessment
MRUUV	Mission Reconfigurable Unmanned Undersea Vehicle
ms	Millisecond
MSL	Mean Sea Level
MSFCMA	Magnuson Stevens Fishery Conservation Management Act
N	Nitrogen
NAAQS	National Ambient Air Quality Standards
NAS	Naval Air Station
NASWI	Naval Air Station Whidbey Island
NATO	North Atlantic Treaty Organization
NAVFAC NW	Naval Facilities Engineering Command Northwest
NAVFAC PAC	Naval Facilities Engineering Command Pacific
NAVMAG	Naval Magazine
NAVSEA	Naval Sea Systems Command
NAVSPECWARCOM	Naval Special Warfare Command
NAVSTA	Naval Station
NBK	Naval Base Kitsap
NEPA	National Environmental Policy Act
NEW	Net Explosive Weight
NHPA	National Historic Preservation Act
Nm	nautical miles
NMFS	National Marine Fisheries Service
NMML	National Marine Mammal Laboratory
NO2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NOTAM	Notice to Airmen
NOTMAR	Notice to Mariners
NOx	Nitrogen Oxide
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
NSCT-1	Naval Special Clearance Team ONE
NSW	Naval Special Warfare
NSWC	Naval Surface Warfare Center
NSWG	Naval Special Warfare Group
NSWG-3	Naval Special Warfare Group Three
N-UCAS	Navy Unmanned Combat Air System
NUWC	Naval Undersea Warfare Center
NWSTF	Naval Weapons Systems Training Facility
NWTRC	Northwest Training Range Complex
OAAQS	Oregon Ambient Air Quality Standards
OAR	Oregon Administrative Rules
O3	Ozone
OCMP	Oregon Coastal Management Program
OCNMS	Olympic Coast National Marine Sanctuary
ODEQ	Oregon Department of Environmental Quality
OEIS	Overseas Environmental Impact Statement
OLF	Outlying Landing Field
OPA	Oil Pollution Act of 1990
OPAREA	Operating Area
OPFOR	Opposition Force
OPNAV	Office of the Chief of Naval Operations
OPNAVINST	Chief of Naval Operations Instruction
ORMA	Ocean Resources Management Act
OTB	Over the Beach
PA	Programmatic Agreement
PAC	pre-action calibration and alignment
PACFLT	Pacific Fleet
PACNW	Pacific Northwest
PADS	Portable Air Defense System
PAH	Polycyclic Aromatic Hydrocarbons
PBX	Plastic Bonded Explosives
PCB	Polychlorinated Biphenyl
PCFA	Pacific Coast Feeding Aggregation
PFMC	Pacific Fisheries Management Council
pH	Alkalinity
PM	Program Manager
PM10	Particulate Matter up to 10 micrometers
PMAP	Protective Measures Assessment Protocol
PMAR	Navy Primary Mission Area
PNEC	probable no effect concentration

ppb	parts per billion
ppt	parts per thousand
psi	pounds per square inch
PSC	Pacific Salmon Commission
PSWQAT	Puget Sound Water Quality Action
PTS	Permanent Threshold Shift
PUTR	Portable Undersea Tracking Range
R-	Restricted Area
RCD	Required Capabilities Document
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RDT&E	Research, Development, Test and Evaluation
RDX	(1) Royal Demolition Explosive (2) Research Department Explosive
RF	Radio Frequency
RHA	Rivers and Harbors Act
RHIB	Rigid Hull Inflatable Boats
RIMPAC	Rim of the Pacific Exercise
ROD	Record of Decision
ROG	Reactive Organic Gases
ROI	region of influence
S	South
S-A	Surface-to-Air
S-S	Surface-to-Surface
SAM	Surface-to-Air Missile
SAMEX	Surface to Air Missile Exercise
SAR	Search and Rescue
SBUs	Special Boat Units
SCI	
SDVT-1	SEAL Delivery Vehicle Team ONE
SEAD	Suppression of Enemy Air Defenses
SEAL	Sea, Air, Land
SEPA	State Environmental Policy Act
SEPTAR	Seaborne Powered Targets
SFA	Sustainable Fisheries Act
SINKEX	Sinking Exercise
SIP	State Implementation Plan
SMA	Shoreline Management Act
SME	Subject Matter Experts
SMS	Sediment Management Standard
SO2	Sulfur Dioxide
SOCAL	Southern California
SOF	Special Operations Forces
SONAR	Sound Navigation And Ranging
SOP	Standard Operating Procedure
SPAWAR	Space and Naval Warfare Systems
SPIE	Special Purpose Insertion and Extraction
SQG	Small Quantity Generator
SSBN	Nuclear-Powered Ballistic Missile Submarine
SSG	Surface Strike Group
SSGN	Guided Missile Submarines
STW	Strike Warfare
SUA	Special-Use Airspace
SUBASE	Submarine Base
SURTASS	Surveillance Towed Array Sensor System
SUS	Signal, Underwater Sound
TALDs	Tactical Air Launched Decoys
TAP	Tactical Training Theater Assessment Planning
TDU	Target Drone Unit
TFR	Temporary Flight Restriction
TMDL	Total Maximum Daily Load
TNT	Trinitrotoluene
TOC	Total Organic Carbon
TORPEX	Torpedo Exercise
TRACKEX	Tracking Exercise
TRADET	Training Detachment
TSCA	Toxic Substances Control Act
TSDR	Transfer, Storage, or Disposal or Recycle
TTS	Temporary Threshold Shift
TM	Tympanic Membrane
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
ULT	Unit Level Training
UNDET	Underwater Detonation
UNDS	Uniform National Discharge Standards
U.S.	United States
USAF	U.S. Air Force
U.S.C.	United States Code
USCG	United States Coast Guard
USEPA	U.S. Environmental Protection Agency
USFF	United States Fleet Forces
USFWS	United States Fish and Wildlife Service
USMC	United States Marine Corps
USN	United States Navy
USW	Undersea Warfare
USWTR	Undersea Warfare Training Range
UUV	Unmanned Underwater Vehicle
UXO	Unexploded Ordnance
VFR	Visual Flight Rules
VTNF	Variable, Timed, Non-Fragmentation
VTUAS	Vertical Takeoff And Landing Unmanned Aerial System
VTS	Vessel Traffic Service
W	West
W-	Warning Area
WAAQS	Washington Ambient Air Quality Standards
WAC	Washington Annotated Code
WDNR	Washington Department of Natural Resources
WDOE	Washington Department of Ecology
WSDE	Washington State Department of Ecology

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Glossary

MASTER GLOSSARY OF TERMS

Term	Definition
Acoustics	The scientific study of sound, especially of its generation, transmission, and reception.
Active sonar	Detects objects by creating a sound pulse, or ping, that transmits through the water and reflects off the target, returning in the form of an echo. This is a two-way transmission (source to reflector to receiver).
Alternative	A different method for accomplishing the Proposed Action. An alternative can consist of the same action in a different location, or a modification to the Proposed Action.
Ambient noise	The typical or persistent environmental background noise present in the ocean.
Anadromous	Species of fish that are born in freshwater, migrate to the ocean to grow into adults, and return to freshwater to spawn.
Anthropogenic noise	Noise related to, or produced by, human activities.
Antisubmarine warfare (ASW)	Naval operations conducted against submarines, their supporting forces, and operating bases.
Baleen	In some whales (see Mysticete below), the parallel rows of fibrous plates that hang from the upper jaw and are used for filter feeding.
Bathymetry	The measurement of water depth at various places in a body of water; the information derived from such measurements.
Behavioral effect	Defined in this EIS/OEIS as a variation in an animal's behavior or behavior patterns that results from an anthropogenic acoustic exposure and exceeds the normal daily variation in behavior, but which arises through normal physiological process (it occurs without an accompanying physiological effect).
Benthic	Referring to the bottom-dwelling community of organisms that creep, crawl, burrow, or attach themselves to either the sea bottom or such structures as ships, buoys, and wharf pilings (e.g., crabs, clams, worms).
Biologically important activities/behaviors	Those activities or behaviors essential to the continued existence of a species, such as migration, breeding/calving, or feeding.
Cetacean	An order of aquatic mammals such as whales, dolphins, and porpoises.
Critical Habitat	Critical habitat is defined in section 3 of the Endangered Species Act (ESA) as (1) the specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the ESA, on which are found those physical or biological features (i) essential to the conservation of the species and (ii) that may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by a species at the time it is listed, upon a determination that such areas are essential for the conservation of the species.
Cumulative impact	The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.
Decibel (dB)	A unit used to express the relative difference in power, usually between acoustic or electrical signals, equal to 10 times the common logarithm of the ratio of the two levels. Since the decibel scale is exponential and not linear, a 20-dB sound is 10 times louder than a 10-dB sound, a 30-dB sound is 100 times louder than a 10-dB sound.
Demersal	Living at or near the bottom of a waterbody, but having the capacity for active swimming. Term used particularly when describing various fish species.

Term	Definition
Distinct population segment (DPS)	A vertebrate population or group of populations that is discrete from other populations of the species and significant in relation to the entire species. The ESA provides for listing species, subspecies, or distinct population segments of vertebrate species.
Endangered species	Any species that is in danger of extinction throughout all or a significant portion of its range (ESA §3[6]).
Energy flux density level (EFDL)	The energy traversing in a time interval over a small area perpendicular to the direction of the energy flow, divided by that time interval and by that area. EFDL is stated in dB re 1 μPa^2-s for underwater sound.
Epifauna	Organisms living on the surface of the sediment/sea bed/substrate.
Essential fish habitat (EFH)	Those waters and substrate that are defined within Fishery Management Plans for federally-managed fish species as necessary to fish for spawning, breeding, feeding, or growth to maturity.
Evolutionary Significant Unit (ESU)	A stock that is reproductively isolated from other stocks of the same species and which represents an important part of the evolutionary legacy of the species. An ESU is treated as a species for purposes of listing under the ESA. NMFS uses this designation.
Exclusive Economic Zone (EEZ)	A maritime zone adjacent to the territorial sea that may not extend beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured.
Expended Materials	Those munitions, items, devices, equipment and materials which are uniquely military in nature, and are used and expended in the conduct of the military training and testing mission, such as: sonobuoys, flares, chaff, drones, targets, bathymetry measuring devices and other instrumentation, communications devices, and items used as training substitutes. This definition may also include materials expended (such as propellants, weights, guidance wires) from items typically recovered, such as aerial target drones and practice torpedoes.
Federal Register	The official daily publication for actions taken by the Federal government, such as Rules, Proposed Rules, and Notices of Federal agencies and organizations, as well as Executive Orders and other Presidential documents.
Frequency	Description of the rate of disturbance, or vibration, measured in cycles per second. Cycles per second are usually referred to as Hz, the unit of measure.
Harassment	As defined in this document, harassment is intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering.
High frequency	As defined in this document, frequencies greater than 10 kHz.
Hydrography	The characteristic features (e.g., flow, depth) of bodies of water.
Hydrophone	An underwater receiver used to detect the pressure change caused by sound in the water. That pressure is converted to electrical energy. It can then be translated to something that can be heard by the human ear. Sometimes the detected acoustic pressure is outside the human range of hearing.
Infauna	Animals living within the sediment.
Isobath	A line on a chart or map connecting points of equal depths; bathymetric contour.
Letter of authorization (LOA)	The Marine Mammal Protection Act provides for a “small take authorization” (i.e., letter of authorization) for maritime activities, provided NMFS finds that the takings would be of small numbers (i.e., taking would have a negligible impact on that species or stock), would have no more than a negligible impact on those marine mammal species not listed as depleted, and would not have an unmitigable adverse impact on subsistence harvests of these species.

Term	Definition
Level A harassment	Level A harassment includes any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild. Injury is identified as the destruction or loss of biological tissue. The destruction or loss of biological tissue will result in an alteration of physiological function that exceeds the normal daily physiological variation of the intact tissue.
Level A harassment zone	Extends from an acoustic or impulsive source out to the distance and exposure at which the slightest amount of injury is predicted to occur. The acoustic exposure that produces the slightest degree of injury is therefore the threshold value defining the outermost limit of the Level A harassment zone.
Level B harassment	Level B harassment includes all actions that disturb or are likely to disturb a marine mammal or marine mammal stock in the wild through the disruption of natural behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild. Unlike Level A harassment, which is solely associated with physiological effects, both physiological and behavioral effects have the potential to cause Level B harassment.
Level B harassment zone	Begins just beyond the point of slightest injury and extends outward from that point. It includes all animals that may potentially experience Level B harassment. Physiological effects extend beyond the range of slightest injury to a point where slight temporary distortion of the most sensitive tissue occurs, but without destruction or loss of that tissue. The animals predicted to be in this zone experience Level B harassment by virtue of temporary impairment of sensory function (altered physiological function) that can disrupt behavior.
Low frequency	As defined in this document, frequencies less than 1 kilohertz (kHz).
Masking	The obscuring of sounds of interest by interfering sounds, generally at the same frequencies.
Mid-frequency	As defined in this document, frequencies between 1 and 10 kHz.
Mitigation measure	Measures that will minimize, avoid, rectify, reduce, eliminate, or compensate for significant environmental effects.
Munitions (Military)	All ammunition products and components produced or used by or for the U.S. Department of Defense, or the U.S. Armed Services for national defense and security, including military munitions under the control of the Department of Defense, the U.S. Coast Guard, the U.S. Department of Energy, and the National Guard.
Mysticete	Any whale of the suborder Mysticeti having plates of whalebone (baleen plates) instead of teeth. Mysticetes are filter-feeding whales, also referred to as baleen whales, such as blue, fin, gray, and humpback whales.
Notice of intent (NOI)	A written notice published in the Federal Register that announces the intent to prepare an EIS. Also provides information about a proposed federal action, alternatives, the scoping process, and points of contact within the lead federal agency regarding the EIS.
Odontocete	Any toothed whale (without baleen plates) of the suborder Odontoceti such as sperm whales, killer whales, dolphins, and porpoises.
Onset permanent threshold shift (onset PTS)	PTS (defined below) is non-recoverable and, by definition, must result from the destruction of tissues within the auditory system. PTS therefore qualifies as an injury and is classified as Level A harassment under the wording of the Marine Mammal Protection Act. In this EIS/OEIS, the smallest amount of PTS (onset PTS) is taken to be the indicator for the smallest degree of injury that can be measured. The acoustic exposure associated with onset PTS is used to define the outer limit of the Level A harassment zone

Term	Definition
Onset temporary threshold shift (onset TTS)	TTS (defined below) is recoverable and is considered to result from the temporary, non-injurious distortion of hearing-related tissues. In this EIS/OEIS, the smallest measurable amount of TTS (onset TTS) is taken as the best indicator for slight temporary sensory impairment. Because it is considered non-injurious, the acoustic exposure associated with onset TTS is used to define the outer limit of the portion of the Level B harassment zone attributable to physiological effects. This follows from the concept that hearing loss potentially affects an animal's ability to react normally to the sounds around it. Therefore, the potential for TTS qualifies as a Level B harassment that is mediated by physiological effects upon the auditory system.
Ordnance	Explosives, chemicals, pyrotechnics, and similar stores (e.g., bombs, guns and ammunition, flares, smoke, or napalm).
Passive sonar	Detects the sound created by an object (source) in the water. This is a one-way transmission of sound waves traveling through the water from the source to the receiver.
Pelagic	Pelagic is a broad term applied to species that inhabit the open, upper portion of marine waters rather than waters adjacent to land or near the sea floor.
Permanent threshold shift (PTS)	Exposure to high-intensity sound may result in auditory effects such as noise-induced threshold shift, or simply a threshold shift (TS). If the TS becomes a permanent condition, generally as a result of physical injury to the inner ear and hearing loss, it is known as PTS.
Physiological effect	Defined in the EIS/OEIS as a variation in an animal's physiology that results from an anthropogenic acoustic exposure and exceeds the normal daily variation in physiological function.
Ping	Pulse of sound created by a sonar.
Pinger	A pulse generator using underwater sound transmission to relay data such as subject location.
Pinniped	Any member of a suborder (Pinnipedia) of aquatic carnivorous mammals (i.e., seals and sea lions) with all four limbs modified into flippers.
Platform	A vessel, pier, barge, etc. from which test systems can be deployed.
Predation	A biological interaction where a predator organism feeds on another living organism or organisms known as prey. The act of predation results in the ecologically significant death of the prey.
Received level	The level of sound that arrives at the receiver, or listening device (hydrophone). The received level is the source level minus the transmission losses from the sound traveling through the water.
Record of Decision (ROD)	A concise summary of the decision made by the project proponent (e.g., Navy) from the alternatives presented in the Final EIS. The ROD is published in the *Federal Register*.
Resonance	A phenomenon that exists when an object is vibrated at a frequency near its natural frequency of vibration – the particular frequency at which the object vibrates most readily. The size and geometry of an air cavity determine the frequency at which the cavity will resonate.
Scoping	An early and open process with federal and state agencies and interested parties to identify possible alternatives and the significant issues to be addressed in an EIS.
Sonobuoy	A device launched from an aircraft to determine environmental conditions for determination of best search tactics, to communicate with friendly submarines, and to conduct search, localization, tracking, and, as required, attack of designated hostile platforms. Sonobuoys provide both a deployable acoustical signal source and reception of underwater signals of interest.

Term	Definition
<u>So</u>und <u>Na</u>vigation and <u>R</u>anging (Sonar)	Any anthropogenic (man-made) or animal (e.g., bats, dolphins) system that uses transmitted acoustic signals and echo returns for navigation, communication, and determining position and bearing of a target. There are two broad types of anthropogenic sonar: active and passive.
Sound pressure level (SPL)	A measure of the root-mean square, or "effective," sound pressure in decibels. SPL is expressed in dB re 1 μPa for underwater sound and dB re to 20 μPa for airborne sound.
Source level	The sound pressure level of an underwater sound as measured one meter from the source.
Substrate	Any object or material upon which an organism grows or to which an organism is attached.
Tactical Sonar	A category of sonar emitting equipment that includes surface ship and submarine hull-mounted active sonars.
Take	Defined under the MMPA as "harass, hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect."
Temporary threshold shift (TTS)	Exposure to high-intensity sound may result in auditory effects such as noise-induced threshold shift, or simply a threshold shift (TS). If the TS recovers after a few minutes, hours, or days it is known as TTS.
Threatened species	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range (ESA §3[20]).
Transmission loss	Energy losses that occur as the pressure wave, or sound, travels through the water. The associated wavefront diminishes due to the spreading of the sound over an increasingly larger volume and the absorption of some of the energy by water.

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1 Purpose and Need of Proposed Action

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1 PURPOSE AND NEED OF PROPOSED ACTION

1.1 INTRODUCTION

The National Environmental Policy Act of 1969 (NEPA) requires Federal agencies to examine the environmental effects of their proposed actions. An Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) is a detailed public document providing an assessment of the potential effects a Federal action might have on the human, natural, or cultural environment. The United States (U.S.) Department of the Navy (DoN) is preparing this Draft EIS/OEIS (hereafter referred to as "EIS/OEIS") to assess the potential environmental effects associated with ongoing and proposed naval activities (described in detail in Chapter 2) within most of the U.S. Navy's (Navy) existing Northwest Training Range Complex (NWTRC). The Naval Weapons Systems Training Facility (NWSTF) Boardman exists within the defined NWTRC, but is geographically separate from the rest of the NWTRC. In addition, NWSTF Boardman has a distinct purpose and mission that sets it apart from the Range Complex. Therefore, NWSTF Boardman and the activities occurring on NWSTF Boardman, are not included in this EIS/OEIS Study Area, but is analyzed in a separate environmental analysis. The Navy is the lead agency for the EIS/OEIS, and the National Marine Fisheries Service (NMFS) is a cooperating agency.

This EIS/OEIS will analyze Navy training activities in surface and subsurface ocean operating areas (OPAREAs) from Washington to Northern California, military airspace over the Pacific Ocean and over Washington, Oregon, Northern California and Idaho, and land training areas in Washington, as described and discussed in detail in Chapter 2 (see Figures 1-1 and 1-2).

The Navy's mission is to organize, train, equip, and maintain combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. This mission is mandated by Federal law (Title 10 U.S. Code (U.S.C.) § 5062), which charges the Chief of Naval Operations (CNO) with responsibility for ensuring the readiness of the Nation's naval forces.[1] The CNO meets that directive, in part, by establishing and executing training programs, including at-sea training and exercises, including mid-frequency active (MFA) sonar activities, and ensuring naval forces have access to the ranges, OPAREAs, and airspace needed to develop and maintain skills for conducting naval activities. Activities involving Research, Development, Test, and Evaluation (RDT&E) for naval systems are an integral part of this readiness mandate.

The existing NWTRC plays a vital part in the execution of this naval readiness mandate. The NWTRC serves as a backyard range for those units homeported in the Pacific Northwest area, including those aviation, surface ship, submarine, and Explosive Ordnance Disposal (EOD) units homeported at Naval Air Station (NAS) Whidbey Island, Naval Station (NAVSTA) Everett, Puget Sound Naval Shipyard, and Naval Base Kitsap (NBK) Bremerton, NBK-Bangor, formerly known as SUBBASE Bangor. Additionally, the NWTRC supports other non-resident users and their training requirements to include Naval Special Warfare (NSW) units. The Navy's Proposed Action is a step toward ensuring the continued vitality of this essential naval training resource.

[1] Title 10, Section 5062 of the United States Code provides: "The Navy shall be organized, trained, and equipped primarily for prompt and sustained combat incident to operations at sea. It is responsible for the preparation of Naval forces necessary for the effective prosecution of war except as otherwise assigned and, in accordance with Integrated Joint Mobilization Plans, for the expansion of the peacetime components of the Navy to meet the needs of war."

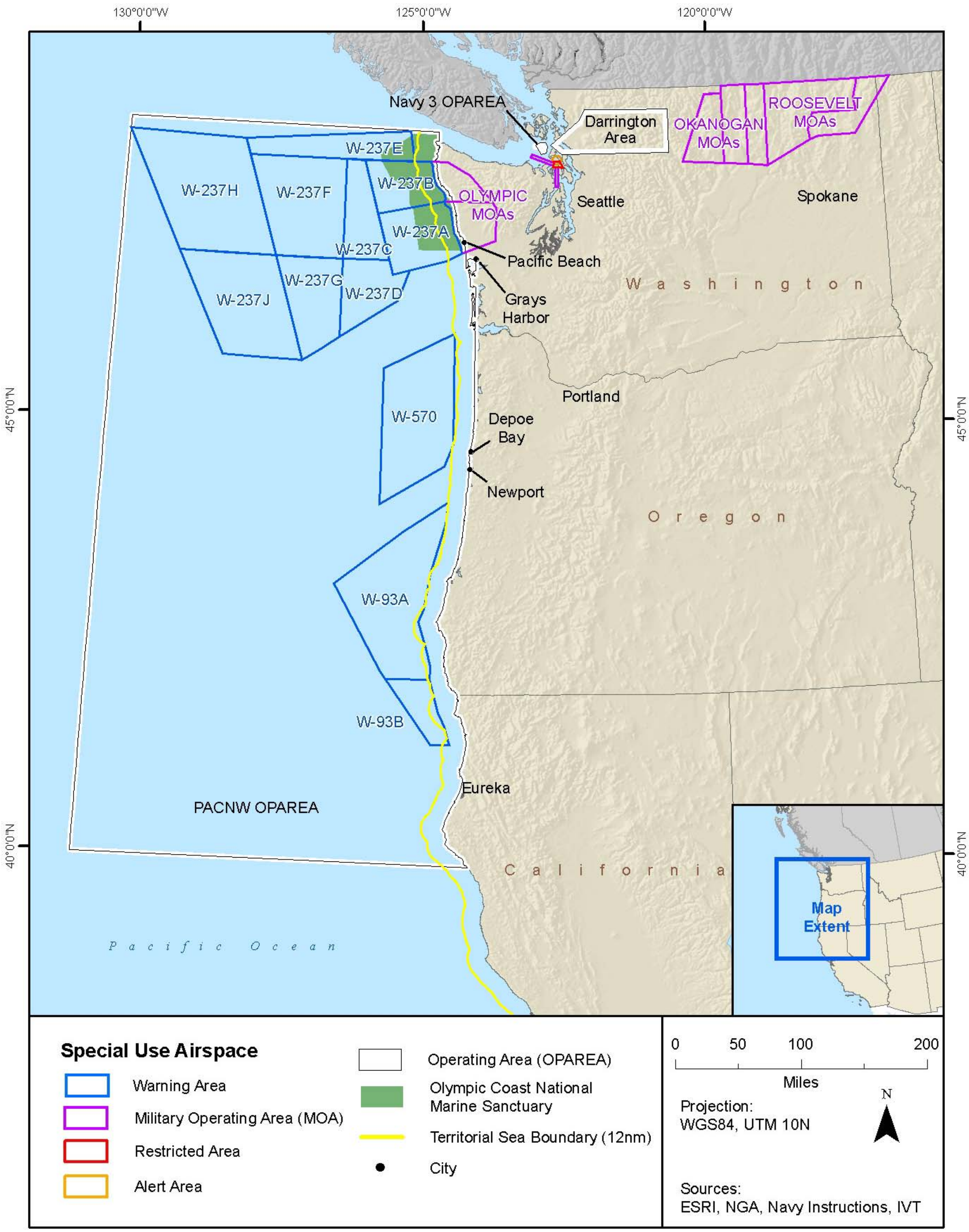

Figure 1-1: NWTRC EIS/OEIS Study Area

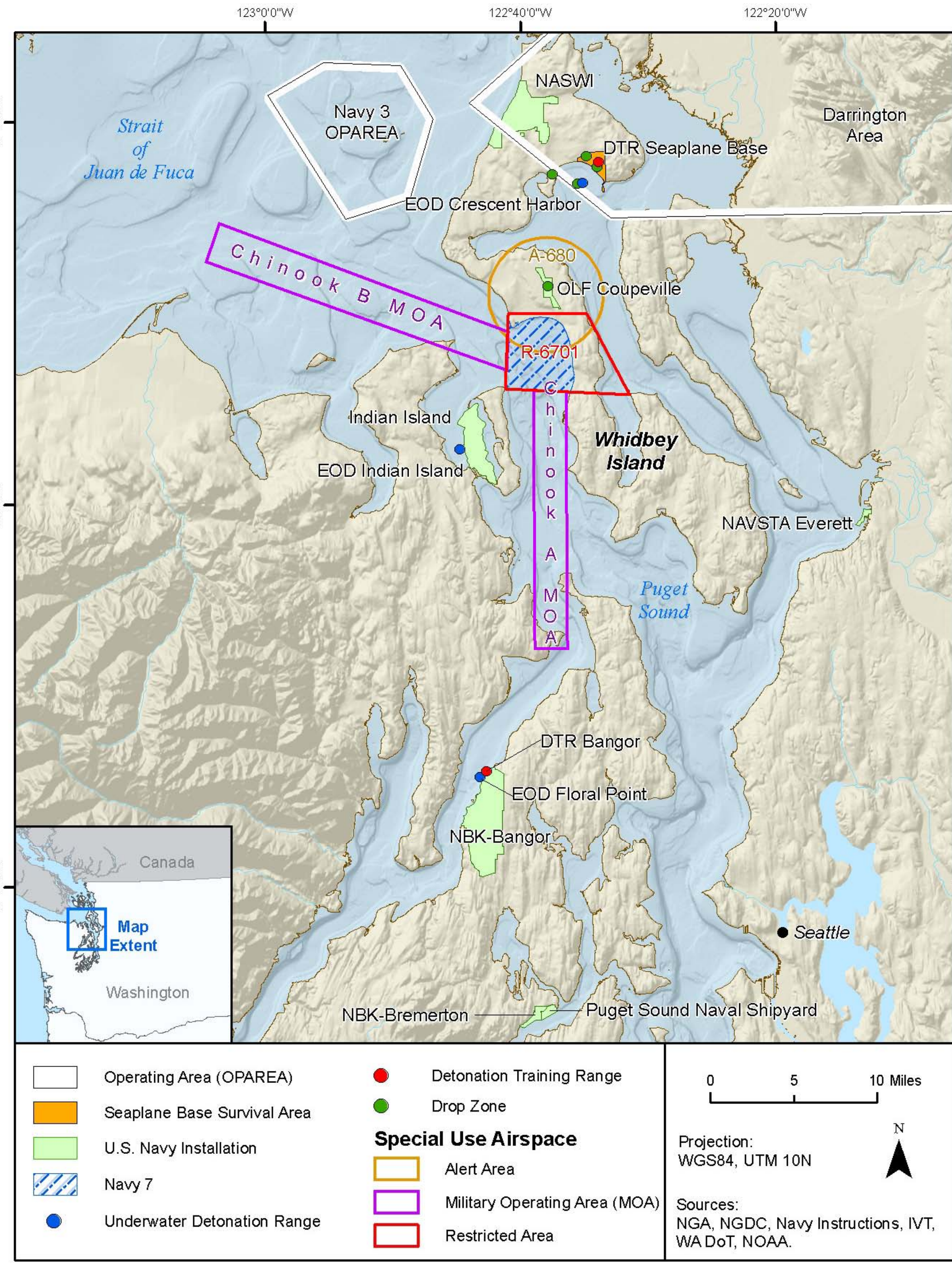

Figure 1-2: Puget Sound Training Areas of the NWTRC

The Navy proposes to implement actions within the NWTRC to:

- Maintain baseline training and RDT&E (UASs only) activities at current levels;
- Increase certain training and RDT&E activities from current levels as necessary to support the Fleet Response Training Plan (FRTP);
- Accommodate mission requirements associated with force structure changes and introduction of new weapons and systems to the Fleet; and
- Implement enhanced Range Complex capabilities.

The Proposed Action does not involve extensive changes to the NWTRC facilities, operations, or training capacities, nor does it involve an expansion of the existing NWTRC. Rather, the Proposed Action would result in selectively focused but critical enhancements and increases in training that are necessary if the Navy is to maintain a state of military readiness commensurate with the national defense mission.

The purpose of the Proposed Action is to achieve and maintain Fleet readiness using the NWTRC to support and conduct current, emerging, and future training and RDT&E activities, while enhancing training resources through investment on the ranges. The RDT&E activities in the NWTRC are comprised primarily of unmanned aerial system (UAS) activities. Undersea RDT&E is conducted at the Naval Sea Systems Command (NAVSEA) Keyport range and is analyzed in the NAVSEA Naval Undersea Warfare Command (NUWC) Keyport Range Extension EIS/OEIS (http://www-keyport.kpt.nuwc.navy.mil/EIS_Home.htm). The decision to be made by the Assistant Secretary of the Navy (Installations & Environment) is to determine both the scope of training and RDT&E (UASs only) to be conducted and the nature of range enhancements to be made within the NWTRC.

To support an informed decision, the EIS/OEIS identifies objectives and criteria for naval activities in the NWTRC. The core of the EIS/OEIS is the development and analysis of different alternatives for achieving the Navy's objectives. Alternatives development is a complex process, particularly in the dynamic context of military training. The touchstone for this process is a set of criteria that respond to the naval readiness mandate as it is implemented in the NWTRC. The criteria for developing and analyzing alternatives to meet these objectives are set forth in Section 2.2.1. These criteria provide the basis for the statement of the Proposed Action and Alternatives and selection of alternatives for further analysis (Chapter 2), as well as analysis of the environmental effects of the Proposed Action and Alternatives (Chapter 3).

This EIS/OEIS is being prepared in compliance with NEPA (42 U.S.C. § 4321 *et seq.*); the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations [C.F.R.] §§ 1500-1508); Department of the Navy Procedures for Implementing NEPA (32 C.F.R. § 775); and Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions* (44 Fed. Reg. 1957 Jan 4, 1979). The NEPA process ensures that environmental impacts of proposed major Federal actions are considered in agency decision-making. EO 12114 requires consideration of environmental impacts of actions outside the United States such as in non-territorial ocean areas. The Overseas EIS process is used outside 12 nautical miles. The areas off the coast of Washington which are part of the scope of this proposal extend outside 12 nautical miles, therefore both the EIS and OEIS process will be described in the final document. This EIS/OEIS satisfies the requirements of both NEPA and EO 12114.

1.2 BACKGROUND

The U.S. Navy has been training in the area now defined as the NWTRC for national defense purposes since World War II. The land, air, and sea spaces of the NWTRC have provided and will continue to provide a safe and realistic training and testing environment for naval forces charged with defense of the Nation.

1.2.1 Why the Navy Trains

The United States military is maintained to ensure the freedom and safety of all Americans both at home and abroad. In order to do so, Title 10 of the United States Code requires the Navy to “maintain, train and equip combat-ready naval forces capable of winning wars, deterring aggression and maintaining freedom of the seas” (10 U.S.C. §5062). Modern war and security operations are complex. Modern weaponry has brought both unprecedented opportunity and innumerable challenges to the Navy. Smart weapons, used properly, are very accurate and actually allow the Navy to accomplish its mission with greater precision and far less destruction than in past conflicts. But these modern smart weapons are very complex to use. U.S. military personnel must train regularly with them to understand their capabilities, limitations, and operation. Modern military actions require teamwork between hundreds or thousands of people, and their various equipment, vehicles, ships, and aircraft, all working individually and as a coordinated unit to achieve success. Navy training addresses all aspects of the team, from the individual to joint and coalition teamwork. To do this, the Navy employs a building block approach to training. Training doctrine and procedures are based on operational requirements for deployment of naval forces. Training proceeds on a continuum, from teaching basic and specialized individual military skills, to intermediate skills or small unit training, to advanced, integrated training events, culminating in multi-service (Joint) exercises or pre-deployment certification events.

In order to provide the experience so important to success and survival, training must be as realistic as possible. The Navy often employs simulators and synthetic training to provide early skill repetition and to enhance teamwork, but live training in a realistic environment is vital to success. This requires sufficient sea and airspace to maneuver tactically, realistic targets and objectives, simulated opposition that creates a realistic enemy, and instrumentation to objectively monitor the events and learn to correct errors.

Range Complexes provide a controlled and safe environment with threat representative targets that enable U.S. forces to conduct realistic combat-like training as they undergo all phases of the graduated buildup needed for combat ready deployment. The Navy’s ranges and operating areas provide the space necessary to conduct controlled and safe training scenarios representative of those that U.S. forces would have to face in actual combat. The Range Complexes are designed to provide the most realistic training in the most relevant environments, replicating to the best extent possible the operational stresses of warfare. The integration of undersea ranges and OPAREAs with land training ranges are critical to this realism, allowing execution of multi-dimensional exercises in complex scenarios. Ranges and OPAREAs also provide instrumentation that captures the performance of Navy tactics and equipment in order to provide the feedback and assessment that is essential for constructive criticism of personnel, equipment, and tactics. The live-fire phase of training facilitates assessment of the Navy’s ability to place weapons on target with the required level of precision while under a stressful environment. Live training, most of it accomplished in the waters off the nation’s East and West Coasts, will remain the cornerstone of readiness as U.S. military forces are transformed for a security environment characterized by threats of terrorism.

Navy training activities focus on achieving proficiency in each of several functional areas encompassed by Navy operations. These functional areas, known as Primary Mission Areas (PMARs), are: Anti-Air Warfare (AAW), Amphibious Warfare (AMW), Anti-Surface Warfare (ASUW), Anti-submarine Warfare (ASW), Mine Warfare (MIW), Strike Warfare (STW), Electronic Combat (EC), and Naval Special Warfare (NSW). Each training event addressed in the EIS/OEIS is categorized under one of the PMARS.

The NWTRC is one of several Navy Range Complexes used for training of operational forces, RDT&E (UASs only) of military equipment, and other military activities. As with each Navy Range Complex, the primary mission of the NWTRC is to provide a realistic training environment for naval forces to ensure they have the capabilities and high state of readiness required to accomplish assigned missions.

Training is focused on preparing for worldwide deployment. Naval forces deploy in specially organized units called Strike Groups. A Strike Group may be organized around one or more aircraft carriers, together with several surface combatant ships and submarines, collectively known as a Carrier Strike Group (CSG). A naval force known as a Surface Strike Group (SSG) consists of three or more surface combatant ships. The Navy and Marine Corps deploy CSGs and SSGs on a continuous basis. The number and composition of Strike Groups deployed, and the schedule for deployment, is determined based on the worldwide requirements and commitments.

Pre-deployment training is governed by the Navy's FRTP. The FRTP sets a deployment cycle for the Strike Groups that includes three phases: (1) basic, intermediate, and advanced pre-deployment training and certification, (2) deployment, and (3) post-deployment sustainment, training, and maintenance. While several Strike Groups are always deployed to provide a global naval presence, Strike Groups must also be ready to "surge," or deploy rapidly outside of their normal deployment schedule in response to directives from the National Command Authority. One objective of the FRTP is to provide this surge capability. The FRTP calls for the ability to train and deploy six CSGs in a very short time, and two more in stages soon thereafter. Established in 2003, the FRTP calls for changes in the Fleet training cycle, including acceleration of the cycle and near-simultaneous execution of similar training events. Deployment schedules are not fixed, but must remain flexible and responsive to the Nation's security needs. The capability and capacity of ranges such as the NWTRC Range Complex to support the entire training continuum must be available when and as needed.

1.2.2 Tactical Training Theater Assessment and Planning (TAP) Program

The goal of the Navy in training its forces is to replicate as nearly as possible the operational environments expected in war. Navy Range Complexes provide the training sites, and must be capable of providing the training environments necessary to support comprehensive training of naval forces. A Range Complex is a designated area that can encompass a land mass, body of water (above and below the surface), and/or airspace used to conduct training and RDT&E (UASs only) of military hardware, personnel, tactics, ordnance, explosives, or electronic combat systems. A Range Complex can consist of several ranges, OPAREAs, military operating areas (MOAs), and special use airspace (SUA).

The TAP Program serves as the Navy's range sustainment program. The purpose of TAP is to support Navy objectives that: (1) promote use and management of ranges (such as the NWTRC) in a manner that supports national security objectives and a high state of combat readiness, and (2) ensure the long-term viability of range assets while protecting human health and the environment. The TAP Program focuses specifically on the sustainability of ranges, OPAREAs, and airspace areas that support the FRTP.

The Navy's Required Capabilities Document (RCD) of September 2005, is a product of the TAP program. The purpose of the RCD is to quantitatively define the required capabilities that would allow Navy ranges to support mission-essential training and RDT&E (UASs ONLY). In sum, the RCD defines required range capabilities in much the same manner as a specification for an aircraft might define required flight characteristics and other system capabilities. The RCD uses several factors to determine range capability requirements or criteria. These factors include range attributes, range-related systems, training levels, and PMARs.

- *Range attributes* include Airspace, Sea Space, Undersea Space, and Land Area. The RCD identifies spatial dimensions required to conduct a given level or type of training in a given training medium.

- *Range-related systems* include systems and infrastructure for scheduling, communications, meteorological data, targets, training instrumentation, and opposition force simulation.
- *Training levels* consist of Basic, Intermediate, and Advanced.
- *PMARs* are the functional areas encompassed by Navy operations. The eight PMARs are: AAW, AMW, ASUW, ASW, MIW, STW, EC, and NSW. The RCD also captures the required capabilities associated with naval aviation and surface/subsurface RDT&E (UASs only).

The RCD provides guidelines for range requirements, but is not range-specific. The Navy therefore has developed an analysis of its requirements for each Range Complex. These analyses:

- Provide comprehensive descriptions of ranges, OPAREAs, and training areas within a given Range Complex;
- Assess training and RDT&E (UASs only) activities currently conducted within the Range Complex;
- Identify investment needs and strategy for maintenance, range improvement, and modernization;
- Develop a strategic vision for range activities with a long-term planning horizon;
- Provide Range Complex sustainable management principles and practices, to include environmental stewardship and community outreach; and
- Identify encroachments on ranges, and evaluate the potential impacts of encroachments on training and RDT&E (UASs only).

For the NWTRC, this analysis serves as a useful planning tool for developing the Proposed Action and Alternatives to be assessed in this EIS/OEIS.

1.2.3 The Strategic Importance of the Existing NWTRC

The NWTRC is characterized by a unique combination of attributes that make it a strategically important Range Complex for the Navy. These attributes include:

Proximity to the Homeport of Units in the Pacific Northwest. The NWTRC serves as a backyard range for those units homeported in the Pacific Northwest area including those aviation, surface ship, submarine, and EOD forces homeported at NAS Whidbey Island, NAVSTA Everett, NBK-Bremerton, NBK-Bangor, and Puget Sound Naval Shipyard.

The Pacific Northwest region is home to thousands of military families. The Navy strives, and in many cases is required by law to track and where possible limit “personnel tempo,” meaning the amount of time Sailors and Marines spend deployed away from home. Personnel tempo is an important factor in family readiness, morale, and retention. The availability of the NWTRC as a “backyard” training range is critical to Navy efforts in these areas.

Uniqueness. The NWTRC Study Area is unique in that it offers training across the spectrum of naval missions in all weather conditions and over many varied environments from deep ocean to shallow inland waters and from coastal beaches to mountains. The radio frequency spectrum is relatively unencumbered, which allows more realistic EC training for P-3 and EP-3 Orion, and EA-6B Prowler aircraft. The EC mission is further enabled by the presence of an electronic signal threat simulator located at Outlying Landing Field (OLF) Coupeville and increased opportunities for realistic suppression of enemy air defense training. The signal threat simulator generates electronic signals that simulate threat radar systems. Aircrews train to recognize that signal and react to it.

Naval Special Warfare, specifically Navy Sea Air Land (SEAL) forces, requires cold water operating areas for certain aspects of their training. The open ocean and coastal areas in the Northwest and protected waters of Puget Sound provide this environment throughout the year. SEAL Delivery Vehicle Team One maintains equipment at Naval Undersea Warfare Center Division Keyport and trains here regularly due to the area's unique qualities.

Area of Training Space. The NWTRC has a large amount of air and surface/subsurface area within the complex boundaries. Detailed descriptions of these areas are provided in Section 1.3.2. The abundance of special use airspace within the complex provides both over water and over land training opportunities for the local P-3 and EA-6B aircraft. The Pacific Northwest Ocean Surface/Subsurface Operating Area (PACNW OPAREA) is the second largest of the Navy's ocean operating areas. It provides ample space for large scale naval exercises and opportunities for joint and allied training.

1.3 Overview of the NWTRC

1.3.1 Mission

The NWTRC is the principle backyard range for surface, submarine, aviation, and EOD units located at NAS Whidbey Island, NAVSTA Everett, Puget Sound Naval Station, NBK-Bremerton and NBK-Bangor, WA, in addition to supporting other non-resident users and their training requirements to include NSW units. Accordingly, the Commander, U.S. Pacific Fleet (CPF) and Commander, United States Navy Fleet Forces (USFF) strategic vision for this complex is for the Range Complex to support naval operational readiness by providing a realistic, live-training environment for forces assigned to the Pacific Fleet and other users with the capability and capacity to support current, emerging, and future training and RDT&E (UASs only) requirements.

1.3.2 Primary Components

The Range Complex includes ranges, OPAREAs, and airspace that extend west to 250 nautical miles (nm) (463 kilometers [km]) beyond the coast of Washington, Oregon, Northern California and east to the Washington/Idaho border. The components of the NWTRC encompass 122,400 nm^2 (420,163 km^2) of surface/subsurface ocean OPAREAs, 46,048 nm^2 (157,928 km^2) of SUA, and 875 acres (354 hectares) of land. For range management and scheduling purposes, the NWTRC is divided into numerous sub-component ranges or training areas used to conduct training and RDT&E activities (UASs only), as described in detail in Chapter 2. The NWTRC consists of two primary components; the Offshore Area and the Inshore Area.

1.3.2.1 Offshore Area

The ocean areas of the Range Complex include surface and subsurface operating areas extending generally west from the coastline of Northern California, Oregon, and Washington for a distance of approximately 250 nm (463 km) into international waters (see Figure 1-1).

- Pacific Northwest Ocean Surface/Subsurface OPAREA. The PACNW OPAREA is approximately 510 nm (945 km) in length from the northern boundary to the southern boundary, and 250 nm (463 km) from the coastline to the western boundary at 130^o W longitude. Total surface area of the PACNW OPAREA is 122,400 nm^2 (420,163 km^2).
- Warning Area 237. W-237 comprises 33,997 nm^2 (116,606 km^2) of airspace that generally overlays the NWTRC Ocean OPAREAS off the coast of Washington, W-237 begins approximately 3 nm (5 km) off the coast and extends westward in international waters and airspace for a distance of approximately 250 nm (463 km) from the ocean surface up to several specified altitudes depending upon which sub-area is used. The floor of W-237 airspace begins at the ocean surface, and the ceiling varies between 27,000 ft (8,230 m) and unlimited altitude.

- W-570, located off the central coast of Oregon, is 4,470 nm^2 (15,330 km^2) in size. The airspace begins at the ocean's surface and extends to 50,000 ft (15,240 m). This area is used by P-3 aircraft for reconnaissance training.
- W-93 is located south of W-570, off the coast of Oregon and northern California. The 4,652 nm^2 (15,960 km^2) of airspace in W-570 is also used for P-3 reconnaissance training and extends from the surface to 50,000 ft (15,240 m).

1.3.2.2 Inshore Area

The Inshore Area includes all air, land, sea, and undersea ranges and OPAREAs inland of the coastline and including Puget Sound. There are several areas within Puget Sound routinely used by the Navy for a variety of surface and underwater activities. These areas are depicted on Figure 1-2 and include:

- Navy 3. Navy 3 is a polygon of water space used by Navy ships for training. This 46 nm^2 (158 km^2) area is located 8 nm (15 km) west of Ault Field, NAS Whidbey Island, in the Strait of Juan de Fuca.
- Navy 7. Navy 7 is defined as the sea surface and subsurface area beneath R-6701.
- Crescent Harbor Underwater EOD Range. This EOD underwater range is located in Crescent Harbor off of the Seaplane Base at Whidbey Island.
- Indian Island Underwater EOD Range. This area is located offshore, just west of Naval Magazine (NAVMAG) Indian Island.
- Floral Point Underwater EOD Range. This area, also known as the Bangor EOD Underwater Range, is located within a Navy operating area in Hood Canal, near NBK-Bangor.
- Olympic MOAs. The Olympic A and B MOAs are located over the northwest coast of the Olympic Peninsula in Washington and extends out 3 nm to join with W-237. The MOAs cover 1,641 nm^2 (5,628 km^2) of area. Olympic A and B have a floor of 6,000 feet (ft) (1,829 meters [m]) and a ceiling of 18,000 ft (5,486 m). Olympic B air traffic controlled assigned airspace (ATCAA) has a floor of 18,000 ft (5,486 m) and a ceiling of 50,000 ft (15,240 m).
- The Chinook A and B MOAs are adjacent to R-6701 over the eastern portion of the Strait of Juan de Fuca and Admiralty Inlet respectively. Both Chinook MOAs cover 56 nm^2 (192 km^2) of surface area and have a floor of 300 ft (91 m) and a ceiling of 5,000 ft (1,524 m).
- Restricted Area 6701. R-6701 is a 22 nm^2 (75 km^2) area over central Whidbey Island that extends from the surface to 5,000 ft (1,524 m). The combination of R-6701 and the waters beneath it are sometimes referred to as the Admiralty Bay Mining Range.
- Okanogan MOA. The Okanogan MOA is located above north central Washington and covers 4,364 nm^2 (14,968 km^2) in area. This MOA is divided into A, B, and C sections. Okanogan A is available from 9,000 ft (2,743 m) to 18,000 ft (5,486 m). Okanogan B and C have a floor of 300 ft (91 m) above the ground and a ceiling of 9,000 ft (2,743 m). The ATCAAs corresponding to the Okanogan MOA extends the airspace to 50,000 ft (15,240 m).
- Roosevelt MOA. The Roosevelt MOA is located just east of the Okanogan MOA and covers an area of 5,413 nm^2 (18,566 km^2). This MOA is divided into two sections. Roosevelt A has a floor of 9,000 ft (2,743 m) and a ceiling of 18,000 ft (5,486 m). Roosevelt B has a floor of 300 ft (91 m) above the ground and a ceiling of 9,000 ft (2,743 m). ATCAAs associated with the Roosevelt MOA extends its airspace to 50,000 ft (15,240 m).
- Land Ranges. The land areas of the Inshore Area, all of which are on Navy property, include the Seaplane Base Survival Area, OLF Coupeville, the EOD detonation training range at NBK-Bangor, and Indian Island. Seaplane Base Survival Area comprises approximately 875 acres (354 hectares) of undeveloped Navy property, located adjacent to Crescent Harbor. It provides a robust suite of range capabilities for use in small unit amphibious and land tactical maneuvers, land

navigation, and survival training. Additionally, Seaplane Base Survival Area has several unimproved helicopter landing zones, and small boat landing beaches. Several parachute drop zones are located at Seaplane Base Survival Area and at OLF Coupeville as shown on Figure 1-2. Indian Island is located west of Marrowstone Island between the waters of Port Townsend and Whidbey Island. It is approximately 4.2 miles (6.7 km) long and oriented on a north-south axis. Indian Island is used by NSW to conduct insertion/extraction activities. All activities at Indian Island are covert in nature, and no live fire weapons or other ordnance are used.

1.3.3 Shortfalls of the NWTRC

The NWTRC currently provides strategically vital training attributes (see Section 1.2.3). Nevertheless, certain shortfalls constrain its ability to support required training. Correcting these shortfalls would enhance the Range Complex to provide the minimum acceptable training environment required by naval forces that utilize the Range Complex. Current shortfalls include an inadequate number and type of effective targets, inadequate "opposition forces" training environments, and insufficient instrumentation systems for the conduct of AAW, ASUW, STW, EC and NSW/EOD training. The capabilities of the NWTRC must be sustained, upgraded, and modernized to address these deficiencies. Moreover, the Range Complex must have the flexibility to adapt and transform the training environment as new weapons systems are introduced, new threat capabilities emerge, and new technologies offer improved training opportunities.

1.4 PURPOSE AND NEED FOR THE PROPOSED ACTION

Given the vital importance of the NWTRC to the readiness of naval forces, the unique training environment provided by the Range Complex and the shortfalls in the Range Complex that affect the quality of training, the Navy proposes to take actions for the purposes of:

- Achieving and maintaining Fleet readiness using the NWTRC to support and conduct current, emerging, and future training and RDT&E activities (primarily Unmanned Aerial Systems [UASs]);
- Expanding warfare missions supported by the NWTRC, consistent with the requirements of the FRTP; and
- Upgrading and modernizing existing range capabilities to address shortfalls and deficiencies in current training ranges.

The Proposed Action is needed to provide a training environment consisting of ranges, training areas, and range instrumentation with the capacity and capabilities to fully support required training tasks for operational units and military schools. The Navy has developed alternatives criteria based on this statement of the purpose and need for Chapter 2 (Proposed Action).

In this regard, the NWTRC furthers the Navy's execution of its roles and responsibilities under Title 10. To comply with its Title 10 mandate, the Navy needs to:

- Maintain current levels of military readiness by training in the NWTRC;
- Accommodate future increases in operational training tempo in the NWTRC and support the rapid deployment of naval units or Strike Groups;
- Achieve and sustain readiness of ships, submarines, and aviation squadrons using the NWTRC so that the Navy can quickly surge significant combat power in the event of a national crisis or contingency operation, consistent with the FRTP;
- Support the acquisition and implementation into the Fleet of advanced military technology using the NWTRC to conduct training events for new platforms and associated weapons systems (EA-18G Growler aircraft, Guided Missile Submarines [SSGN], P-8 Multimission Maritime Aircraft [MMA], and RDT&E for several types of Unmanned Aerial Systems [UASs]);

- Identify shortfalls in range capabilities, particularly training infrastructure and instrumentation, and address through range enhancements; and
- Maintain the long-term viability of the NWTRC as a premiere Navy training and testing area while protecting human health and the environment, and enhancing the quality and enhancing the capabilities and safety of the Range Complex.

1.5 SCOPE AND CONTENT OF THE EIS/OEIS

This EIS/OEIS provides an assessment of environmental effects associated with current and proposed training activities, changes in force structure (to include new training requirements associated with evolving weapons systems and platforms), and range enhancements in the Range Complex.

Under customary international law, U.S. Territory extends out into the ocean a distance of 3 nm (5.6 km) from the coastline. By Presidential Proclamation 5928 (issued December 27, 1988), the United States extended its exercise of sovereignty and jurisdiction under international law to 12 nm (22 km), but the Proclamation expressly provides that it does not extend or otherwise alter existing Federal law or any associated jurisdiction, rights, legal interests, or obligations. The Proclamation thus did not alter existing legal obligations under NEPA. As a matter of policy, however, the Department of the Navy has elected to include areas of the NWTRC that lie within 12 nm (22 km), or the territorial seas, for analysis under NEPA. Environmental effects in the areas outside of U.S. territorial seas (i.e., outside of 12 nm) are analyzed under EO 12114 and associated implementing regulations.

1.6 THE ENVIRONMENTAL REVIEW PROCESS

1.6.1 The National Environmental Policy Act

The National Environmental Policy Act of 1969 requires Federal agencies to examine the environmental effects of their Proposed Actions. An EIS is a detailed public document that provides an assessment of the potential effects that a Federal action might have on the human, natural, or cultural environment. The Navy is the lead agency for the EIS/OEIS; NMFS is a cooperating agency.

The Navy is preparing an EIS/OEIS for the NWTRC to assess the effects of ongoing and proposed future activities on the environment. The EIS/OEIS also gives the Navy an opportunity to review its procedures and ensure the benefits of recent scientific and technological advances are applied toward minimizing environmental effects.

The first step in the NEPA process is the preparation of a notice of intent (NOI) to develop the EIS. The NOI provides an overview of the Proposed Action and the scope of the EIS (see Appendix A). The NOI for this project was published in the *Federal Register* on July 27, 2007, and in seven (7) local newspapers (*Seattle Times, Kitsap Sun, Whidbey News-Times, Peninsula Daily, Daily World, The News Guard, Times-Standard*). The NOI and newspaper notices included information regarding the procedure for submitting comments, a list of information repositories (public libraries), the project website address (http://www.NWTRangecomplexEIS.com), and the dates and locations of the scoping meetings.

Scoping is an early and open process for developing the "scope" of issues to be addressed in the EIS/OEIS and for identifying significant issues related to a Proposed Action. The five scoping meetings for this EIS/OEIS (held in Oak Harbor, WA; Pacific Beach, WA; Grays Harbor, WA; Depoe Bay, OR; and Eureka, CA) helped to define, prioritize, and convey issues to the Navy (see Appendix F for information on the scoping meetings). Comments from the public, as well as agencies and special interest groups, have been considered in the preparation of this EIS/OEIS.

Some of the comments received during the scoping process are categorized and summarized in Table 1-1. This table is not intended to provide a complete listing, but to show the extent of the scope of comments. (For a complete list of scoping comments, refer to Appendix F).

Table 1-1: Public Scoping Comment Summary

Category	Commentator	Discussion Topic/ Summary of Concern
Alternatives	Olympic Coast National Marine Sanctuary (OCNMS) Advisory Council Private Citizen Olympic Coast Alliance	Navy consideration of a broader analysis of alternatives within the OCNMS and outside the Study Area. Alternatives to clean up Puget Sound. Alternative that includes reducing training.
Marine Life	Private Citizens California Coastal Commission	Impacts to marine life and habitat from sound, hazardous materials, pollution. ESA-listed species.
Airborne Noise	Private Citizens	Noise from aircraft.
Sonar, Sound in the Water	California Coastal Commission Private Citizen	Mid- and low-frequency sound sources, ranges, power settings, etc. Underwater detonations.
Birds and Terrestrial Species	OCNMS Advisory Council California Coastal Commission Environmental Protection Agency (EPA)	Noise disturbance of nesting or migratory waterfowl, shore birds, or other Avian species within the OCNMS. Bird strike hazards. Habitat fragmentation from land use.
Cultural Resources	OCNMS Advisory Council EPA, Olympic Coast Alliance	Damage to cultural and historical resources, interference with tribal fishing and tribal ceremonial harvesting. Consultation with Native American tribes.
Economic Impacts	Private Citizen	Impacts to commercial and recreational fishing.

Subsequent to the scoping process, this Draft EIS/OIES was prepared to assess the potential effects of the Proposed Action and Alternatives on the environment. It was then provided to the U.S. EPA for review and comment. A notice of availability was published in the *Federal Register* and notices were placed in the aforementioned newspapers announcing the availability of the Draft EIS/OEIS. The Draft EIS/OEIS is now available for general review and is being circulated for review and comment. Public meetings will be advertised and held in the same geographic locations as the scoping meetings to receive public comments on the Draft EIS/OEIS.

A Final EIS/OEIS will be prepared that responds to all public comments received on the Draft EIS/OEIS. Responses to public comments may take various forms as necessary, including correction of data, clarifications of and modifications to analytical approaches, and inclusion of additional data or analyses. A notice of availability will be published in the Federal Register and the Final EIS/OEIS will be made available for public review.

The Record of Decision (ROD) reflects the Navy's final decision on the Proposed Action, the rationale behind that decision, and any commitments to monitoring and mitigation. A ROD will be issued by the Navy following the issuance of the Final EIS/OEIS and a 30-day review/no action period. The ROD will be published in the *Federal Register*, distributed to agencies and interested parties, and posted on the NWTRC EIS/OEIS website. Its availability will also be announced in local newspapers.

1.6.2 Government-to-Government Consultations

As part of this EIS/OEIS process, the Navy has invited Government-to-Government consultations with 19 federally recognized tribes from Washington and 11 federally recognized tribes from Oregon and California. A full listing of tribes is provided in Section 3.12.1.3 of this EIS/OEIS. Meetings were initiated on September 5, 2007 and will continue as the EIS/OEIS is developed. It is Navy's intention to complete the Government-to-Government consultations on this document before the public release of the ROD.

The National Marine Sanctuaries Act (NMSA) (16 U.S.C. §§ 1431 et. seq.) requires federal agencies whose actions are "likely to destroy, cause the loss of, or injure a sanctuary resource," to consult with the program before taking the action. The program is, in these cases, required to recommend reasonable and prudent alternatives to protect sanctuary resources. It was determined that Federal interagency consultation pursuant to section 304(d) of the NMSA was not necessary because the Proposed Action does not include new activities.

1.6.3 Regulatory Agency Briefings

The Navy held a series of regulatory agency briefings between September 7 and September 27, 2007, with the following regulators: National Oceanic and Atmospheric Administration (NOAA)/ National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), Washington Department of Natural Resources (WDNR), and the Washington State Governor's Office.

The parties to these meetings raised a variety of issues and concerns. In brief, some of the main concerns included clarification on current quantity and types of training, proposed increases in training activities, new training activities and systems, hypoxia events off the Washington coast, impacts to geoduck aquaculture, expended materials and debris in the water, bioaccumulation of ordnance related constituents and other toxic materials, underwater detonations and their effects on fish and marine mammals, use of sonar in Puget Sound, use of medium frequency active sonar (MFAS), encroachment, fuel spill issues, and conflicts with fisherman and crabbers that use the areas within the NWTRC.

1.6.4 Jurisdictional Considerations (EO 12114)

Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*, directs Federal agencies to provide for informed decision-making for major Federal actions outside the U.S. territorial sea, including action within the Exclusive Economic Zone (EEZ) of, but not including action within the territorial sea of, a foreign nation. For purposes of this EIS/OEIS, areas outside U.S. territorial seas are considered to be areas beyond 12 nm (22 km) from shore. Since this EIS/OEIS satisfies the requirements of EO 12114, analysis of activities or impacts occurring, or proposed to occur, outside of 12 nm (22 km) is provided. Table 1-2 presents a list of training and RDT&E activities (by warfare area) and the geographical area in which they occur (0-3 nm, 3-12 nm, and 12 nm and beyond). As shown in Table 1-2, the training activities that occur exclusively outside of territorial waters (not within 12 nm of shore) are Air-to-Air Missile exercises, Surface-to-Air Gunnery exercises, Surface-to-Air Missile exercises, Surface-to-Surface Gunnery exercises, Air-to-Surface Bombing exercises, Sinking Exercises, and ASW Tracking exercise-EER. In addition, certain types of training occur predominantly in waters outside of 12 nm (22 km). For example, more than 85% of current AAW and ASW training occurs beyond 12 nm (22 km) from shore.

For the majority of resource sections addressed in this EIS/OEIS, projected impacts outside of U.S. territorial waters would be similar to those within territorial waters. Beyond 12 nm (22 km) is simply a jurisdictional boundary and is not delineated for purposes of scheduling or management of military training activities. In addition, the baseline environment and associated impacts to the various resource areas analyzed in this EIS/OEIS are not substantially different within or outside the 12 nm (22 km) jurisdictional boundary. Therefore, for these resource sections, the impact analyses contained in the main body of the EIS/OEIS is comprehensive and follow both NEPA and EO 12114 guidelines. The description of the affected environment addresses areas both within and beyond U.S. territorial sea.

1.6.5 Coastal Zone Management Act

The *Coastal Zone Management Act* (CZMA) of 1972 (16 U.S.C. § 1451) encourages coastal States to be proactive in managing coastal uses and coastal resources in the coastal zone. The CZMA is a voluntary program; participating States submit a Coastal Management Plan (CMP) to NOAA for approval. Activities of Federal agencies affecting the coastal zone are consistent to the maximum extent practicable with the enforceable policies of NOAA-approved CMPs.

Table 1-2: Geographical Occurrence of Current Training and RDT&E Activities

Training Activities		0-3 NM	3-12 NM	Beyond 12 NM
AAW[1]	Air Combat Maneuvers	X	X	X
	Air-to-Air Missile Exercise			X
	Surface-to-Air Gunnery Exercise			X
	Surface-to-Air Missile Exercise			X
ASUW	Surface-to-Surface Gunnery Exercise			X
	Air-to-Surface Bombing Exercise			X
	Sinking Exercise			X
ASW	Antisubmarine Warfare Tracking Exercise (ASW TRACKEX) - MPA	X	X	X
	Antisubmarine Warfare Tracking Exercise (ASW TRACKEX) - EER			X
	Antisubmarine Warfare Tracking Exercise (ASW TRACKEX) – Surface Ship		X	X
	Antisubmarine Warfare Tracking Exercise (ASW TRACKEX) - Submarine		X	X
EC	Electronic Combat Exercises	X	X	X
MIW	Mine Countermeasures	X		
	Land Demolitions	X		
NSW	Insertion/Extraction	X		
	NSW Training	X		
STW	HARM Exercise (Non-firing)	X	X	X
Support Ops	Intelligence, Surveillance, and Reconnaissance (ISR)	X	X	X
	Unmanned Aerial System Training and RDT&E	X	X	X
1 –The majority of AAW activities (>85%) occur beyond 12 nm				

As a component of the Proposed Action, the Navy will initiate a Federal consistency process under the CZMA with the Washington Department of Ecology (DOE), the Oregon Department of Land Conservation and Development (DLCD), and the California Coastal Commission. The Navy will submit its consistency determination to the Washington CZM Program, the Oregon DLCD, and the California Coastal Commission in due course. The coastal consistency determination process, by law, requires the Washington CZM Program, the Oregon DLCD, and the California Coastal Commission to afford public comment and involvement on Federal consistency determinations.

Washington, Oregon, and California participate in the CZMA through approved CMPs. The coastal zone is defined in the CZMA (at 16 U.S.C. § 1453). Accordingly, the coastal zone extends 3 nm seaward from the shoreline (i.e., "to the outer limit of State title and ownership under the Submerged Lands Act"). The coastal zone extends inland from the shorelines only to the extent necessary to control the shorelines; however, excluded from the coastal zone are lands the use of which is by law subject solely to the discretion of or which is held in trust by the Federal Government (16 U.S.C. § 1453). Each state determines the extent of its coastal zone.

1.6.5.1 Washington Coastal Zone

Washington became the first State to achieve a Federally-approved State coastal management program in 1976. As defined by the Washington DOE (Washington Administrative Code 173- 18; 20; 22; 27), Washington’s coastal zone is comprised of the following fifteen counties: Clallam, Grays Harbor, Island, Jefferson, King, Kitsap, Mason, Pacific, Pierce, San Juan, Skagit, Snohomish, Thurston, Wahkiakum, and Whatcom. Each of these counties is bounded by saltwater, either by the Pacific Ocean, Strait of Juan de Fuca, or Puget Sound. Because the Columbia River contains measurable quantities of salt water upstream to Pillar Rock, Wahkiakum County is included as a coastal zone county. The coastal zone includes all non-federal lands and waters from the coastline seaward for 3 nm. For the areas that abut the ocean, the coastline is defined as the position of ordinary low water. The coastline along the inland marine waters is located at the seaward limit of rivers, bays, estuaries, or sound (Washington State Department of Ecology 2001).

The relationship of NWTRC training areas to Washington's coastal zone are classified in accordance with the following:

- Outside. Includes areas that are located outside of coastal counties and are not contiguous to the coastal zone.
- Inside. Includes areas that are located in coastal counties and are not under sole control of the Federal government.
- Contiguous. Includes areas that are located within coastal counties, but are Federally excluded from the coastal zone because they are under sole control of the Federal government (e.g., Federally owned lands or Federally controlled waters).

“Coastal use or resource” is any land or water use or natural resource of the coastal zone. Coastal uses include, but are not limited to: public access, recreation, fishing, historic or cultural preservation, development, hazards management, marinas and floodplain management, scenic and aesthetic enjoyment, and resource creation or restoration projects. Natural resources include biological or physical resources that are found permanently or cyclically within a State's coastal zone. Biological and physical resources include, but are not limited to: air, tidal and non-tidal wetlands, ocean waters, estuaries, rivers, streams, lakes, aquifers, submerged aquatic vegetation, land, plants, trees, minerals, fish, shellfish, invertebrates, amphibians, birds, mammals, reptiles, and coastal resources of national significance (Department of the Navy 2002).

The enforceable policies for the State of Washington are those which are legally binding through constitutional provisions, laws, regulations, land use plans, ordinances, or judicial or administrative decisions, by which a State exerts control over private and public land and water uses and natural resources in the coastal zone, and which are incorporated in the Federally-approved State coastal program. The enforceable policies of the Washington DOE include the following five laws:

- Shoreline Management Act (SMA),
- Ocean Resources Management Act (ORMA),
- Clean Water Act (CWA),
- Clean Air Act (CAA), and

- Energy Facility Site Evaluation Council (EFSEC) Law.

1.6.5.2 Oregon Coastal Zone

The Oregon Coastal Management Program (OCMP) was Federally-approved in 1977 (Oregon Revised Statutes 197.628- 197.650; Oregon Administrative Rules Chapter 660). The Oregon Department of Land Conservation and Development (DLCD) is the State's designated coastal management agency and is responsible for reviewing projects for consistency with the OCMP and issuing coastal management decisions. DLCD's reviews involve consultation with local governments, State agencies, Federal agencies, and other interested parties in determining project consistency with the OCMP.

As defined by the OCMP, Oregon's coastal zone extends from the Washington border on the north to the California border on the south, seaward to the extent of State jurisdiction as recognized by Federal law (the Territorial Sea, extending 3 nm [5.5 km] offshore), and inland to the crest of the coastal mountain range. There are three exceptions where the coastal boundary is different. The three exceptions occur where the basins of the Columbia, Umpqua, and Rogue Rivers lie predominantly inland of the crest of the coastal mountains. In these cases the coastal zone boundary crosses these rivers and extends to Bradwood, Scottsburg, and Agness, respectively.

The enforceable policies of the OCMP include the following:

- Oregon's 19 Statewide Planning Goals. Goal 19-Ocean Resources is the primary goal that is applicable to the proposed action. Other goals potentially applicable to the proposed action include: Goal 16-Estuarine Resources, Goal 17-Coastal Shorelands, and Goal 18-Beaches and Dunes.
- Land use plans by cities and counties approved by DLCD. Most are not likely to be applicable to the proposed action based on lack of land-based activities in Oregon's coastal zone. DLCD consults with local government during the Federal Consistency Review process.
- State laws such as Oregon Beach Bill and Removal/Fill Law. Most are not likely to be applicable to the proposed action based on lack of land-based activities in Oregon's coastal zone.
- Oregon Territorial Sea Plan.

The action proponent should notify DLCD as early as possible, but at least 90 days before final approval of the Federal action. State review generally takes 45-90 days. It can take up to six months if significant management issues are raised, if additional information has been requested by DLCD and is not readily forthcoming, or if a permit applicant has failed to apply for required local and State permits.

1.6.5.3 California Coastal Zone

The *California Coastal Act* (CCA) of 1976 (California Public Resources Code, § 30000 et seq) implements California's CZMA program. The CCA includes policies to protect and expand public access to shorelines, and to protect, enhance and restore environmentally sensitive habitats including intertidal and nearshore waters, wetlands, bays and estuaries, riparian habitat, certain wood and grasslands, streams, lakes, and habitat for rare or endangered plants or animals.

Coastal Zones that fall under the CCA include that land and water area of the State of California from the Oregon border to the border of the Republic of Mexico, extending seaward to the state's outer limit of jurisdiction, including all offshore islands, and extending inland generally 1,000 yards from the mean high tide line of the sea. In significant coastal estuarine, habitat, and recreational areas it extends inland to the first major ridgeline paralleling the sea or five miles from the mean high tide line of the sea, whichever is less, and in developed urban areas the zone generally extends inland less than 1,000 yards. The coastal zone of California extends seaward to the 3 nm territorial sea.

1.6.6 Other Environmental Requirements Considered

The Navy must comply with a variety of other Federal environmental laws, regulations, and EOs. These include (among other applicable laws and regulations):

- Marine Mammal Protection Act (MMPA);
- Endangered Species Act (ESA);
- Migratory Bird Treaty Act (MBTA);
- Rivers and Harbors Act (RHA);
- Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) for Essential Fish Habitat (EFH);
- Clean Air Act (CAA);
- National Marine Sanctuaries Act (NMSA);
- Federal Water Pollution Control Act (Clean Water Act [CWA]);
- National Historic Preservation Act (NHPA);
- EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations; and
- EO 13045, Environmental Health and Safety Risks to Children.

In addition, laws and regulations of the States of Washington, Oregon, and California appropriate to Navy actions are identified and addressed in this EIS/OEIS. This EIS/OEIS will facilitate compliance with applicable, appropriate State laws and regulations.

1.7 RELATED ENVIRONMENTAL DOCUMENTS

According to CEQ regulations for implementing NEPA, material relevant to an EIS may be incorporated by reference with the intent of reducing the size of the document (40 C.F.R. § 1502.21). Some of the programs and projects at the NWTRC that have undergone, or are undergoing, environmental review and documentation to ensure NEPA compliance, and which are identified below, are incorporated herein by reference.

- U.S. Department of the Navy, 1997. Environmental Assessment for Electronic Combat Training Facility at OLF Coupeville, Naval Air Station, Whidbey Island, Washington. June 1997.
- U.S. Department of the Navy, 2000. Environmental Assessment: Relocation of the Explosive Ordnance Disposal Demolition Training Range. Prepared by EDAW, Inc. July 2000.
- U.S. Department of the Navy, 2005. Environmental Assessment for Replacement of EA-6B Aircraft with EA-18G Aircraft at Naval Air Station Whidbey Island, Washington. January 2005.
- U.S. Department of the Navy, 2005. Environmental Assessment for Joint Logistics Over-the-Shore 2005 (JLOTS 2005), Naval Magazine, Indian Island. April 2005.
- U.S. Department of the Navy, 2006. Commander, U.S. Pacific Fleet Marine Resources Assessment for the Pacific Northwest Operating Area, Final Report. September 2006.
- U.S. Department of the Navy, 2008. Draft Environmental Impact Statement for the Introduction of the P-8A Multi-Mission Maritime Aircraft into the U.S. Navy Fleet, March 2008.
- National Oceanic and Atmospheric Administration, 1993. Olympic Coast National Marine Sanctuary Final Environmental Impact Statement / Management Plan Volumes 1&2. November 1993.

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2 Description of Proposed Action and Alternatives

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2 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

The Proposed Action does not involve extensive changes to the Northwest Training Range Complex (NWTRC) facilities, activities, or training capacities as they currently exist. Rather, the Proposed Action would result in selectively focused but critical enhancements and increases in training that are necessary to ensure the NWTRC supports Navy training and readiness objectives.

Actions to support current, emerging, and future training and research, development, test and evaluation (RDT&E) (Unmanned Aerial Systems [UASs] only) activities at the NWTRC, including implementation of range enhancements, will be evaluated in this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS). These actions include:

- Potential increase in the number of training activities of the types currently being conducted in the NWTRC.
- Operate air target services for locally based aircraft, surface, and submarine combatant ships with a capability to support air-to-air missile exercise (A-A MISSILEX), electronic combat (EC) Opposition Force (OPFOR) requirements, and surface-to-air (S-A) gunnery and missile exercises.
- Operate surface target services for locally based aircraft, surface combatant ships and submarines with a capability to support air-to-surface (A-S) bombing and missile exercises, surface-to-surface (S-S) gunnery and missile exercises, and EC OPFOR.
- Develop an additional land based EC threat signal emitter capability along the Washington coast for offshore use by aircraft, surface and subsurface combatants in W-237, the Olympic Military Operating Areas (MOAs), and portions of the Pacific Northwest (PACNW) Surface and Submarine Operating Areas (OPAREA).
- Development of a small scale underwater training minefield.
- Potential use of a Portable Undersea Tracking Range (PUTR).

This chapter is divided into the following major subsections: Section 2.1 provides a detailed description of the NWTRC. Sections 2.2 through 2.5 describe the major elements of the Proposed Action and Alternatives to the Proposed Action including the No Action Alternative.

2.1 DESCRIPTION OF THE NWTRC STUDY AREA

Military activities in the NWTRC Study Area occur (1) on the ocean surface, (2) under the ocean surface, (3) in the air, and (4) on land. A summary of the land, air, sea, undersea space addressed in this EIS/OEIS is provided in Table 2-1. To aid in the description of the ranges covered in the NWTRC EIS/OEIS, the ranges are divided into three major geographic and functional subdivisions. Each of the individual ranges falls into one of these two major range subdivisions:

- The Offshore Area. This area consists of all air, sea, and undersea ranges, OPAREAs, and military training activities in international airspace and waters out to approximately 250 nautical miles west of the coastline.
- The Inshore Area includes all air, land, sea, and undersea ranges and OPAREAs inland of the coastline and including Puget Sound.

Table 2-1 provides an overview of the size of each range within these areas. Table 2-2 summarizes the major component areas of the NWTRC Offshore Area.

Table 2-1: Summary of the Air, Sea, Undersea, and Land Space

Area Name	Airspace (square nautical miles [nm^2])			Sea Space (nm^2)	Undersea Space (nm^2)	Land Range (acres)
	International Airspace	Restricted Airspace	MOA / Other			
Offshore Area	122,400*	NA	NA	122,400	122,400	NA
Inshore Area	NA	367	11,684	61	61	875
TOTAL	**122,400**	**367**	**11,684**	**122,421**	**122,400**	**875**

* International Airspace is over-water in the PACNW OPAREA and includes 33,997 nm^2 of Warning Area airspace
Source: 366 Report to Congress

Table 2-2: NWTRC Offshore Areas

Area Designation	Description
Pacific Northwest Ocean Surface/Subsurface Operating Area (PACNW OPAREA)	The Pacific Northwest Ocean Surface/Subsurface Operating Area (PACNW OPAREA) extends from the northern coast of California to the Strait of Juan de Fuca, from the coast line westward to 130° West longitude.
Warning Area 237 (W-237 [A-H, J])	W-237 airspace extends westward starting 3 nautical miles (nm) (5.5 kilometers [km]) offshore from the coast of Washington State and is divided into nine areas (A-H, and J) of designated SUA (Special Use Airspace).
Warning Area 570 (W-570)	W-570 is a smaller warning area that begins approximately 12 nm (22.2 km) off the central coast of Oregon.
Warning Area 93 (W-93 [A/B])	Warning Area 93 is located approximately 12 nm (22.2 km) off the coast of Oregon, approximately 10 nm (18.5 km) south of and similar in size to W-570.

2.1.1 Northwest Training Range Complex Offshore Area Overview

The PACNW OPAREA serves as maneuver water space for ships and submarines to conduct training and to use as transit lanes. It extends from the Strait of Juan de Fuca in the north, to approximately 50 nm (92.6 km) south of Eureka, California in the south, and from the coast line of Washington, Oregon, and California westward to 130° West longitude (Figure 2-1).

2.1.1.1 Air Space

The Special Use Airspace (SUA) in the Offshore Area is comprised of three Warning Areas that overlay portions of the PACNW OPAREA. W-237 extends westward off the coast of Northern Washington State and is divided into nine sub-areas (A-H, and J). U.S. and Allied ships, submarines, and aircraft conduct training in W-237 in Anti-Submarine Warfare (ASW), Anti-Surface Warfare (ASUW), Anti-Air Warfare (AAW), and Electronic Combat (EC).

W-570 is a smaller warning area located 12 nm off the central coast of Oregon. W-570 is primarily used by United States Air Force (USAF) Western Air Defense Sector aircraft from McChord AFB. P-3 aircraft from Commander, Patrol and Reconnaissance Wing TEN (CPRW-10) at Naval Air Station Whidbey Island (NASWI) occasionally use W-570 for reconnaissance training activities. Additionally, occasional training activities occur in international airspace outside of Warning Areas in accordance with international agreements on “Operations and Firings Over the High Seas.”

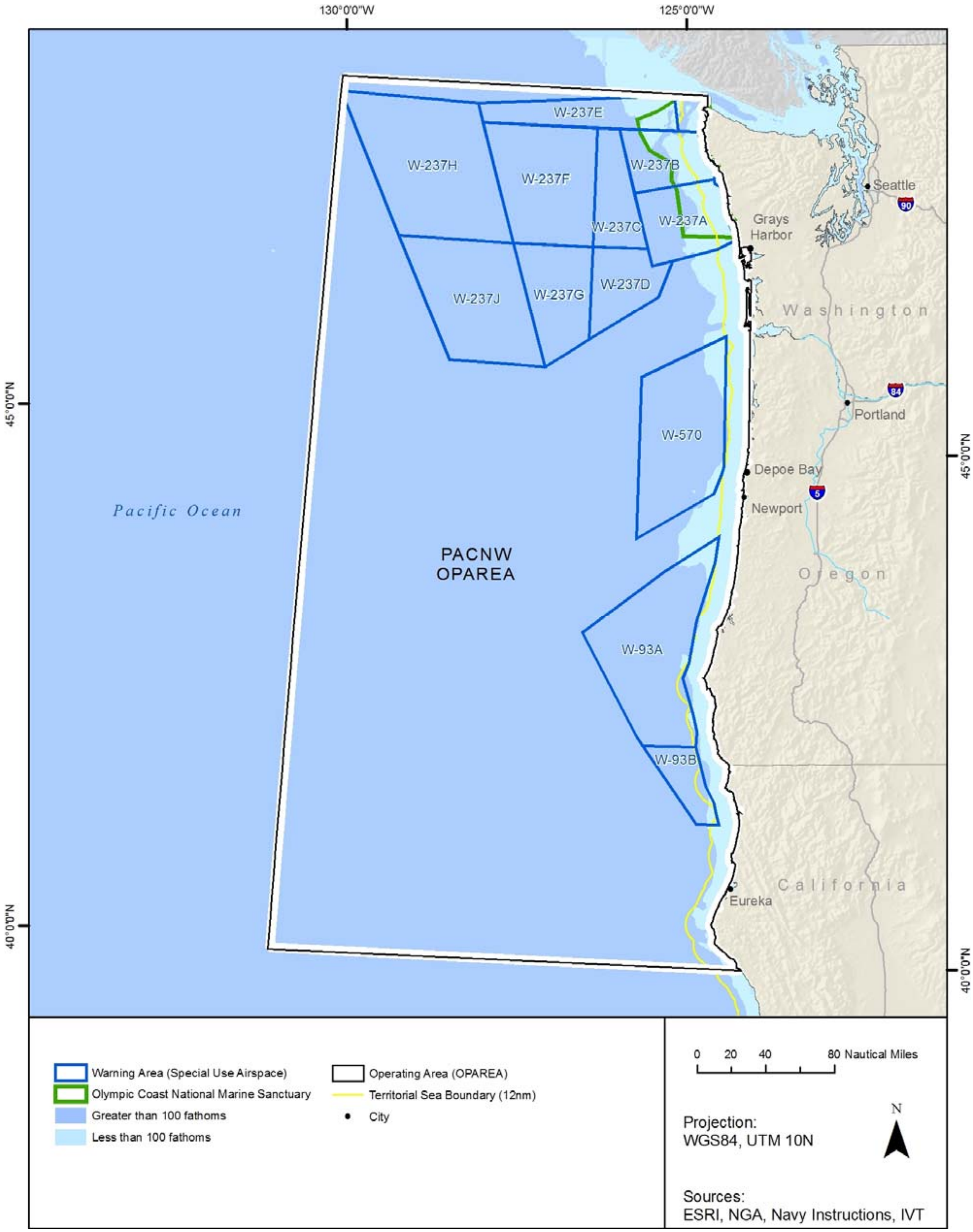


Figure 2-1: NWTRC Offshore Area

W-93 is located 12 nm off the coast of Oregon and northern California, approximately 10 nm south of and similar in size to W-570. It is primarily used by Oregon Air National Guard aircraft; however, W-93 is also used occasionally by CPRW-10 P-3 aircraft for reconnaissance training. USAF and Air National Guard aircraft activities conducted in W-570 and W-93 are not part of the proposed action and are not considered in this EIS/OEIS.

2.1.1.2 Sea Space

The PACNW OPAREA is approximately 510 nm (945 km) in length from the northern boundary to the southern boundary, and 250 nm (463 km) from the coastline to the western boundary at 130^{o} W longitude. Total surface area of the PACNW OPAREA is 122,400 nm^2 (420,163 km^2). Commander Submarine Force, U.S. Pacific Fleet (COMSUBPAC) Pearl Harbor manages this water space as transit lanes for U.S. submarines. While the sea space is ample for all levels of Navy training, no infrastructure is in place to support training. For example, there are no dedicated training frequencies, no permanent instrumentation, no meteorological and oceanographic operations (METOC) system, and no OPFOR or EC target systems. In this region of the Pacific Ocean, storms and high sea states can create challenges to surface ship training between October and April. In addition, strong undersea currents in the Pacific Northwest make it difficult to place bottom-mounted instrumentation such as hydrophones.

2.1.1.3 Undersea Space

The Offshore Area undersea space lies beneath the PACNW OPAREA as described above. The bathymetry chart depicts a 100 fathom curve parallel to the coastline approximately 12 nm (22.2 km) to sea, and in places 20 nm (37 km) out to sea. The area of deeper water of more than 100 fathoms (600 ft) is calculated to be approximately 115,800 nm^2 (397,183 km^2), while the shallow water area of less than 100 fathoms (600 ft) is all near shore and amounts to approximately 6,600 nm^2 (22,637 km^2). Figure 2-1 depicts the 100 fathom curve.

2.1.2 NWTRC Inshore Area Overview

Inshore Areas (see Figures 2-2 and 2-3) include MOAs and associated Air Traffic Control Assigned Airspace (ATCAA) which superimposes the MOAs, air and surface/subsurface Restricted Areas, the Darrington Area, Explosive Ordnance Disposal (EOD) Ranges and Outlying Landing Field (OLF) Coupeville. Naval Special Warfare (NSW) forces have no dedicated ranges in the NWTRC, but train in Puget Sound waters and conduct on-land training at several Navy-owned locations. NSW land training typically occurs at Indian Island, and occasionally at the Seaplane Base survival area and OLF Coupeville. Refer to Section 2.3.1.6 for a description of NSW activities. Table 2-3 summarizes the NWTRC inshore areas.

MOAs are SUA of defined vertical and lateral dimensions established outside Class A airspace to separate/segregate certain non-hazardous military activities from instrument flight rules (IFR) traffic in controlled airspace and to identify for visual flight rules (VFR) traffic where these activities are conducted. Four MOAs provide military aircraft maneuver space for training. They are the Olympic, Chinook, Okanogan, and Roosevelt MOAs. The ATCAAs associated with the MOAs include the Olympic, Okanogan/Molson, and Roosevelt/Republic ATCAA. There is no ATCAA associated with the Chinook MOAs.

Table 2-3: NWTRC Inshore Areas

Area Designation	Description
Olympic MOA (A/B) Olympic ATCAA (A/B)	Olympic MOA is located over the Olympic Peninsula, along the Washington State coast. The MOA lower limit is 6,000 ft above mean sea level (MSL) but not below 1200 feet above ground level (AGL), and the upper limit is flight level (FL) 180, with a total area coverage of 1,614 nm^2 (5,536 km^2). The ATCAA starts at FL180 with an upper limit of FL500. (See Figure 2-2)
Chinook MOA (A/B)	The Chinook MOAs are both located over water west of Whidbey Island. The two small air corridors, A and B, are each 2nm wide (3.7 km) and extend from 300 feet above the surface to 5,000 feet MSL. They are used for aircraft ingress and egress for the Admiralty Bay Range (R-6701/Navy 7). (See Figure 2-3)
Okanogan MOA (A/B/C) Okanogan/Molson ATCAA	Okanogan MOA is located in north-central Washington near the U.S.-Canadian border. MOA parts B &C have lower limits of 300 feet AGL and an upper limit of 9,000 feet MSL. MOA part A has a lower limit of 9,000 feet MSL up to but not including FL180. The Okanogan and Molson ATCAAs start at FL180 and the upper limit is FL500; with a total area coverage of 4,339 nm^2 (14,882 km^2). (See Figure 2-2)
Roosevelt MOA (A/B) Roosevelt/Republic ATCAA	Roosevelt MOA is located in north-central Washington near the U.S.-Canadian border. The lower limit of segment A is 9,000 ft MSL and the lower limit of segment B is 300 ft AGL. The upper limit of segment A is FL 180 and the upper limit of segment B is 9,000 ft MSL. The Roosevelt and Republic ATCAAs start at FL180 with an upper limit of FL500. The total area coverage is 5,319 nm^2 (18,244 km^2). (See Figure 2-2)
Darrington Area	Darrington Area is a block of airspace used for electronic countermeasures training and functional check flight missions. This area is not a designated MOA (although it is used like a MOA) and is used by NASWI based units only (EA6, EP3, and P3). The lower limit is 10,000 ft MSL and the upper limit is FL 230 (higher altitude is available upon request) with a total area of 2,131 nm^2 (7,309 km^2).(See Figure 2-2 and 2-3)
R-6701 (Admiralty Bay) Navy 7 OPAREA	R-6701 (Admiralty Bay) is a Restricted Area over Admiralty Bay, WA with a lower limit at the ocean surface and an upper limit of 5,000 ft MSL. Navy 7 OPAREA is the surface and subsurface restricted area that underlays R-6701. They cover a total area of 56 nm^2 (192 km^2). (See Figure 2-3)
Navy 3 OPAREA	Navy 3 OPAREA is a surface and subsurface restricted area off the west coast of northern Whidbey Island. (See Figure 2-3)
A-680 (OLF Coupeville)	A-680 is a 3 nm (5.5 km) circle centered on OLF Coupeville located 15 nm (27.8 km) south of NASWI. (See Figure 2-3)
Seaplane Base Survival Area	The Seaplane Base Survival Area includes forest, grassland, and beach area at Navy Seaplane Base/Crescent Harbor, NASWI. This area includes the DTR Seaplane Base (See Figure 2-3).
EOD Crescent Harbor	Water range located in Crescent Harbor.
EOD Floral Point	Floral Point Underwater EOD Range, located in Hood Canal, near NBK-Bangor, is active but seldom used.
EOD Indian Island	Indian Island Underwater EOD Range, located adjacent to Indian Island, is active but seldom used.
DTR Bangor	The DTR at Bangor is used for small detonations on land at NBK-Bangor.
OLF Coupeville	OLF Coupeville is a single runway airfield with ample surrounding open space for a variety of training activities including helicopter insertion/extraction and parachute training.

The Darrington Area, while not a designated MOA, is a block of airspace established by Letter of Agreement with Seattle Air Route Traffic Control Center for EC training and other non-live firing missions. The R-6701 is airspace located over central Whidbey Island, restricted for military use. Navy 7 is a sea surface and subsurface area beneath R-6701. Navy 3 is a surface and subsurface restricted area off the west coast of northern Whidbey Island. Restricted airspace, such as that in R-6701, is SUA designated under 14 CFR Part 73 within which the flight of aircraft, while not wholly prohibited, is subject to restriction. The specific limits and regulations of restricted surface areas such as Navy 3 and Navy 7 are included in the appropriate U.S. Coast Pilot. OLF Coupeville is used primarily for Field Carrier Landing Practice (FCLP) for EA-6Bs from NASWI, but is also used as a Drop Zone (DZ) for parachute training, Landing Zone (LZ) for helicopter training, and for small unit ground training events as well. An alert area (A-680) establishes a 3-nm (5.5-km) radius alert area around the OLF. An alert area is SUA wherein a high volume of pilot training activities or an unusual type of aerial activity is conducted, neither of which is hazardous to aircraft. Nonparticipating pilots are advised to be particularly alert when flying in these areas. Table 2-4 summarizes the airspace attributes of the inshore areas.

Table 2-4: Inshore Area Airspace Summary

Airspace	nm²	Lower limit	Upper limit	Over Land?	Controlling/ Scheduling Authority
Inshore					
A-680 (OLF Coupeville)	28	Surface	3,000 ft MSL	Yes	NASWI
Admiralty Bay Mining Range R-6701	22	Surface	5,000ft MSL	No	NASWI
Chinook MOA (A,B) SUA corridors for R-6701	56	300ft MSL			
Olympic MOA (A,B)	1,614	6000ft MSL	FL180	Yes	NASWI
Olympic ATCAA		FL180	FL500		
Darrington Area	2,131	10,000ft MSL	FL230, higher alt avail on request	Yes	NASWI
Okanogan MOA (A,B,C)	4,339	A: 9000ft MSL B: 300ft AGL C: 300ft AGL	A: FL180 B: 9000ft MSL C: 9000ft MSL	Yes	NASWI
Okanogan ATCAA		FL180	Up to but not including FL240		
Molson ATCAA		FL240	FL500		
Roosevelt MOA (A,B)	5,319	A: 9000ft MSL B: 300ft AGL	A: FL180 B: 9,000ft MSL	Yes	NASWI
Roosevelt ATCAA		FL180	Up to but not including FL240		
Republic ATCAA		FL240	FL500		
TOTAL	**13,509**				

Source: 366 Report to Congress, AP-1A Flight Information Publication

Three EOD units are located in the NWTRC, all in the Inshore Area: Headquarters element, EOD Mobile Unit Eleven (HQ EODMU-11), EODMU-11 Detachment (Det.) Naval Base Kitsap-Bangor (NBK-Bangor) and EODMU-11 Det. Whidbey Island. EODMU-11 Det. Whidbey Island is based at the Seaplane Base, NASWI and conducts most of their underwater detonations in adjacent Crescent Harbor Underwater EOD Range (referred to as EOD Crescent Harbor), and occasionally uses the Indian Island Underwater EOD Range (EOD Indian Island). Although still open as a training site, EOD Indian Island, adjacent to Indian Island, is seldom used for underwater detonations. EODMU 11 Det. NBK-Bangor conducts much of their non-explosive training in Hood Canal, Dabob Bay at the Floral Point Underwater EOD Range (EOD Floral Point). Most ground training events are conducted in the Survival Area and the upland Demolition Training Range (DTR) located there (DTR Seaplane Base). EOD units also conduct parachute training at a DZ at OLF Coupeville, at a DZ in Crescent Harbor, and occasionally at other DZs in the area. EODMU 11 Det. NBK-Bangor conducts land demolition training at the Bangor EOD DTR. Figure 2-3 depicts the EOD Ranges.

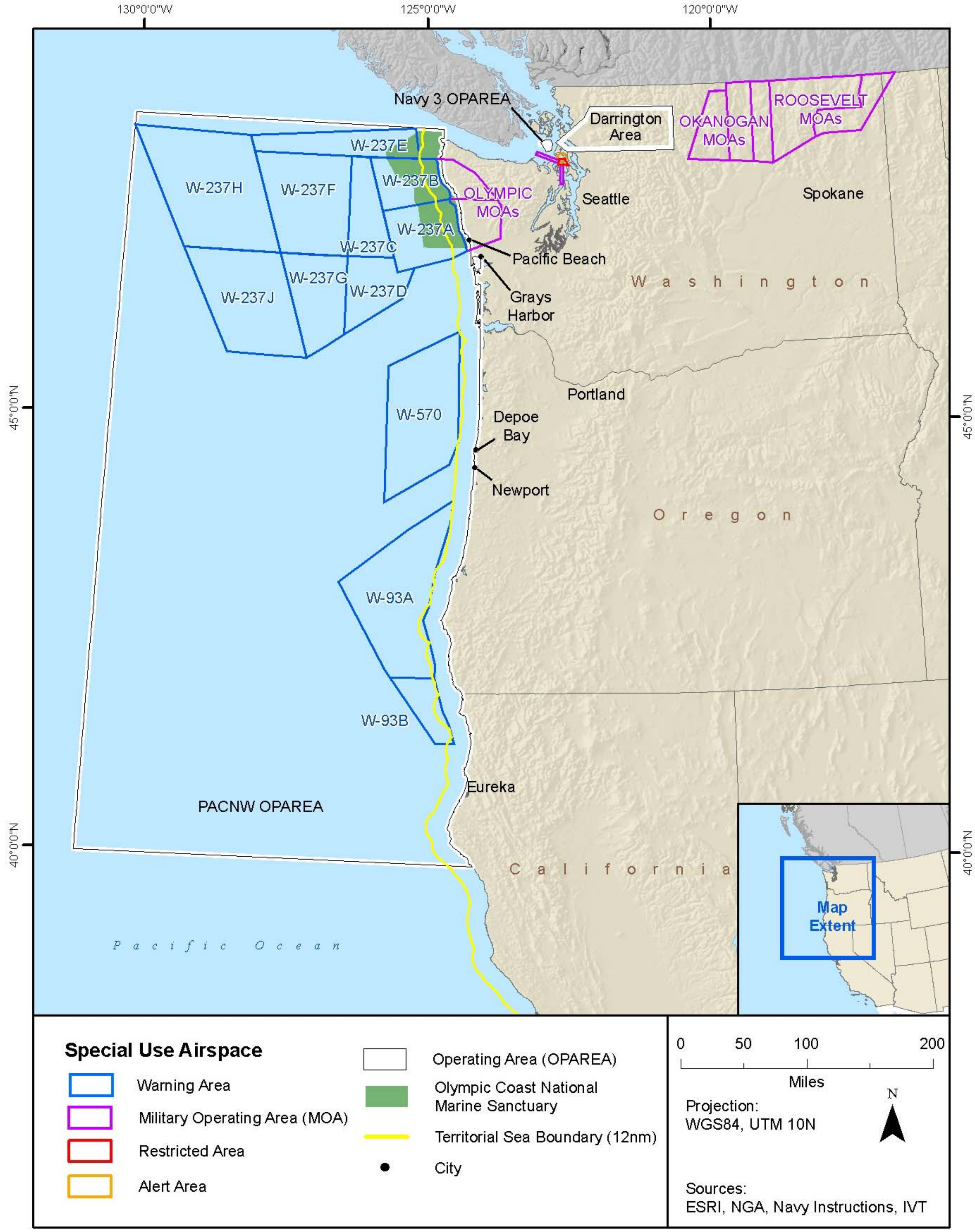


Figure 2-2: NWTRC Proposed Action Area, Including Inshore Area

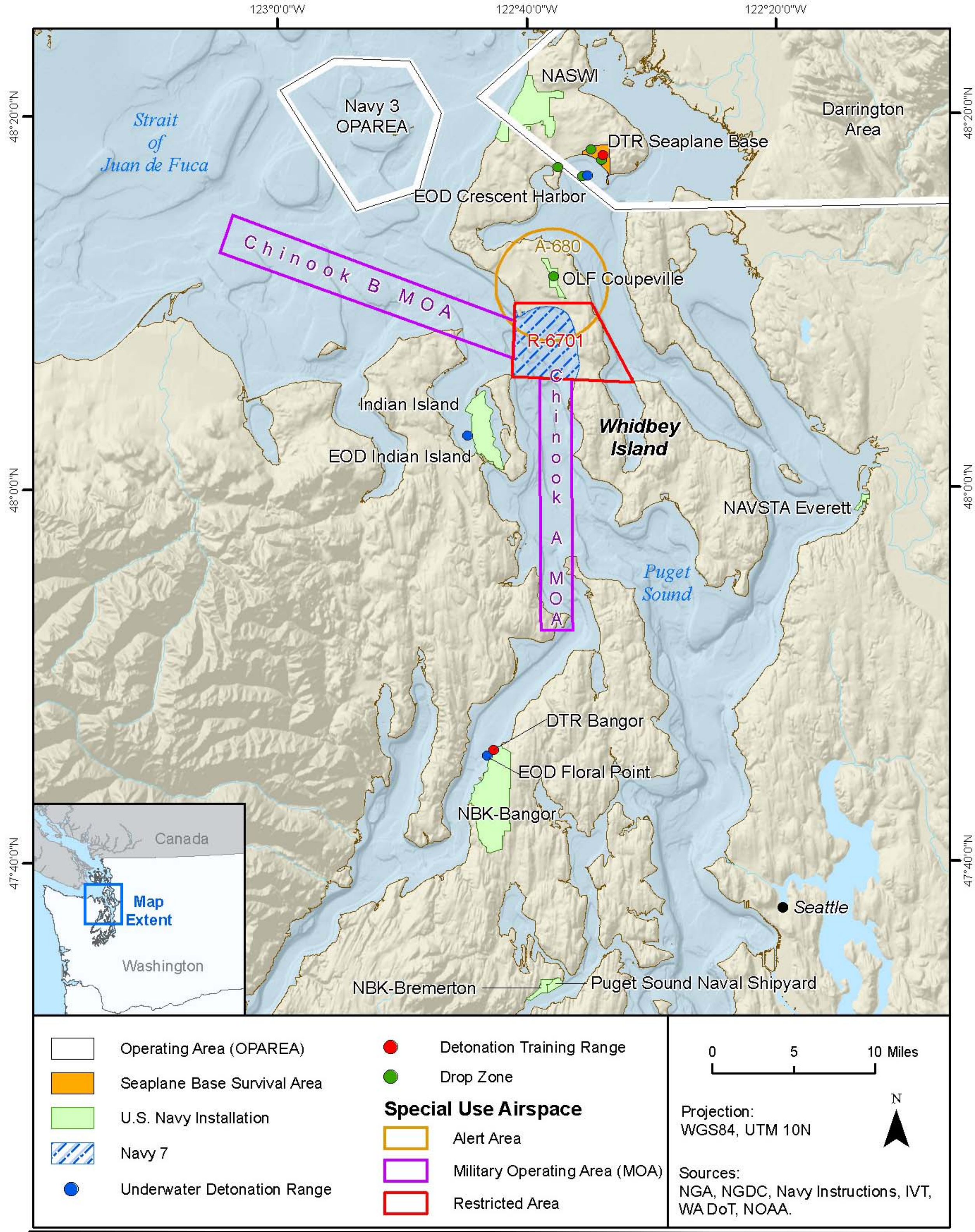


Figure 2-3: NWTRC Inshore Area (Puget Sound)

2.2 NAVY SONAR SYSTEMS

Navy sonar training is a significant piece of overall Navy training. Recently, sonar and its potential impacts to the marine environment have become a controversial issue. This section is designed to better inform the reader about: a) What is sonar; b) Why the Navy trains with Sonar; and c) What sonar is used in the NWTRC. The analysis of impacts of sonar to the marine environment is conducted in Chapter 3 of this EIS/OEIS.

2.2.1 What is Sonar?

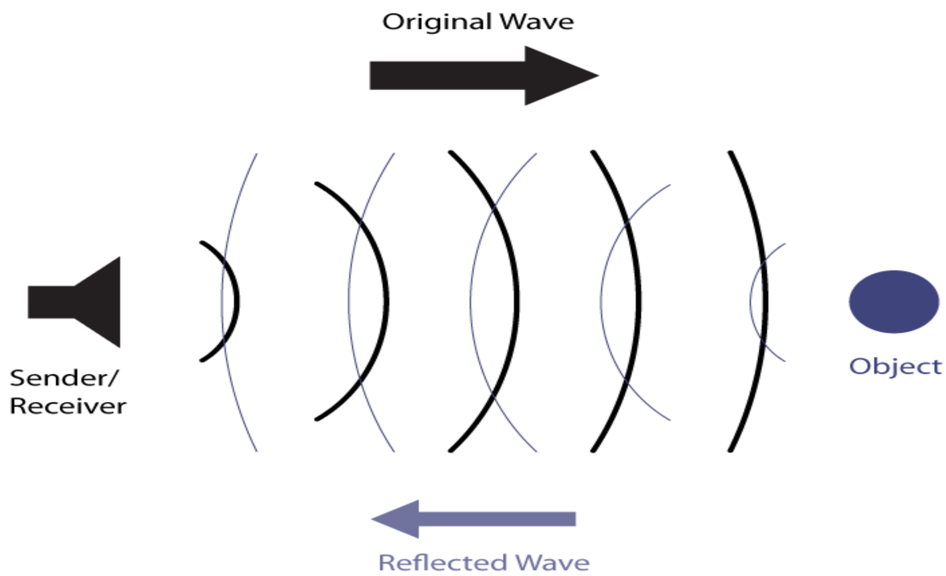
Sonar, which stands for "**SO**und **N**avigation **A**nd **R**anging," is a tool that uses underwater acoustics to navigate, communicate, or detect other underwater objects. There are two basic types of sonar; active and passive.

- **Active sonar** emits pulses of sound waves that travel through the water, reflect off objects, and return to the receiver on the ship. By knowing the speed of sound in water and the time for the sound wave to travel to the target and back, we can quickly calculate distance between the ship and the underwater object. As examples, active sonar systems can be used to track targets and realign internal navigation systems by identifying known ocean floor features. Whales, dolphins and bats use the same technique, echolocation, for identifying their surroundings and locating prey.
- **Passive sonar** is a listening device that uses hydrophones (underwater microphones) that receive, amplify, and process underwater sounds. Passive sonar is used primarily to detect the presence of submarines. The advantage of passive sonar is that is places no sound in the water, and thus does not reveal the location of the listening vessel. Passive sonar can indicate the presence, character, and direction of submarines.

Underwater sounds in general, and sonar specifically can be categorized by their frequency. For the analysis in this EIS/OEIS, sonar falls into one of three frequency ranges; low-frequency, mid-frequency, and high-frequency.

- **Low-frequency** sonar is sonar that emits sounds in the lower frequency range, less than 1 kilohertz (kHz). Low-frequency sonar is useful for detecting objects at great distances, as low-frequency sound does not dissipate as rapidly as higher frequency sounds. However, lower frequency sonar provides less accuracy than other sonars.
- **Mid-frequency** sonar uses sound in the frequency spectrum between 1 and 10 kHz. With a typical range of up to 10 nm, mid-frequency sonar is the Navy's primary tool for detecting and identifying submarines. Sonar in this frequency range provides a valuable combination of range and target resolution (accuracy).
- **High-frequency** sonar uses frequencies greater than 10 kHz. Although high-frequency sonar dissipates rapidly, giving it a shorter effective range, it provides higher resolution and is useful at detecting and identifying smaller objects such as sea mines.

Modern sonar technology includes a multitude of sonar sensor and processing systems. In concept, the simplest active sonar emits sound waves, or "pings," sent out in multiple directions (i.e., is omnidirectional). Sound waves reflect off the target object and move in multiple directions (Figure 2-4). The time it takes for some of these sound waves to return to the sonar source is calculated to provide a variety of information, including the distance to the target object. More sophisticated active sonars emit an omnidirectional ping and then rapidly scan a steered receiving beam to provide directional as well as range information. Even more advanced sonars use multiple pre-formed beams to listen to echoes from several directions simultaneously and provide efficient detection of both direction and range. For more information about sonar or sound in the sea, go to http://www.dosits.org.



Source: ManTech-SRS, 2008

Figure 2-4: Principle of an Active Sonar

2.2.2 Why The Navy Trains With Sonar

Sea control is the foundation for the United States' global power projection. If the United States cannot command the seas and airspace above them, it cannot project power to command or influence events ashore and cannot shape the security environment. For the last century, submarines have been the weapon of choice for countries intending on contesting another nation's control of the seas. Today, there are more than 300 modern, quiet diesel submarines around the world, operated by more than 40 nations, including Iran and North Korea. The United States cannot in good conscience ask its young Sailors and Marines to serve on ships at sea without the ability to defend themselves against this threat. The key to maintaining the Navy's ability to defend against adversary submarines is a comprehensive "at-sea" training regime to prepare U.S. Sailors for this contingency. This training requires the use of active sonar. The skills developed during this training are perishable and require periodic refreshing, which can't be regenerated easily. If training is not as realistic as possible, the Navy will quickly lose its edge in this critical dimension of the battlefield.

Submarines have been and are likely to remain the weapon system with the highest leverage in the maritime domain. The ability to locate and track a submarine is a mission skill that must be possessed by every ASW-capable ship, submarine, and aircraft. There are three fundamental truths about ASW. First, it is critically important to our strategies of sea control, power projection, and direct support to land campaigns.

Second, ASW requires a highly competent team of air, surface and sub-surface platforms to be effective in a complex and a highly variable three-dimensional environment. Each asset has unique strengths that contribute to the full spectrum of undersea, surface, airborne, and space-based ASW systems. The undersea environment – ranging from the shallows of the littoral to the vast depths of the great ocean basins and polar regions under ice – demand a multi-disciplinary approach: reliable intelligence; oceanography; and surveillance and cueing of multiple sensors, platforms and undersea weapons. Most importantly, it takes highly skilled, trained, and motivated people.

Finally, ASW is extremely difficult. As an example, during the 1982 Falklands conflict, the Argentine submarine SAN LUIS operated in the vicinity of the British task force for more than a month and was a constant concern to Royal Navy commanders. Despite the deployment of five nuclear attack submarines, 24-hour per day airborne ASW operations, and expenditures of precious time, energy, and ordinance, the British never once detected the Argentine submarine. Today, this complex and challenging mission taxes naval forces to their very limits. The U.S. Navy must continue to improve or its performance compared to other world powers will most certainly decline.

As modern submarines have become significantly quieter, passive sonar is not effective enough in tracking and prosecuting all enemy submarines. Mid-frequency active sonar has become a necessary piece of the Navy's ASW program. Without mid-frequency active sonar, the U.S. Navy would be severely limited in its ability to counter the threat posed by modern, quiet submarines. Training with mid-frequency active sonar is, therefore, critical to national security.

ASW remains the linchpin of sea control. With the proliferation of modern, quiet submarines and the expansion of the Navy mission to both littoral and deep waters, the ASW challenge has become more severe. To counter the adversarial submarine challenges, the Navy's best course of action is to conduct extensive training including the use of active sonar that mirrors the intricate operating environment that would be present in hostile waters.

2.2.3 Sonars Used in the NWTRC

For the purposes of this EIS/OEIS, the term sonar refers to a system, either passive or active, used to locate underwater objects. In addition to those systems commonly referred to as sonar, there are other acoustic sources used by the Navy in the NWTRC. For example, the MK-84 tracking pinger and the PUTR uplink transmitter both are sources of underwater sound. Although not technically sonars, they do create sound and are considered in this analysis as acoustic systems. Tables 2-5 and 2-6 list typical U.S. Navy mid-frequency and high-frequency acoustic systems and identifies those used during training activities conducted in the NWTRC. All sources used in the NWTRC were analyzed for potential impacts to the marine environment.

Certain systems, because of their frequent use or high power output, were quantitatively modeled for their acoustic impacts. The acoustic systems presented in Table 2-5 have been quantitatively modeled. Table 2-6 lists the systems that have been qualitatively analyzed, but not quantitatively modeled. The systems that were not modeled included systems that are typically operated at frequencies greater than 200 kHz. Because it is not used in the NWTRC, low-frequency sonar was not analyzed in this EIS/OEIS.

Table 2-5: Acoustic Systems Quantitatively Modeled

Systems Quantitatively Modeled				
System	***Frequency***	***Associated Platform***	***System Use/Description***	***Used in NWTRC?***
AN/SQS-53C	MF	Surface ship sonar (DDG)	120 pings per hour	Yes
AN/SQS-56C	MF	Surface ship sonar (FFG)	120 pings per hour	Yes
AN/SSQ-62 DICASS Sonobuoy	MF	Helicopter and MPA deployed	12 pings, 30 seconds between pings	Yes
AN/SSQ-110A Explosive source sonobuoy	Impulsive	MPA deployed	Contains two 4.1 lb charges	Yes
MK-48 Torpedo	HF	Submarine fired torpedo	Active for 15 min per torpedo run	Yes

DDG – Guided Missile Destroyer; DICASS – Directional Command-Activated Sonobuoy System; FFG – Fast Frigate; HF – High-Frequency; MF – Mid-Frequency; MPA – Maritime Patrol Aircraft

It is important to note that, as a group, marine mammals have functional hearing ranging from 10 hertz (Hz) to 200 kHz; however, their best hearing sensitivities are well below 200 kHz. Since active sonar sources operating at 200 kHz or higher dissipate rapidly and are at or outside the upper frequency limit of even the ultrasonic species of marine mammals, further consideration and modeling of these higher frequency acoustic sources are not warranted. As such, high-frequency active sonar systems in excess of 200 kHz are not analyzed in this EIS/OEIS.

Table 2-6: Acoustic Systems Not Quantitatively Modeled

Systems Not Quantitatively Modeled				
System	***Frequency***	***Reason Not Modeled***	***System Use/Description***	***Used in NWTRC?***
AN/BQS-15	HF	Minimal use, limited impact of HF source	Submarine mine detection sonar	Yes
MK-84 Range Tracking Pinger	HF	Minimal use, limited impact of HF source	PUTR target tracking	Yes
PUTR Uplink Transmitter	MF/HF	Minimal use, limited impact of HF source	PUTR tracking uplink signal	Yes
AN/AQS-13 or AN/AQS-22	MF	Not used in NWTRC	Helicopter dipping sonar	No
AN/SQQ-32	HF	Not used in NWTRC	MCM over the side system	No
MK-46 Torpedo	HF	Not used in NWTRC	Surface ship and aircraft fired exercise torpedo	No
AN/SLQ-25 (NIXIE)	MF	Not used in NWTRC	DDG, CG, and FFG towed array	No
AN/SQS-53 and AN/SQS-56 (Kingfisher)	MF	Not used in NWTRC	DDG, CG, and FFG hull-mounted sonar (small object detection)	No
AN/BQQ-10	MF	Not used in NWTRC	Submarine hull-mounted sonar	No
ADC MK-3 and MK-2	MF	Not used in NWTRC	Submarine fired countermeasure	No
Surface Ship and Submarine Fathometer	12 kHz	System is not unique to military and operates identically to commercially available bottom sounder	Depth finder on surface ships and submarines	Yes
SQR-19	Passive	System is a passive towed array emitting no active sonar	A listening device towed behind a surface ship	Yes
TB-16/23/29/33	Passive	System is a passive towed array emitting no active sonar	A listening device towed behind a submarine	Yes
AN/SSQ-53 DIFAR Sonobuoy	Passive	Sonobuoy is passive and emits no active sonar	Passive listening sonobuoys deployed from helicopter or MPA	Yes
AN/AQS-14/20/24	>200 kHz	System frequency outside the upper limit for marine mammals	Helicopter towed array used in MIW for the detection of mines	No

ADC – Acoustic Device Countermeasure; DDG – Guided Missile Destroyer; DIFAR – Directional Frequency Analysis and Recording; FFG – Fast Frigate; HF – High-Frequency; kHz – Kilohertz; MCM Mine Countermeasures; MF – Mid-Frequency; MIW – Mine Warfare; MPA – Maritime Patrol Aircraft

2.3 PROPOSED ACTION AND ALTERNATIVES

2.3.1 Alternatives Development

NEPA implementing regulations provide guidance on the consideration of alternatives in an EIS. These regulations require the decision maker to consider the environmental effects of the Proposed Action and a range of alternatives to the Proposed Action (40 C.F.R. § 1502.14). The range of alternatives includes reasonable alternatives, which must be rigorously and objectively explored, as well as other alternatives that are eliminated from detailed study. To be "reasonable," an alternative must meet the stated purpose of and need for the Proposed Action.

The purpose of including a No Action Alternative in environmental impact analyses is to ensure that agencies compare the potential impacts of the proposed major Federal action to the known impacts of maintaining the status quo.

With regard to the No Action Alternative, it currently exists in the EIS/OEIS as a baseline, where the action presented represents a regular and historical level of activity on the NWTRC to support this type of training and exercises. In other words, the EIS/OEIS baseline, or No Action Alternative, represents no change from current levels of training usage. The potential impacts of the current level of training and RDT&E activity on the NWTRC (defined by the No Action Alternative) are compared to the potential impacts of activities proposed under Alternative 1 and Alternative 2.

Alternatives considered in this EIS/OEIS were developed by the Navy after careful assessment by subject-matter experts, including units and commands that utilize the ranges, range management professionals, and Navy environmental managers and scientists. The Navy has developed a set of criteria for use in assessing whether a possible alternative meets the purpose of and need for the Proposed Action. Each of these criteria assumes implementation of mitigation measures for the protection of natural resources as appropriate. Any alternative considered for future analysis should support or employ:

1. All requirements of the Fleet Response Training Plan[1] (FRTP) as they apply to training conducted in the NWTRC;
2. Achievement of training tempo requirements based on Fleet deployment schedules;
3. Joint training events;
4. Basic and Intermediate training of Navy forces across all applicable Navy Primary Mission Areas (PMARs);
5. Training requirements of formal military schools located at Navy installations throughout the Northwest Pacific region;
6. Navy RDT&E activities associated with unmanned aerial systems (UASs);
7. Allied military training activities;
8. Alignment of the NWTRC infrastructure with Naval Force structure, including training with new weapons, systems, and platforms (vessels and aircraft) as they are introduced into the Fleet;
9. Sustainable range management practices that protect and conserve natural and cultural resources; and
10. Preservation of access to training areas for current and future training requirements, while addressing potential encroachments that threaten to impact range capabilities.

NEPA regulations require that the Federal action proponent study means to mitigate adverse environmental impacts by virtue of going forward with the proposed action or an alternative (40 C.F.R. §

[1] Predeployment training is governed by the FRTP. The FRTP establishes a training cycle that includes four phases: (1) maintenance; (2) unit-level training; (3) integrated training; and (4) sustainment.

1502.16). Additionally, an EIS is to include study of appropriate mitigation measures not already included in the proposed action or alternatives (40 C.F.R. § 1502.14 [h]). Each of the alternatives, including the Proposed Action considered in this EIS/OEIS, includes mitigation measures intended to reduce the environmental effects of Navy activities. Mitigation measures, such as current requirements and practices are discussed throughout this EIS/OEIS.

2.3.2 Alternatives Eliminated from Further Consideration

2.3.2.1 Alternative Range Complex Locations

The NWTRC is a unique national range asset that derives its primary value from its diverse and extensive training capabilities and its location close to the Fleet concentration area in the Puget Sound. There are over 23 military shore commands, 21 aviation squadrons, and 21 ships based around the Puget Sound that depend on the NWTRC and associated offshore areas as a "backyard" range for meeting basic and intermediate training requirements in order to achieve readiness prior to deployment. In the Pacific, only two other Navy Range Complexes provide similar or greater range capabilities; the Southern California (SOCAL) Range Complex and the Hawaii Range Complex. Both are unsuitable to meet the daily training requirements of PACNW forces due to transit times to these Range Complexes. SOCAL, the nearer of the two, is over 1000 nm, or about 3 sailing days from the NWTRC. Factors that make the NWTRC uniquely suited to its mission are discussed in Section 1.2.3. These attributes include:

- Proximity to the homeport of units in the Pacific Northwest. The NWTRC serves as a backyard range for those units homeported in the Pacific Northwest area including those aviation, surface ship, submarine, and EOD forces homeported at NASWI, Naval Station Everett, NBK-Bremerton, NBK-Bangor, and Puget Sound Naval Shipyard.
- Proximity to military families. By having training areas as close to homeports as possible, it minimizes the time that Sailors have to spend away from their families, improves morale, and improves retention of personnel.
- Offers training across the spectrum of naval missions. The radio frequency spectrum is relatively unencumbered, which allows more realistic EC training for P-3, EP-3, and EA-6B aircraft. The EC mission is further enabled by the presence of an electronic signal threat simulator and increased opportunities for realistic surface to air missile defense training.
- Inland waterways of the Range Complex that provide an ideal littoral training environment. This training takes place in a variety of warfare areas for ships and submarines as they transit to and from their home ports.
- Cold water operating areas for certain aspects of NSW training. The protected waters of Puget Sound provide this environment throughout the year. Although there are no locally based NSW units in the Range Complex, SEALs from out of the area train here regularly due to the area's unique qualities.
- Large amounts of airspace and surface/subsurface range area within the complex boundaries. The abundance of special use airspace within the complex provides both over-water and over-land training opportunities for the local P-3 and EA-6B aircraft. The PACNW OPAREA is the second largest of the Navy's ocean operating areas. It provides ample space for large scale naval exercises, and opportunities for joint and allied training.

The location of the NWTRC and its supporting operational environments allow readiness training to be conducted to properly build skills required for deploying naval forces and developing systems for their use. The NWTRC is the only northwestern United States Range Complex capable of supporting Navy readiness training. For this reason, alternative Navy range sites do not meet the purpose and need of the proposal, and therefore were eliminated from further study and analysis.

2.3.2.2 Simulated Training

Navy training includes extensive use of computer-simulated virtual training environments, and involves command and control exercises without operational forces (constructive training) where possible. These training methods have substantial value in achieving limited training objectives. Computer technologies provide excellent tools for implementing a successful, integrated training program while reducing the risk and expense typically associated with live military training. However, virtual and constructive training are an adjunct to, not a substitute for, live training, including live-fire training. Unlike live training, simulated training does not provide the requisite level of realism necessary to attain combat readiness, and cannot replicate the high-stress environment encountered during combat operations.

Aviation simulation has provided valuable training for aircrews in specific limited training situations. However, the numerous variables that affect the outcome of any given training flight cannot be simulated with a high degree of fidelity. Landing practice and in-flight refueling are two examples of flight training missions that aircraft simulators cannot effectively replicate.

The Navy continues to research new ways to provide realistic training through simulation, but there are limits to realism that simulation can provide, most notably in dynamic multi-threat environments involving numerous forces, and where the training media is too complex to accurately model, such as sound behavior in the ocean.

Although sound behavior in water can be modeled for general results, ASW training simulation requires a degree of fidelity that exceeds current technology. In ASW training, this reality limits the usefulness of both active and passive sonar simulation. Initial training of sonar technicians can and does take place using simulators, but at some point a simulator cannot match the dynamic nature of the environment, either in bathymetry, sound propagation properties, or oceanography. Specifically, coordinated unit level and Strike Group Training activities require multiple crews to interact in a variety of acoustic environments that cannot be simulated.

Sonar operators and crews must train regularly and frequently to develop the skills necessary to master the process of identifying underwater threats in the complex underwater environment. They cannot reliably simulate this training through current computer technology because the actual marine environment is too complex. Sole reliance on simulation would deny Navy strike groups the training benefit and opportunity to derive critical lessons learned in the employment of active sonar in the following specific areas:

- Bottom bounce and other environmental conditions;
- Mutual sonar interference;
- Interplay between ship and submarine target; and
- Interplay between ASW teams in the strike group.

Currently, these factors cannot be adequately simulated to provide the fidelity and level of training necessary in the employment of active sonar. Further, like any combat skill, employment of active sonar is a perishable skill that must be exercised – in a realistic and integrated manner - in order to maintain proficiency. Eliminating the use of active sonar during the training cycle would cause ASW skills to atrophy and thus put U.S. Navy forces at risk during real world operations.

While classroom training and computer simulations are valuable methods for basic, operator-level sonar training, they are no substitute for real-time, at-sea training which mimics the conditions the U.S. Navy and its allies would encounter in actual operating environments. The use of active sonar is especially important when sonar technicians begin learning the mechanics of sonar use, but is also critical for maintaining and improving proficiency throughout their career.

This alternative—substitution of simulation for live training—fails to meet the purpose of and need for the Proposed Action and was therefore eliminated from detailed study.

2.3.2.3 Reduction in the Level of Current Training in the Northwest Training Range Complex

The Navy's requirements for training have been developed through many years of iteration to ensure Sailors and Marines achieve levels of readiness to ensure they are prepared to properly respond to the many contingencies that may occur during an actual mission. These training requirements are designed to provide the experience and proficiency needed to ensure Sailors are properly prepared for operational success. The Navy has identified training requirements to acquire war fighting proficiency. There is no "extra" training built in to the Navy training program. Any reduction of training would not allow the Navy to achieve satisfactory levels of proficiency and readiness required to accomplish assigned missions. For this reason, alternatives that would reduce training would not meet the purpose and need of the proposal, and therefore were eliminated from further study and analysis.

2.3.3 Proposed Action and Alternatives Considered

Three alternatives are analyzed in this EIS/OEIS: 1) The No Action Alternative – Current Activities; 2) Alternative 1 – Increase Training Activities and Accommodate Force Structure Changes; and 3) Alternative 2 – Increase Training Activities, Accommodate Force Structure Changes, and Implement Range Enhancements.

As noted in Section 1.4, the purpose of the Proposed Action is to achieve and maintain Fleet readiness using the NWTRC to support current and future training activities. The Navy proposes to:

1) Conduct training and RDT&E (UASs only) activities of the same types, and at the same levels of training intensity as currently conducted, without change in the nature or scope of military activities in the EIS/OEIS Study Area;
2) Increase training activities from current levels as necessary in support of the FRTP;
3) Accommodate force structure changes (new platforms and weapons systems); and
4) Implement range enhancements associated with the NWTRC.

The components that make up the Proposed Action are discussed in the following sections.

2.4 NO ACTION – CURRENT TRAINING ACTIVITIES WITHIN THE NWTRC

The Navy has been operating in the NWTRC since the early 1900's. Under the No Action Alternative, training activities and major range events would continue at current levels. The NWTRC would not accommodate an increase in training activities required to execute the FRTP or implement proposed force structure changes, nor would it implement range enhancements as necessary by the Navy. Evaluation of the No Action Alternative in this EIS/OEIS provides a baseline for assessing environmental impacts of Alternative 1 and Alternative 2 (Preferred Alternative), as described in the following subsections.

Training activities currently conducted in the NWTRC are described below. Each military activity described in this EIS/OEIS meets a requirement that can be ultimately traced to requirements from the National Command Authority. Training activities in the NWTRC vary from basic individual or unit level events of relatively short duration involving few participants to integrated major range training events, which may involve hundreds of participants over several days.

Over the years, the tempo and types of activities have fluctuated within the NWTRC due to changing requirements, the dynamic nature of international events, the introduction of advances in warfighting doctrine and procedures, and force structure changes. Such developments have influenced the frequency, duration, intensity, and location of required training. The factors influencing tempo and types of activities are variable by nature, and will continue to cause fluctuations in training activities within the NWTRC. Accordingly, training activity data used throughout this EIS/OEIS are a representative baseline for evaluating impacts that may result from the proposed training activities.

With reference to criteria identified in Section 2.2.1, the No Action Alternative supports criteria 3, 6, 7, and 9, while only partially satisfying criteria 1 and 5. The No Action Alternative does not support criteria 2, 4, 8, and 10.

2.4.1 Description of Current and Future Training Activities within the NWTRC

For purposes of analysis, activities data for use in the EIS/OEIS are organized according to the eight PMARs: (Anti-Air Warfare [AAW], Anti-Mine Warfare [AMW], Anti-Surface Warfare [ASUW], Anti-Submarine Warfare [ASW], Mine Warfare [MIW], Strike Warfare [STW], Electronic Combat [EC], and Naval Special Warfare [NSW]. In addition, activities data include some RDT&E (UASs only) events. Summary descriptions of current training activities conducted in the NWTRC are provided in the following subsections. Unless specified as “Future Activity”, the activities described currently take place in the NWTRC. Table 2-6, located at the end of this section, contains summary data regarding these activities. As stated earlier, the No Action Alternative stands as a baseline of current range usage, thus allowing a comparative analysis between the current tempo and desired new uses and accelerated tempo of use. Table 2-6 identifies summarizes training activities conducted in the NWTRC, categorized by PMAR. This table also identifies the location within the Range Complex where the training activity is conducted. For descriptions and locations of the OPAREA, range areas, and airspace within the NWTRC, refer to Tables 2-1 through 2-5, and Figures 2-1 and 2-2.

2.4.1.1 Anti-Air Warfare (AAW) Training

Anti-Air Warfare (AAW) is the PMAR that addresses combat activities by air and surface forces against hostile aircraft.

Air Combat Maneuvers (ACM): Air Combat Maneuvers (ACM) includes Basic Flight Maneuvers (BFMs) where aircraft engage in offensive and defensive maneuvering against each other. During an ACM engagement, no ordnance is fired. These maneuvers typically involve two aircraft; however, based upon the training requirement, ACM exercises may involve over a dozen aircraft. For the purposes of this document, aircraft activities will be described by the term ‘sortie.’ A sortie is defined as a single operation by one aircraft, which uses a range or operating area. A single aircraft sortie is one complete flight (i.e., one takeoff and one final landing).

ACM activities within the NWTRC are primarily conducted by EA-6B Prowlers (and EA-18G Growlers in the future) within the MOAs, and warning areas. However, for purposes of this study, ACM includes other aircraft activities conducted routinely in preparation for more advanced training flights. These other activities include instrument training, in-flight refueling, basic familiarization training, and formation flying. Additionally, Air Force or Air National Guard F-15s and Marine Corps FA-18s also conduct ACM in these areas, although on a much less frequent basis (about 5% of the total sorties). Typically, ACM sorties last about an hour to an hour and a half and do not occur below 5,000 feet (ft). No ordnance is released during this exercise.

Air to Air Missile Exercise (AAMEX) (Future Activity): During an Air-to-Air-Missile Exercise (AAMEX), aircraft attack a simulated threat target aircraft with A-A missiles with the goal of destroying the target.

A typical Basic Phase (Unit Level Training) Scenario would involve a flight of two aircraft operating between 15,000 to 25,000 ft and at a speed of about 450 kts that approach a target from several miles away and, when within missile range, launch their missiles against the target. Approximately half of the missiles have live warheads and about half have an inert telemetry head package. The missiles fired are not recovered. The target is either a Tactical Air-Launched Decoy (TALD) or a LUU-2B/B illumination paraflare. Both the TALDs and the paraflares are expended. These exercises last about one hour, and are conducted in a warning area at sea outside of 12 nm and well above 3,000 ft altitude.

Surface-to-Air Gunnery Exercise (GUNEX S-A): During a Surface-to-Air Gunnery Exercise (GUNEX S-A), a ship's gun crews engage threat aircraft or missile targets with their guns with the goal of disabling or destroying the threat. A typical scenario involving a guided missile destroyer (DDG) with 5-inch guns or a fast frigate (FFG) with 76 mm Main Battery Guns is a threat aircraft or anti-ship missile simulated by an aircraft towing a target toward the ship below 10,000 ft, at a speed between 250 and 500 kts. Main battery guns would be manned and 5-inch or 76 mm rounds fired at the threat with the goal of destroying the threat before it reaches the ship. This is a defensive exercise where each gun mount fires about six rounds of 5-inch ammunition and 12 rounds of 76 mm ammunition at a target towed by an aircraft. The ship will maneuver as necessary and will typically operate at 10 to 12 kts or less during the exercise. The exercise lasts about two hours which normally includes several non-firing tracking runs followed by one or more firing runs. The target must maintain an altitude above 500 ft for safety reasons and is not destroyed during the exercise.

A typical scenario involving a DDG or FFG with 20 mm Close-in-Weapon System (CIWS) is similar, except the ships involved engage the simulated threat aircraft or missile with the CIWS. CIWS equipped ships can expend between 900 to 1400 rounds per mount per firing run for a total of up to five runs during the typical two hour exercise. The actual number of rounds expended during this exercise is dependent on the ship class, the CIWS model installed, and the available ammunition allowance. Preventive maintenance requires test firing of the CIWS prior to this exercise. Approximately 250 rounds of 20 mm are expended annually during these test firings which typically last for 30 minutes. Some of the 20 mm CIWS rounds may contain depleted uranium (DU). The likelihood of DU presence and potential impacts to the environment are discussed in Chapter 3 of this EIS/OEIS.

Surface to Air Missile Exercise (SAMEX) (Future Activity): During a Surface to Air SAMEX, surface ships engage threat missiles and aircraft with surface-to-air missiles (SAMs) with the goal of disabling or destroying the threat. One live or telemetered-inert-missile is expended against a target towed by an aircraft after two or three tracking runs. The exercise lasts about two hours. A BQM-74 target drone, sometimes augmented with a Target Drone Unit (TDU), is used as an alternate target for this exercise. The BQM target is a subscale, subsonic, remote controlled ground or air launched target. A parachute deploys at the end of target flight to enable recovery at sea. The launched SAMs can be a Rolling Airframe Missile if installed on an aircraft carrier; otherwise the SAM used is the NATO Sea Sparrow Missile.

2.4.1.2 Anti-Surface Warfare (ASUW) Training

Anti-Surface Warfare (ASUW) is the PMAR that addresses combat (or interdiction) activities by air, surface, or submarine forces against hostile surface ships and boats.

Surface-to-Surface Gunnery Exercise (GUNEX): Surface gunnery exercises take place in the open ocean to provide gunnery practice for Navy ship crews. Exercises can involve a variety of surface targets that are either stationary or maneuverable. Gun systems employed against surface targets include the 5-inch, 76mm, 57mm, .50 caliber and the 7.62mm. A GUNEX lasts approximately one to two hours, depending on target services and weather conditions.

Air-to-Surface Bombing Exercises (BOMBEX A-S): During Air-to-Surface Bombing Exercises (BOMBEX A-S), Maritime Patrol Aircraft (MPA) and other fixed-wing aircraft deliver bombs against simulated surface maritime targets, typically a smoke float. MPA is a term used to describe both the P-3C Orion aircraft and the P-8 Poseidon. The P-8, also referred to as the Multi-mission Maritime Aircraft (MMA) will begin to replace the P-3 by 2013.

MPA use bombs to attack surfaced submarines and surface craft that would not present a major threat to the MPA itself. A single MPA approaches the target at a low altitude. In most training exercises, it drops inert training ordnance, such as the Bomb Dummy Unit (BDU-45) on a MK-58 smoke float used as the target. Historically, ordnance has been released throughout W-237, just south of W-237, and in international waters in accordance with international laws, rules, and regulations. P-3C squadrons from CPRW-10 are required to conduct one live-fire drop per 24-month cycle. CPRW-10 consists of three active duty VP squadrons and one Reserve squadron (VP-69). There are a total of 12 crews in each squadron. One crew will drop live-fire (consisting of four MK-82 500 lb general purpose bombs) while the remaining 11 crews will drop inert ordnance (consisting of four Bomb Dummy Units [BDU-45s]) for a total of 12 drops per squadron per cycle. Accordingly, 96 pieces of ordnance, consisting of eight MK-82 and 88 BDU-45, are dropped annually. Each BOMBEX A-S can take up to 4 hours to complete.

High-Speed Anti-Radiation Missile Exercise (HARMEX): A High Speed Anti-Radiation Missile Exercise (HARMEX) is an integral part of EA-6B squadron training. It trains aircrews to conduct electronic attack using the HARM missile, which is the primary weapon for the Suppression of Enemy Air Defenses (SEAD), and is designed to attack emitting radars. Only non-firing HARMs are used during HARMEX events on the Range Complex. During a typical HARMEX, an EA-6B flying at a high altitude (>10,000 ft.), would receive and identify an electronic signal from a simulated enemy radar. The aircrew would then position themselves for the optimum firing solution and simulate firing a HARM missile at the electronic signal. HARMEXs are non-firing events that typically last one to two hours. In addition to HARMEX training in support of ASUW, it also supports STW and is included under that warfare area also.

Sinking Exercise (SINKEX): A Sinking Exercise (SINKEX) is typically conducted by aircraft, surface ships, and submarines in order to take advantage of a full size ship target and an opportunity to fire live weapons.

The target for a SINKEX is typically a decommissioned combatant or merchant ship. These target vessels are remediated to standards set by the Environmental Protection Agency (EPA). In accordance with EPA permits, the target is towed out to sea (at least 50 nm [92.6 km]) and set adrift at the SINKEX location, typically in deep water (at least 1,000 fathoms [6,000 feet]) where it will not be a navigation hazard to other shipping. The EPA granted the Department of the Navy a general permit through the Marine Protection, Research, and Sanctuaries Act to transport vessels "for the purpose of sinking such vessels in ocean waters…" (40 CFR Part 229.2). Subparagraph (a) (3) of this regulation states "All such vessel sinkings shall be conducted in water at least 1,000 fathoms (6,000 feet) deep and at least 50 nautical miles from land."

Ship, aircraft, and submarine crews typically are scheduled to attack the target with coordinated tactics and deliver live ordnance to sink the target. Inert ordnance is often used during the first stages of the event so that the target may be available for a longer time. The duration of a SINKEX is unpredictable because it ends when the target sinks, but the goal is to give all forces involved in the exercise an opportunity to deliver their live ordnance. Sometimes the target will begin to sink immediately after the first weapon impact and sometimes only after multiple impacts by a variety of weapons. Typically, the exercise lasts 4 to 8 hours, especially if inert ordnance such as 5-inch gun projectiles or MK-76 dummy bombs are used during the first hours. If the hulk is not sunk by weapons, it will be sunk by EOD personnel setting off demolition charges previously placed on the ship.

2.4.1.3 Anti-Submarine Warfare (ASW) Training

Tracking Exercise (TRACKEX) for ASW trains aircraft, ship, and submarine crews in tactics, techniques, and procedures for search, detection, localization, and tracking of submarines with the goal of determining a firing solution that could be used to launch a torpedo and destroy the submarine. A typical unit-level exercise involves one ASW unit (aircraft, ship, or submarine) versus one target, usually a MK-30 Mobile ASW target, a MK-39 Expendable Mobile ASW Training Target (EMATT), or a live submarine. The target may be non-evading while operating on a specified track or fully evasive. Participating units use active and passive sensors, including hull-mounted sonar, towed arrays, variable depth sonar, and sonobuoys for tracking. If the exercise continues into the firing of a practice torpedo it is termed a Torpedo Exercise (TORPEX). The ASW TORPEX usually starts as a TRACKEX to achieve the firing solution.

ASW TRACKEX Maritime Patrol Aircraft (MPA): During these activities, a typical scenario would involve a single MPA dropping sonobuoys, from an altitude below 3,000 ft, and sometimes as low as 400 ft, into specific patterns designed for both the anticipated threat submarine and the specific water conditions. These patterns vary in size and coverage area based on anticipated threat and water conditions. Typically, passive sonobuoys will be used first, so the threat submarine is not alerted. Active sonobuoys will be used as required either to locate extremely quiet submarines, or to further localize and track submarines previously detected by passive sonobuoys. A TRACKEX-MPA usually takes two to four hours. No torpedoes are fired during this training activity

ASW TRACKEX Extended Echo Ranging (EER): This activity is an at-sea flying event, typically conducted below 3,000 ft, that is designed to train MPA crews in the deployment and use of the Extended Echo Ranging (EER) sonobuoy systems. This system uses the SSQ-110A as the signal source and the SSQ-77 as the receiver sonobuoy. This activity typically lasts six hours, with one hour for sonobuoy pattern deployment and five hours for active search.

ASW TRACKEX (Surface Ship): In the PACNW OPAREA, locally based surface ships do not routinely conduct ASW Tracking exercises. However, mid-frequency active (MFA) sonar is used occasionally (one to one and a half hours) during ship transits through the OPAREA. All surface ship MFA sonar use is documented in this training activity description.

ASW TRACKEX (Submarine): ASW TRACKEX is a primary training exercise for Bangor-based submarines. Training is conducted at the intermediate level and occurs in the PACNW OPAREA. These activities involve P-3 aircraft approximately 30% of the time. Training events in which P-3s are used typically last 8 to 12 hours. During these activities submarines use passive sonar sensors to search, detect, classify, localize and track the threat submarine with the goal of developing a firing solution that could be used to launch a torpedo and destroy the threat submarine. However, no torpedoes are fired during this training activity.

2.4.1.4 Electronic Combat (EC) Training

Electronic Combat (EC) prevents or reduces the effective use of enemy electronic equipment and ensures the continued use of friendly equipment as well as the command and control of said equipment. To provide effective training, this type of training needs to be conducted against sea based, land based, and airborne threats, or a combination of all three.

Electronic Support (ES) provides the capability to intercept, identify, and locate enemy emitters while Electronic Attack (EA) employs tactics, such as electronic jamming, to prevent or reduce effective use of enemy electronic equipment and command and control capability. EA and ES are subsets of EC. Typical EC activities include signals analysis and use of airborne and surface electronic jamming devices to defeat tracking radar systems. During these activities, aircraft, surface ships, and submarines attempt to control critical portions of the electromagnetic spectrum used by threat radars, communications equipment, and electronic detection equipment to degrade or deny the enemy's ability to defend its forces from attack and/or recognize an emerging threat early enough to take the necessary defensive actions.

EP-3, P-3C, and EA-6B aircraft stationed at NASWI train with a land based electronic signal emitter located at OLF Coupeville and conduct ES and EA training in the Darrington Area. EA-6B aircraft also fly threat profiles against surface ships to train shipboard crews on the detection of threat aircraft electronic signatures or to counter jamming of their own electronic equipment. EC training activities typically last one to two hours.

2.4.1.5 Mine Warfare (MIW) Training

Mine Countermeasures: Naval EOD activities require proficiency in underwater mine neutralization. Mine neutralization activities consist of underwater demolitions designed to train personnel in the destruction of mines, unexploded ordnance (UXO), obstacles, or other structures in an area to prevent interference with friendly or neutral forces and non-combatants.

EOD units conduct underwater detonation training at EOD Crescent Harbor, EOD Indian Island, and EOD Floral Point. A 2.5 lb charge of C-4 is used, consisting of one surface or one subsurface detonation. Only one detonation takes place per activity, and only one activity occurs in any one day. .Small boats such as MK-5, 7, or 9 (meters in length, respectively) Rigid Hull Inflatable Boats (RHIB) are used to insert personnel for underwater activities and either a helicopter (H-60) or RHIB is used for insertion for surface activities. A typical scenario involves placing a dummy mine shape on the seafloor. Two divers from one of two small boats enter the water and begin searching for the mine. When located, the mine is marked with a buoy. Later, two divers place the C-4 charge on or around the mine. Typically, the mine and charge are lifted approximately 10 ft above the seafloor. Following confirmation that the area is visually clear of marine mammals and birds, the charge is detonated manually (with a time-delay fuse) or remotely. After the detonation, both boats return to the detonation site. All surface debris, consisting mainly of floats and attached equipment, is retrieved. The divers retrieve debris from the seafloor, which consists mainly of pieces of the mine (the charge is consumed in the explosion). In cases where the mine is only disabled, not destroyed, the mine is either loaded into the primary boat, if the mine is small enough, or suspended below the boat. The total duration of the exercise is four hours for an underwater detonation and one hour for a surface detonation.

Land Demolitions: Land demolitions occur at the DTR Seaplane Base and at DTR Bangor. A typical land demolition training exercise has an eight hour duration and involves disrupting inert Improvised Explosive Devices (IED) using different explosively actuated tools. Typical explosives used are C-4 demolition blocks, detonating cord, and electric blasting caps. The net explosive weight (NEW) training limit is five lbs. per charge at DTR Bangor and an EOD self-imposed limit of one lb per charge at DTR Seaplane Base. Other EOD training activity occurs outside DTR Seaplane Base within the Seaplane Base Survival Area to include locating and defusing (inert) Mark 80 series General Purpose bombs and simulated improvised explosive devices.

Land demolitions are conducted at DTR Seaplane Base approximately six times per month by EODMU-11. EODMU-11 Detachment Bangor conducts approximately six events at DTR Bangor each year.

2.4.1.6 Naval Special Warfare, Explosive Ordnance Disposal, and Search and Rescue Training

NSW forces (SEALs and Special Boat Units [SBUs]) train to conduct military activities in five Special Operations mission areas: unconventional warfare, direct action, special reconnaissance, foreign internal defense, and counterterrorism. Specific training events include:

Insertion/Extraction: Insertion/extraction activities hone individual skills in delivery and withdrawal of personnel and equipment using unconventional methods. Helicopter Rope Suspension Training (HRST) and parachute training are the principal insertion/extraction methods used by EOD teams at the NWTRC.

HRST encompasses Helocast, Special Purpose Insertion and Extraction (SPIE), rappel, and fast rope exercises. Helocast training involves a helicopter flying slowly and low over the water near a target to allow EOD team members to jump out one at a time. The technique is typically used for quick insertion to dispose of hazardous floating mines. A SPIE rigging exercise involves up to eight personnel attached to a rope suspended from a helicopter, allowing the EOD team to be hoisted from or lowered onto the ground without having to land the helicopter. In fast roping, EOD team members slide down a rope from a helicopter, which hovers as high as 60 feet off the ground. Personnel from EODMU-11 detachments conduct HRST training activities monthly throughout the Seaplane Base using an H-60.

The parachute insertion method is designed to place Special Forces teams into an objective area undetected to conduct clandestine activities, either reconnaissance and surveillance, or direct action type missions. Typical duration of one of these activities is three to five hours. Personnel from EODMU-11 detachments perform parachute training four days per month at OLF Coupeville and two days per month at EOD Crescent Harbor.

Insertion/Extraction activities also include Search and Rescue (SAR) training that takes place at the Seaplane Base survival area. This activity involves a helicopter landing and simulated extraction of a survivor (typically one of the helicopter crewmembers). The SAR helicopter, an H-60, approaches the survivor, finds a suitable landing zone, lands, recovers the survivor, then departs the area with the survivor onboard.

NSW (Naval Special Warfare) Training Events: SEAL Delivery Vehicle Team ONE (SDVT-1) from Naval Special Warfare Group THREE (NSWG-3) in San Diego conducts underwater Unit Level Training (ULT) exercises twice a year within the NWTRC. For two to three weeks during these training detachments, SEALs conduct land-based training at Indian Island. The SDV is launched from Port Townsend (see Figure 2-5), travels for approximately three hours, and delivers four to six SEALs to Indian Island where over-the-beach (OTB) and special reconnaissance training occurs. When the land portion of the training is complete—typically 2 days—the SDV returns and the SEALs transit back to Port Townsend via the SDV. No explosives or live ammunition are used during this training.

2.4.1.7 Strike Warfare (STW) Training

Strike Warfare (STW) is the PMAR that addresses combat (or interdiction) activities by air and surface forces against hostile land based forces and assets.

High-Speed Anti-Radiation Missile Exercise (HARMEX): A HARMEX under STW is identical to a HARMEX under ASUW, except that as part of the STW mission, a HARMEX would target a land radar. See Section 2.5.1.2 for HARMEX details.

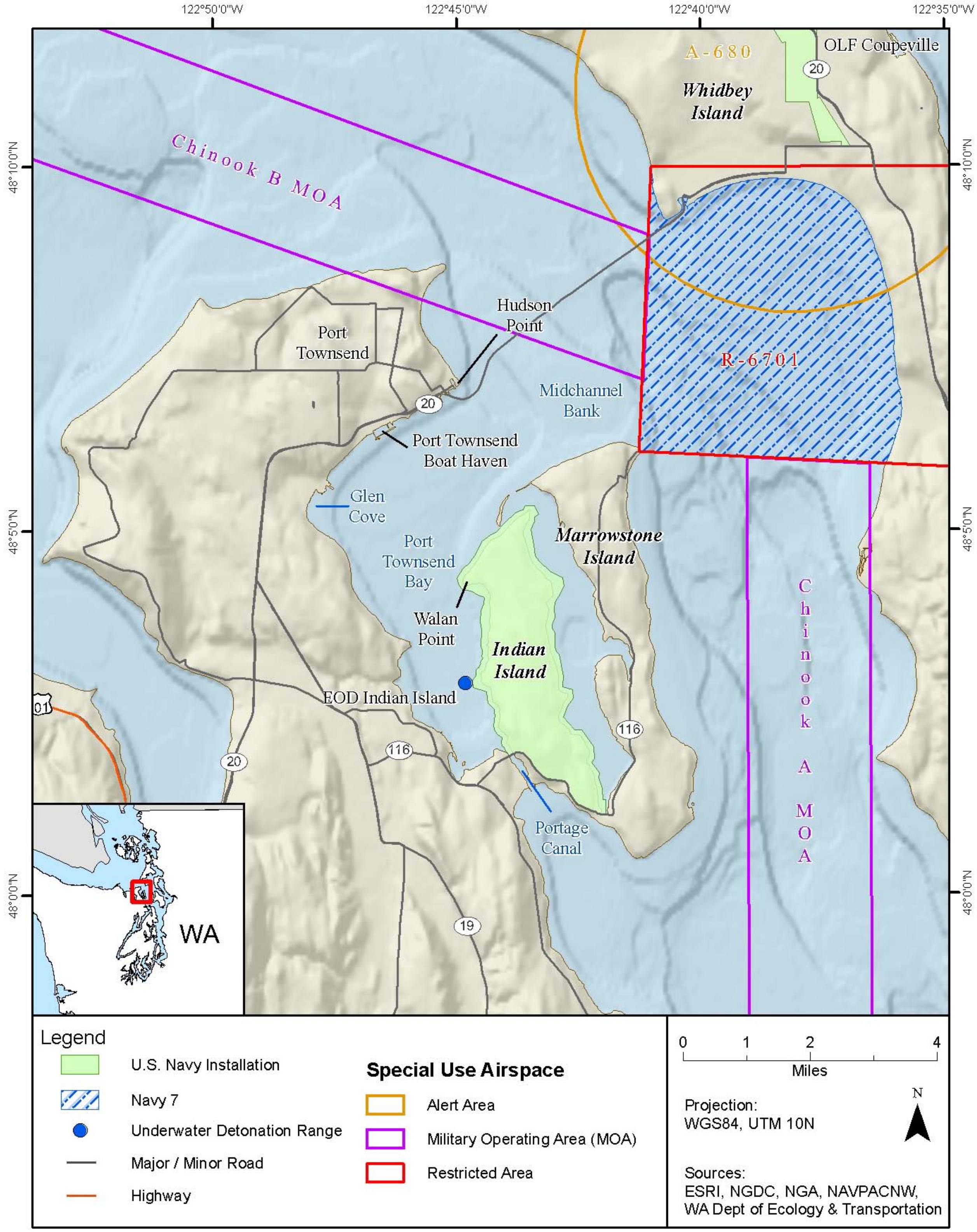


Figure 2-5: NWTRC Inshore Area (Indian Island)

2.4.1.8 Support Activities

Support Activities are activities that directly contribute to the execution and success of forces conducting PMARs.

Intelligence, Surveillance, and Reconnaissance (ISR): Intelligence refers to the information and knowledge obtained through observation, investigation, analysis, or understanding. Surveillance and reconnaissance refer to the means by which the information is observed. Surveillance is the systematic observation of a targeted area or group, usually over an extended time, while reconnaissance is a specific mission performed to obtain specific data about a target.

ISR training is conducted by MPA in W-237 and the PACNW OPAREA. Activities typically last six hours and involve a crew of 11 personnel. P-3 aircrews use a variety of intelligence gathering and surveillance methods, including visual, infrared, electronic, radar, and acoustic. EP-3 and EA-6B crews conduct ISR training as well, but to a lesser extent than P-3C crews.

On occasion, small unit special operations forces (SOF) air, surface, subsurface, and ground ISR activities occur in the Seaplane Base Survival Area. Examples of Special Forces units that have used the Survival Area for ground ISR training include Navy Reserve Mobile Inshore Undersea Warfare Units, U.S. Army Special Forces, and U.S. Army Intelligence forces.

Unmanned Aerial System (UAS) Training and RDT&E: Forces employ UAS to obtain information about the activities of an enemy, potential enemy, or tactical area of operations by use of various onboard surveillance systems including: visual, aural, electronic, photographic, or other means.

There are currently numerous types of UAS employed to obtain intelligence data on threats. UAS are typically flown at altitudes well above 3,000 ft in patterns to best collect the required data, yet remain beyond the reach of threat weapon systems. The UAS may be controlled by a pilot at a remote location, just as if the pilot were onboard, or may fly a preplanned, preprogrammed route from start to finish. Missions will typically last four to six hours, but will vary depending on the scheduled mission training.

The Scan Eagle UAS is a relatively small aircraft that is currently tested in the NWTRC. Typically these activities, conducted in R-6701, occur three times a year for three to four days each, and consist of maritime testing and maritime training. During each of the three to four day testing, the UAS activity lasts approximately six hours. UAS activities can be conducted in W-237. However, due to high sea states, Scan Eagle UAS RDT&E activities in W-237 are not anticipated to continue. The Broad Area Maritime Surveillance (BAMS) system is a future Navy system that may be used for training within the NWTRC. The specific UAS to be used for this system has yet to be determined, but it will likely be a large aircraft such as the Global Hawk, Predator B, or a similar UAS. These aircraft are roughly the size of common military tactical aircraft such as the EA-6B Prowler or FA-18 Hornet. The most likely area in the NWTRC for BAMS, or any other large UAS, training activities would be in W-237. Current Federal Aviation Regulations permit unrestricted UAS activities only in Warning Areas and Restricted airspace. BAMS generally will operate at high altitudes (40,000 ft and higher).

2.5 ALTERNATIVE 1 – INCREASE TRAINING ACTIVITIES AND ACCOMMODATE FORCE STRUCTURE CHANGES

Alternative 1 is a proposal designed to meet Navy and DoD current and near-term operational training requirements. If Alternative 1 were to be selected, in addition to accommodating training activities currently conducted, the NWTRC would support an increase in most training activities to include force structure changes associated with the introduction of new weapon systems, vessels, and aircraft into the Fleet. Under Alternative 1, most baseline-training activities would be increased. In addition, training activities associated with force structure changes would be implemented for the EA-18G Growler, Guided Missile Submarine (SSGN), P-8 Multimission Maritime Aircraft (MMA), and UASs. Force structure changes associated with new weapons systems would include new A-A missiles, and new sonobuoys.

2.5.1 Revised Level of Activities

Table 2-6 identifies the baseline and proposed changes in activities in the NWTRC if Alternative 1 were to be implemented. Although most activities will increase in Alternative 1, mine countermeasure activities will decrease. Under Alternative 1, no more than two underwater detonations per year will take place at Crescent Harbor, and no more than one detonation per year at Indian Island and Floral Point for a maximum of 4 detonations per year.

2.5.2 Force Structure Changes

The NWTRC is required to accommodate and support training with new ships, aircraft, and vehicles as they become operational in the Fleet. In addition, the NWTRC is required to support training with new weapons/sensor systems. The Navy has identified several future platforms and weapons/sensor systems that are in development and likely to be incorporated into Navy training requirements within the 10-year planning horizon. Several of these new technologies are in early stages of development, and thus specific concepts of operations, operating parameters, or training requirements have not yet been developed and thus are not available.

While this alternative meets the Navy’s purpose and need, it does not meet established Navy minimum range capability requirements nor does it optimize the training capabilities of the Range Complex. With reference to the criteria identified in Section 2.2.1, Alternative 1 supports criteria 3, and 6-9, while only partially satisfying criteria 1, 2, and 5. Alternative 1 does not support criteria 4 and 10.

Specific force structure changes within the NWTRC are based on the Navy’s knowledge of future requirements for the use of new platforms and weapons systems and based on the level of information available to evaluate potential environmental impacts. Therefore, this EIS/OEIS, to the extent feasible, will evaluate potential environmental impacts associated with the introduction of the following platforms and weapons/sensor systems.

2.5.2.1 New Platforms/Vehicles

This section describes new aircraft that would be operating in the NWTRC as part of Alternative 1. Each of these aircraft has been analyzed previously in separate NEPA documents.

EA-18G Growler

The EA-18G Growler is an electronic combat version of the FA-18 E/F that will replace the EA-6B Prowler. The Growler will have an integrated suite of EC systems that will allow it to perform the same missions as the EA-6B. In addition to the EA-6B missions, the EA-18G will have a limited self-protection capability requiring aircrews to train for offensive air-to-air missile engagements and conduct missile exercises. The advanced capabilities of the Growler weapons systems will require larger training airspace and broader frequency spectrum access than current systems.

P-8 Multimission Maritime Aircraft (MMA)

The P-8A MMA is the Navy’s replacement for the aging P-3 Orion aircraft. It is a modified Boeing 737-800ERX which brings together a highly reliable airframe and high-bypass turbo fan jet engine with a fully connected, state-of-the-art open architecture mission system. This combination, coupled with next-generation sensors, will dramatically improve ASW and ASUW capabilities.

The MMA will ensure the Navy's future capability in long-range maritime patrol. It will be equipped with modern ASW, ASUW, and ISR sensors. In short, MMA is a long-range ASW, ASUW, ISR aircraft that is capable of broad-area, maritime and littoral operations. NASWI is being analyzed as a potential homebasing location for this aircraft in the ongoing MMA Homebasing EIS (DoN 2008). Currently, the P-8/MMA preferred alternative in the Homebasing EIS is 4 P-8 squadrons to replace 4 P-3 squadrons at NASWI. As P-8 live training is expected to be supplemented with virtual training to a greater degree than P-3 training, P-8 training activities in the NWTRC are likely to be less than those currently conducted by P-3's. Initial Operating Capability (IOC) is expected in 2013.

Unmanned Aerial Systems (UAS)

Broad Area Maritime Surveillance (BAMS) UAS. The BAMS UAS is being designed to support persistent, worldwide access through multi-sensor, maritime ISR providing unmatched awareness of the battlespace. It will support a spectrum of Fleet missions serving as a distributed ISR node in the overall naval environment. These missions include maritime surveillance, Battle-Damage Assessment (BDA), port surveillance and homeland security support, MIW, maritime interdiction, surface warfare, counter drug operations, and battlespace management. The BAMS will operate at altitudes above 40,000 feet, above the weather and most air traffic to conduct continuous open-ocean and littoral surveillance of targets as small as exposed submarine periscopes. Operation of these systems could produce new requirements for Range Complexes in terms of airspace and frequency management. Because current FAA airspace structure does not allow unmanned aircraft in MOAs, UAS activities are limited to Restricted Areas or offshore Warning Areas. Due to the size of NWTRC Restricted Areas and the airspace size requirements of the BAMS mission, the activities can only take place in W-237. IOC is anticipated for 2009.

Navy Unmanned Combat Air System (N-UCAS). The N-UCAS (Grumman X-47B) program is a Navy effort to demonstrate the technical feasibility, military utility, and operational value of an aircraft carrier based, networked system of high performance, weaponized UASs to effectively and affordably execute 21st century combat missions, including SEAD, surveillance, and precision strike within the emerging global command and control architecture. Operation of these systems could produce new requirements for range complexes in terms of airspace, frequency management, and target sets. IOC of these systems has not yet been established.

2.5.2.2 New Weapons Systems

Under the Proposed Action, several weapons systems are being introduced that warrant evaluation in this EIS/OEIS. Each of these systems has previously received appropriate NEPA analysis.

AIM-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM)

The Advanced Medium-Range Air-to-Air Missile (AMRAAM) is a supersonic, air launched, aerial intercept, guided missile employing active radar target tracking, proportional navigation guidance, and active Radio Frequency (RF) target detection. It employs active, semi-active, and inertial navigational methods of guidance to provide an autonomous launch and leave capability against single and multiple targets in all environments. The EA-18G Growler, the replacement aircraft for the EA-6B Prowler, will have an air-to-air missile capability. The NWTRC will be required to support training for this new capability. Air-to-air missile training, including use of live AMRAAM missiles, will occur in W-237.

Improved Extended Echo Ranging (IEER) Sonobuoy

The Improved Extended Echo Ranging (IEER) system is an improved multi-static active acoustic sensor, which employs a new sonobuoy coupled with improved processing algorithms to extend the EER deep-water search capability into the shallow waters of the littoral. The IEER system was developed by the Navy in response to the fleet need for a large-area search capability against diesel submarines operating in littoral waters. The system uses the same source sonobuoy as used in the EER system, the AN/SSQ-110A sonobuoy. It operates on one of 31 selectable radio frequency channels and has two sections. The upper section is called the control sonobuoy and is similar to the upper electronics package of the AN/SSQ-62 Directional Command Activated Sonobuoy System (DICASS) sonobuoy. The lower section consists of two Signal Underwater Sound (SUS) explosive payloads of Class A explosive weighing 4.2 pounds each. When commanded by the aircrew, the SUS charges explode, creating a loud acoustic signal. The echoes from the explosive charge are then analyzed on the aircraft to determine a submarine's position. Since IEER has become operationally capable, the Navy has implemented mitigation measures through a coordinated process with NMFS under the national defense exemption of the MMPA. Those measures will be discussed in more detail in Chapter 5 of this document.

Advanced Extended Echo Ranging (AEER)

The Advanced Extended Echo Ranging (AEER) program examines improvements in both long-range shallow and deep water ASW search using active sources (Air Deployable Low Frequency Projector [ADLFP], Advance Ranging Source [ARS]) and passive sonobuoy receivers (Air Deployed Active Receiver, or ADAR). The signal processing is provided by research conducted under the Advanced Multi-static Processing Program (AMSP).

The proposed AEER system is similar to the existing EER/IEER system. The AEER system will use the same ADAR sonobuoy as the acoustic receiver and will be used for a large area ASW search capability in both shallow and deep water. However, instead of using an explosive AN/SQS-110A as an impulsive source for the active acoustic wave, the AEER system will use a battery powered (electronic) source for the AN/SSQ-125 sonobuoy. The output and operational parameters for the AN/SSQ-125 sonobuoy (source levels, frequency, wave forms, etc.) are classified, however, this sonobuoy is intended to replace the EER/IEER's use of explosives and is scheduled to be deployed in 2009. Acoustic impact analysis for the AN/SSQ-125 in this document assumes a similar per-sonobuoy effect as that modeled for the DICASS sonobuoy. IOC for the AEER system is unknown.

2.5.2.3 Relocation of Forces

In April 2008, the Navy made the decision to relocate Explosive Ordnance Disposal Mobile Unit Eleven (EODMU Eleven) forces out of the NWTRC Study Area to a new homebase in Imperial Beach, CA. This move is planned to be completed in the fall of 2009. Two EOD Shore Detachments (Bangor and Northwest) will remain in the NWTRC. These Shore Detachments report to Commander, Navy Region Northwest and respond to regional Navy tasking and incidents. As a result of the EODMU Eleven relocation, mine warfare underwater detonation (UNDET) training will significantly decrease from a yearly maximum of 60 UNDETs as analyzed in the No Action Alternative (the baseline) to no more than four annual UNDETs as analyzed in Alternatives 1 and 2.

2.5.2.4 New Instrumentation Technology

The NWTRC will acquire improved technology and capabilities to score, track, and provide feedback. Technology is also permitting the fielding of non-fixed site, mobile tracking ranges.

2.6 Alternative 2 – Increase Training Activities, Accommodate Force Structure Changes, and Implement Range Enhancements

Implementation of this alternative would include all elements of Alternative 1 (accommodating training activities currently conducted, increasing training activities, and accommodating force structure changes). In addition, under Alternative 2:

- In order to optimize training throughput and meet the FRTP, training activities of the types currently conducted would be increased over levels identified in Alternative 1 (see Table 2-6);
- Range enhancements would be implemented, to include new electronic combat threat simulators/targets, development of a small scale underwater training minefield, development of a PUTR, and development of air and surface target services as described in Section 2.5.2.

Alternative 2 is the Preferred Alternative, because it would optimize the training capability of the NWTRC and meet Navy minimum required capabilities as documented in the Navy Ranges Required Capabilities Document (RCD) of September 8, 2005. Alternative 2 fully meets the criteria identified in Section 2.2.1.

2.6.1 Revised Level of Activities

Table 2-9 identifies the baseline and proposed changes in activities in the NWTRC under Alternative 2. Although most activities will increase in Alternative 2, mine countermeasure activities will decrease. Under Alternative 2, no more than two underwater detonations per year will take place at Crescent Harbor, and no more than one detonation per year at Indian Island and Floral Point for a maximum of 4 detonations per year.

2.6.2 NWTRC Enhancements

The Navy has identified specific enhancements and recommendations to optimize range capabilities required to adequately support training for all missions and roles assigned to the NWTRC. Enhancement recommendations were based on capability shortfalls (or gaps) and were assessed using the Navy range required capabilities as defined by the RCD of September 2005. Proposed enhancements for the NWTRC are discussed below and will be analyzed in this EIS/OEIS.

2.6.2.1 New Electronic Combat (EC) Threat Simulators/Targets

Electronic Combat (EC) is one of the principal elements of an OPFOR. Every warfare type supported by the NWTRC (except basic NSW/EOD) requires an OPFOR with the capability to produce RF signatures characteristic of the employment of EC threats by an OPFOR. For Basic level training, EC Threat Level 1 is required (a limited number [1-2] of threat weapons systems emitters used primarily for signal recognition). For Intermediate level training, EC Threat Level 2 is required (sufficient EC emitters to provide multiple coordinated threats with accurate threat replication). Additionally, EC is the primary mission of the EA-6B, EA-18G, and EP-3, and a secondary mission of the P-3 - all aircraft based at NASWI. These aircrews require multi-axis threat training currently unattainable at the NWTRC. Similarly, ships and submarines require EC training. Due to their antenna height limitations and the curvature of the earth, effective EC training could only be conducted if the emitter is located on or very near the coastline. Pacific Beach, Washington is one potential location for a fixed land based electronic warfare (EW) emitter. This location, or a similar site on the Washington coast, would allow EC training at sea for ships, submarines, and aircraft, and provide the possibility of multi-axis threat training for aircraft when combined with the existing EW emitter at OLF Coupeville or EC threat simulation requirements of contract air-target and/or surface-target services. This location would also allow for EC training of aircrews to take place in the Olympic MOAs.

Effect on Training

The overall number of sorties or training events will not increase as a result of these enhancements. Instead, training flights or ship training events that historically did not include EC training as part of the event, will now conduct that training. For example, a ship operating in the PACNW OPAREA for the purposes of navigation training will simultaneously conduct EC training if a coastal threat simulator is functional. This is a new mission area for ships training in the NWTRC since no coastal threat simulator existed previously. For aircraft, this training was previously conducted only when within range of the NASWI threat simulator, however, they can now include this mission in their W-237 training flights.

2.6.2.2 Development of the Portable Undersea Tracking Range

The PUTR is a self-contained, portable, undersea tracking capability that employs modern technologies to support coordinated undersea warfare training for Forward Deployed Naval Forces (FDNF). PUTR will be available in two variants to support both shallow and deep water remote activities in keeping with Navy requirements to exercise and evaluate weapons systems and crews in the environments that replicate the potential combat area. The system will be capable of tracking submarines, surface ships, weapons, targets, and Unmanned Underwater Vehicles (UUVs) and distribute the data to a data processing and display system, either aboard ship, or at a shore site.

The Portable Undersea Tracking Range (PUTR) would be developed to support ASW training in areas where the ocean depth is between 300 ft and 12,000 ft and at least 3 nm from land. This proposed project would temporarily instrument 25-square-mile or smaller areas on the seafloor, and would provide high fidelity crew feedback and scoring of crew performance during ASW training activities. When training is complete, the PUTR equipment would be recovered. All of the potential PUTR areas have been used for ASW training for decades.

No on-shore construction would take place. Seven electronics packages, each approximately 3 ft long by 2 ft in diameter, would be temporarily installed on the seafloor by a range boat, in water depths greater than 600 ft. The anchors used to keep the electronics packages on the seafloor would be either concrete or sand bags, which would be approximately 1.5 ft-by-1.5 ft and would weigh approximately 300 pounds. Operation of this range requires that underwater participants transmit their locations via pingers (see "Range Tracking Pingers" below). Each package consists of a hydrophone that receives pinger signals, and a transducer that sends an acoustic "uplink" of locating data to the range boat. The uplink signal is transmitted at 8.8 kilohertz (kHz), 17 kHz, or 40 kHz, at a source level of 190 decibels (dB). The Portable Undersea Tracking Range system also incorporates an underwater voice capability that transmits at 8-11 kHz and a source level of 190 dB. Each of these packages is powered by a D cell alkaline battery. After the end of the battery life, the electronic packages would be recovered and the anchors would remain on the seafloor. The Navy proposes to deploy this system for 3 months of the year (approximately June – August), and to conduct TRACKEX activities for 10 days per month in an area beyond 3 nm from shore. During each of the 30 days of annual operation, the PUTR would be in use for 5 hours each day. No additional ASW activity is proposed as a result of PUTR use.

If fishermen, boaters, or whales are observed in the area, training involving weapons training would be stopped or moved to another area.

Range tracking pingers would be used on ships, submarines, and ASW targets when ASW TRACKEX training is conducted on the PUTR. A typical range pinger generates a 12.93 kHz sine wave in pulses with a maximum duty cycle of 30 milliseconds (3% duty cycle) and has a design power of 194 dB re 1 micro-Pascal at 1 meter. Although the specific exercise, and number and type of participants will determine the number of pingers in use at any time, a maximum of three pingers and a minimum of one pinger would be used for each ASW training activity. On average, two pingers would be in use for 3 hours each during PUTR operational days.

Effect on Training

No new training activities would result from the temporary and occasional use of the PUTR. Surface ship MFA sonar use in the NWTRC is anticipated to increase by approximately 10 percent as a result of PUTR use. There will be no increases in aircraft training events or sonobuoy use.

2.6.2.3 Development of Air Target Services

Navy training requires air targets for Basic and Intermediate AAW, A-A, and S-A GUNEX and MISSLEX. Live rotary and/or fixed wing OPFOR aircraft are required for Basic and Intermediate AAW, ASUW, and Intermediate level ASW, STW, and EC. Additionally, EC Threat Level 1 and 2 are required for almost all training types and levels supported in the NWTRC. Air target services can be used to generate EC threats as well as the visual and spectral signatures of real threats. Additionally, local air and surface units, and potentially submarine units in the future, require air target and EC Threat Level 1 capability to complete AAW missile and gunnery training and exercises at the basic level. Additionally, the EA-18G will have an offensive AAW capability and as such, require air targets. Currently, no air target services exist for the NWTRC. All surface combatant ships must complete this training in the Southern California Range Complex. The target system needs to have the capability to support both air-to-air (A-A) and surface-to-air (S-A) missile exercises, and include subsonic and supersonic aircraft or drones that can operate from surface to 50,000 feet for Intermediate level training. The aircraft or drones in the target system should be capable of active EC jamming and simulated cruise missile launch capabilities. For Basic level AAW training, towed targets are required. Air Target services are traditionally used to provide OPFOR targets.

Due to lack of capability in the NWTRC, surface combatants stationed in the Puget Sound must complete parts of their Basic and Intermediate AAW training elsewhere. This results in increased travel costs; ship/aircraft fuel costs, increased maintenance costs due to increased flying and steaming times to go to other training venues to achieve the training as well as time away from homeport and families which negatively impacts retention and quality of service. To meet Chief of Naval Operations mandated time-in-homeport requirements it is important that the NWTRC meet minimum required capabilities to conduct AAW.

Effect on Training

Three current training activities will be positively affected by the introduction of new air target services in the NWTRC. The activities and impacts follow:

- A-A MISSILEX. Aircraft have previously conducted this training activity in the NWTRC, but on a somewhat limited scale. With the introduction of the EA-18G and its air-to-air missile capability, the requirement will increase. The new air services will allow these aircrews to train locally, and with a broader range of targets. See Table 2-6 for specific increases.
- S-A GUNEX. Similar to the A-A MISSILEX for aircraft above, ships will conduct S-A GUNEX at an increased level with the increased targets and opportunities.
- S-A MISSILEX. Aircraft carriers conduct S-A MISSILEX as a training requirement. No other locally based ships are required to complete this live fire training. Previously, locally based aircraft carriers traveled to other training ranges to complete this requirement. If the BQM-74E or similar target is included in the increased air target services, this new mission will be conducted in the NWTRC.

2.6.2.4 Development of Surface Target Services

The Proposed Action includes the development of Surface target services. The Navy requires surface targets for ship, submarine, and aircraft crews to complete ASUW training. Surface target services can be used to generate EC threats as well as the visual and spectral signatures of real threats. The NWTRC does not have ASUW targets or target services in the complex. Surface ships have the ability to launch a Floating At-Sea Target (FAST) which meets the stationary requirement but these do not replicate the visual or spectral signature of threat platforms. Aircraft and submarines do not have the capability to launch a FAST, although aircraft can launch a marine floating marker (flare), which also does not replicate the visual or spectral signature of real threats.

Due to lack of capability in the NWTRC, surface combatants stationed in the Puget Sound must complete parts of their Basic and Intermediate ASUW training in other training venues. This results in increased travel costs; ship/aircraft fuel costs, increased maintenance costs due to increased flying and steaming times to go to other training venues to achieve the training as well as time away from homeport and families which negatively impacts retention and quality of service. To meet Chief of Naval Operations mandated time-in-homeport requirements it is important that the NWTRC meet minimum required capabilities to conduct ASUW.

Effect on Training

Surface-to-surface gunnery exercises will increase as a result of the development of surface target services. Currently, training is limited to the type of targets available for surface ships. New moving targets will greatly enhance the training available in the NWTRC. See Table 2-6 for actual increases in training activities.

2.6.2.5 Small Scale Underwater Training Minefield

The addition of a small scale underwater training minefield in the NWTRC will allow submarines to conduct mine avoidance training in the range complex. Mine avoidance exercises train ship and submarine crews to detect and avoid underwater mines. The underwater minefield will consist of approximately 15 mine-like shapes tethered to the ocean floor, in depths of 500 to 600 ft (150 to 185 m) and rising to within 400 to 500 ft (120 to 150 m) of the ocean surface. These mine-like shapes will be places within an area approximately 2 nm by 2 nm. Although the location for this minefield has not yet been determined, it would not be installed within the boundaries of the Olympic Coast National Marine Sanctuary (Figure 1-1).

Effect on Training

Until this underwater training minefield is installed, no mine avoidance training is possible in the NWTRC. When the minefield is installed, submarine crews will use the AN/BQS-15 high frequency active sonar to locate and avoid the mine shapes. Each mine avoidance exercise involves one submarine operating the AN/BQS-15 sonar for six hours to navigate through the training minefield. A total of seven mine avoidance exercises will occur in the NWTRC annually.

2.6.3 Range Activity Summary Tables

Tables 2-7 through 2-10 summarize the activities in the NWTRC. Table 2-7 lists the active sonar sources in use or proposed for use in the NWTRC. Table 2-8 summarizes the resulting impact to training from each of the NWTRC enhancements. Table 2-9 provides detailed information on each of the Baseline, Alternative 1, and Alternative 2 activities. Table 2-10 lists the annual expenditure of ordnance and other related training materials in the NWTRC.

Table 2-7: Active Sonar Systems and Platforms

System	Frequency	Associated Platform/Use
AN/SQS-53	MF	DDG and CG hull-mounted sonar
AN/SQS-56	MF	FFG hull-mounted sonar
AN/BQS-15	HF	Submarine mine detection sonar
Range Uplink Transducer	MF / HF	Portable Undersea Tracking Range
MK-84 Range Tracking Pingers	HF	Ships, submarines, ASW targets
MK-48 Torpedo	HF	Submarine fired exercise torpedo (used during SINKEX)
Tonal sonobuoy (DICASS) (AN/SSQ-62)	MF	MPA deployed
CG – Guided Missile Cruiser; DDG – Guided Missile Destroyer; DICASS – Directional Command-Activated Sonobuoy System; HF – High-Frequency; MF – Mid-Frequency.		

Table 2-8: Impact of Range Enhancements on Annual Level of Activities

Range Activity	Platform	Before Range Enhancement	After Range Enhancement	% Increase due to Range Enhancement
New Electronic Combat (EC) Threat Simulators/Targets				
Electronic Combat (EC) Exercises	EA-6B/EA-18G	2,290 sorties	4,580 sorties	100%
	P-3	14 sorties	28 sorties	100%
	EP-3	195 sorties	390 sorties	100%
	CVN	0 events	50 events	N/A
	DDG	0 events	50 events	N/A
	FFG	0 events	100 events	N/A
	AOE	0 events	25 events	N/A
	SSGN	0 events	25 events	N/A
	SSBN	0 events	25 events	N/A
New Portable Undersea Tracking Range (PUTR)				
Anti-Submarine Warfare Tracking Exercise – Surface Ship	DDG (SQS-53C)	39 sonar hours	43 sonar hours	10%
	FFG SQS-56)	59 sonar hours	65 sonar hours	10%
New Air Target Services				
Air-to-Air (A-A)Missile Exercise	EA-18G	12 events 15 missiles	24 events 30 missiles	100%
Surface-to-Air (S-A) Gunnery Exercise	DDG	19	38	100%
	FFG	57	113	98%
	AOE	4	9	125%
S-A Missile Exercise	CVN	0	4	N/A
New Surface Target Services				
Surface-to-Surface (S-S) Gunnery Exercise	CVN	4 events	8 events	100%
	DDG	23 events	42 events	83%
	FFG	70 events	126 event	80%
	AOE	2 events	4 events	100%
Small Scale Underwater Training Minefield				
Mine Avoidance	SSGN	0 events	4 events 24 sonar hours	N/A
	SSBN	0 events	3 events 18 sonar hours	N/A

Table 2-9: Current and Proposed Annual Level of Activities

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
ANTI-AIR WARFARE (AAW)						
Aircraft Combat Maneuvers	EA-6B	None	1,353 sorties	2,000 sorties	2,000 sorties	Offshore Area, Inshore Area
	EA-18G*					
	FA-18					
	F-16					
Air-to-Air (A-A)Missile Exercise (*, **)	EA-18G	AIM-7 Sparrow	0 events 0 missiles	12 events 15 missiles	24 events 30 missiles	Offshore Area
		AIM-9 Sidewinder				
		AIM-120 AMRAAM				
Surface-to-Air (S-A) Gunnery Exercise (**)	DDG	5"/54 BLP, 20mm CIWS	72 events	80 events	160 events	Offshore Area
	FFG	76mm, 20mm CIWS				
	AOE	20mm CIWS				
S-A Missile Exercise*	CVN	Sea Sparrow Missile or RAM	0 events	0 events	4 events	Offshore Area
ANTI-SURFACE WARFARE (ASUW)						
Surface-to-Surface (S-S) Gunnery Exercise (**)	CVN	20mm CIWS, 7.62mm, .50 cal	4 events	4 events	8 events	Offshore Area
	DDG	5"/54 BLP, 20mm, 7.62mm, .50 cal	21 events	23 events	42 events	
	FFG	76mm, 20mm, 7.62mm, .50 cal	63 events	70 events	126 event	
	AOE	20mm, 7.62mm, .50 cal	2 events	2 events	4 events	
Air-to-Surface (A-S) Bombing Exercise (**)	P-3C	MK-82 (live), BDU-45 (inert)	24 sorties	30 sorties	30 sorties	Offshore Area
	P-8*	MK-82 (live), BDU-45 (inert)				
HARM Exercise	EA-6B	CATM-88C (not released)	See STW	See STW	See STW	Offshore Area, Inshore Area
	EA-18G*	CATM-88C (not released)				
Sink Exercise (**)	E-2	None	1 event	2 events	2 events	Offshore Area
	P-3	MK-82, AGM-65 Maverick				
	FA-18	MK-82, MK-83, MK-84, SLAM-ER				
	EA-6B	AGM-88C HARM				
	EA-18G*	AGM-88C HARM				
	SH-60	AGM-114 HELLFIRE				
	DDG	5"/54				
	FFG	76mm				
	SSN	MK-48 ADCAP				

Table 2-9: Current and Proposed Annual Level of Activities (cont'd)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
ANTI-SUBMARINE WARFARE (ASW)						
Anti-Submarine Warfare (ASW) Tracking Exercise - MPA	P-3C P-8 MMA*	Targets: SSN, MK-39 EMATT Sonobuoys: SSQ-53 DIFAR (passive) SSQ-62 DICASS (active) SSQ-77 VLAD, SSQ-36 BT	200 sorties	205 sorties	210 sorties	Offshore Area
ASW Tracking Exercise - Extended Echo Ranging (EER)	P-3C P-8 MMA*	SSQ-110A source sonobuoy SSQ-77 VLAD	10 sorties	11 sorties	12 sorties	Offshore Area
ASW Tracking Exercise - Surface Ship	DDG	SQS-53C MFA sonar	24 events 36 sonar hours	26 events 39 sonar hours	26 events 43 sonar hours	Offshore Area
	FFG	SQS-56 MFA sonar	36 events 54 sonar hours	39 events 59 sonar hours	39 events 65 sonar hours	
ASW Tracking Exercise - Submarine	SSBN SSGN	BQQ-5 (passive only) BQQ-5 (passive only)	96 events	100 events	100 events	Offshore Area
ELECTRONIC COMBAT (EC)						
Electronic Combat (EC) Exercises	EA-6B/EA-18G	None	2,135 sorties	2,290 sorties	4,580 sorties	Offshore Area, Inshore Area
	P-3		13 sorties	14 sorties	28 sorties	
	EP-3		182 sorties	195 sorties	390 sorties	
	CVN**		0 events	0 events	50 events	
	DDG**		0 events	0 events	50 events	
	FFG**		0 events	0 events	100 events	
	AOE**		0 events	0 events	25 events	
	SSGN**		0 events	0 events	25 events	
	SSBN**		0 events	0 events	25 events	
MINE WARFARE (MIW)						
Mine Countermeasures (**)	EOD Pers. H-60, RHIB	2.5 lb C-4	60 events 60 detonations 878 pers.	4 events 4 detonations 102 pers.	4 events 4 detonations 102 pers.	Inshore Area, (EOD Ranges)
Land Demolitions (**)	EOD Pers. Truck	C-4, various igniters, fuses, smoke grenades	102 detonations	110 detonations	110 detonations	Inshore Area, (EOD Ranges)

Table 2-9: Current and Proposed Annual Level of Activities (cont'd)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
MINE WARFARE (MIW) (continued)						
Mine Avoidance*	SSGN (1 per event)	AN/BQS-15 HFA Sonar	0 events	0 events	4 events 24 sonar hours	Offshore Area
	SSBN (1 per event)	AN/BQS-15 HFA Sonar	0 events	0 events	3 events 18 sonar hours	
NAVAL SPECIAL WARFARE (NSW)						
Insertion/Extraction	C-130 (1 sortie per event)	None	24 sorties	27 sorties	27 sorties	Inshore Area, EOD Ranges
	H-60 (1 sortie per event)		84 sorties	93 sorties	93 sorties	
	Personnel		1,064 pers.	1,160 pers.	1,160 pers.	
NSW Training	SDV (1 per event)	None	35 events	35 events	35 events	Indian Island
	RHIB (2 per event)		35 events	35 events	35 events	
	NSW Pers.		245 pers.	245 pers.	245 pers.	
STRIKE WARFARE (STW)						
HARM Exercise (Non-firing)	EA-6B, EA-18G*	CATM-88C (not released)	2,724 sorties	3,000 sorties	3,000 sorties	Offshore Area, Inshore Area
SUPPORT Activities						
Intelligence, Surveillance, and Reconnaissance (ISR)	P-3, EP-3, EA-6B, EA-18G*	None	94 sorties	100 sorties	100 sorties	Offshore Area
Unmanned Aerial System(UAS) Research, Development, Test and Evaluation (RDT&E) and Training	Scan Eagle, Global Hawk*, BAMS*	None	12 sorties	112 sorties	112 sorties	Offshore Area, Inshore Area

Notes: * This activity, ordnance, or location is only applicable under Alternative 1 or 2.
** This activity may involve the use of explosive ordnance.

Table 2-10: Annual Ordnance and Expendables Use

Training Area and Ordnance/Expendable Type	Number of Rounds/Expendables Per Year		
	No Action	Alternative 1	Alternative 2
Pacific Northwest Ocean Surface/Subsurface Operating Area (PACNW OPAREA)			
BOMBS			
BDU-45 (Inert)	88	110	110
MK-82 (HE)	12	18	18
MK-83 (HE)	4	8	8
MK-84 (HE)	4	8	8
MISSILES			
AIM-7 Sparrow	0	6	13
AIM-9 Sidewinder	0	5	9
AIM-120 AMRAAM	0	4	7
AGM-65 Maverick	3	6	6
AGM-84 Harpoon	3	6	6
AGM-88 HARM	2	4	4
AGM-114 HELLFIRE	1	2	2
NATO Sea Sparrow Missile	0	0	8
SLAM ER	1	2	2
NAVAL GUNSHELLS			
20 mm	7,200	8,000	16,000
25 mm	15,750	17,500	31,500
57mm	630	700	1,260
76mm	560	800	1,120
5 inch	1,716	2,351	3,463
SMALL ARMS ROUNDS			
7.62mm Projectile	1,224	1,360	2,720
.50 cal machine gun	58,500	65,000	117,000
TORPEDOES			
MK-48 ADCAP	1	2	2
PYROTECHNICS			
LUU-2B/B Flare	0	6	11
MK-58 Marine Marker (Day/Night smoke/flare)	208	215	220
TARGETS			
MK-39 Expendable Mobile ASW Training Target (EMATT)	121	126	126
Tactical Air Launched Decoy (TALD)	0	11	22
TDU-34 Towed Target (Retained, not expended)	72	80	160
BQM-74E	0	0	16
HSMST (Recovered)	0	5	9

Table 2-10: Annual Ordnance and Expendables Use (continued)

Training Area and Ordnance Type	Number of Rounds Per Year		
	No Action	Alternative 1	Alternative 2
Pacific Northwest Ocean Surface/Subsurface Operating Area (PACNW OPAREA) (continued)			
TARGETS (continued)			
Trimaran (Recovered)	0	11	20
SPAR (Recovered)	0	17	31
Killer Tomato	60	67	120
SONOBUOYS			
SSQ-36 BT (Nonacoustic)	288	295	302
SSQ-53 DIFAR (Passive Acoustic)	7,283	7,503	7,661
SSQ-62 DICASS (Active Acoustic)	844	865	886
SSQ-77 VLAD (Passive Acoustic)	593	623	653
SSQ-110A Source (Explosive)	124	136	149
Indian Island Underwater EOD Range			
EXPLOSIVES			
2.5 lb Net Explosive Weight (NEW) charges	3	1	1
20 lb NEW charges	1	0	0
Crescent Harbor Underwater EOD Range			
EXPLOSIVES			
< 2.5 lb NEW charges	3	0	0
2.5 lb NEW charges	45	2	2
5 lb NEW charges	1	0	0
20 lb NEW charges	4	0	0
Floral Point Underwater EOD Range			
EXPLOSIVES			
2.5 lb NEW charges	3	1	1
Seaplane Base Demolition Training Range			
EXPLOSIVES			
Detasheet C-2 (0.083 in)	800	862	862
C-4 1.25 lb block	1,476	1,591	1,591
C-4 2.0 lb block	240	259	259
Igniters	160	172	172
MK142 Firing Device	91	98	98
Hand Grenades	160	172	172
MK174 Ctg Cal .50 Impulse	847	913	913
DetaSheet 2.0 lb (M024)	240	259	259
Blasting Cap, Electric (M130)	1,758	1,896	1,896
Det Cord (ft) (M456)	31,960	34,467	34,467
Fuse, Blasting,Time (ft) (M670)	16,300	17,578	17,578

Table 2-10: Annual Ordnance and Expendables Use (continued)

Training Area and Ordnance Type	Number of Rounds Per Year		
	No Action	Alternative 1	Alternative 2
Seaplane Base Demolition Training Range (continued)			
EXPLOSIVES (continued			
Igniter, Time, Blasting Fuse (M766)	320	345	345
Blasting Cap, Non-Electric (M131)	959	1034	1034
PYROTECHNICS			
Red Smoke, G950	224	241	241
Green Smoke, G940	91	98	98
Violet Smoke, G955	192	207	207
Bangor Demolition Training Range			
EXPLOSIVES			
Detasheet C-2 (0.083 in)	50	55	55
C-4 1.25 lb block	94	102	102
C-4 2.0 lb block	15	16	16
Igniters	10	11	11
MK142 Firing Device	6	6	6
Hand Grenades	10	11	11
MK174 Ctg Cal .50 Impulse	54	58	58
DetaSheet 2.0 lb (M024)	15	17	17
Blasting Cap, Electric (M130)	112	121	121
Det Cord (ft) (M456)	2,040	2,200	2,200
Fuse, Blasting,Time (ft) (M670)	1,040	1,122	1,122
Igniter, Time, Blasting Fuse (M766)	20	22	22
Blasting Cap, Non-Electric (M131)	61	66	66
PYROTECHNICS			
Red Smoke, G950	14	15	15
Green Smoke, G940	6	6	6
Violet Smoke, G955	12	13	13

3 Affected Environment and Environmental Consequences

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3 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter describes existing environmental conditions (affected environment) for resources potentially affected by the Alternatives described in Chapter 2. Potential biological, physical, cultural, and social resource impacts (environmental consequences) are identified, described, and evaluated for the Proposed Action and its Alternatives. As discussed in Chapter 2 under the No Action Alternative, training activities would continue at current levels. Although the No Action Alternative would not meet the Navy's long-term training needs in the Northwest Training Range Complex (NWTRC), existing conditions serve as the baseline for analyzing the impacts of the Action Alternatives (Alternative 1 and Alternative 2, the Preferred Alternative).

The affected environment and environmental consequences are described and analyzed according to 16 categories of resources. The resource categories and their sections in this Draft environmental impact statement (EIS)/overseas environmental impact statement (OEIS), from here on referred to as EIS/OEIS are:

- Geology and Soils (Section 3.1)
- Air Quality (3.2)
- Hazardous Materials and Wastes (3.3)
- Water Resources (3.4)
- Acoustic Environment (3.5)
- Marine Plants and Invertebrates (3.6)
- Fish (3.7)
- Sea Turtles (3.8)
- Marine Mammals (3.9)
- Birds (3.10)
- Terrestrial Biological Resources (3.11)
- Cultural Resources (3.12)
- Traffic (3.13)
- Socioeconomics (3.14)
- Environmental Justice & Protection of Children (3.15)
- Public Safety (3.16)

During the environmental impact analysis process, the resources analyzed are identified and the expected geographic scope of potential impacts for each resource, known as the resource's Study Area, is defined. The discussion and analysis, organized by resource category, covers:

- The offshore area, which includes all air, sea, and undersea ranges west of the coastline.
- The inshore area, which includes all air, land, sea, and undersea ranges inland of the coastline.

In determining environmental consequences, this chapter incorporates current resource protection measures such as standard operating procedures (SOPs), best management practices (BMPs), and conservation measures that are integral to the activities covered by the Proposed Action and its Alternatives. Mitigation measures are discussed at the end of each resource section and summarized in Chapter 5.

3.0 GENERAL APPROACH TO ANALYSIS

The methods used in this EIS/OEIS to assess resource impacts associated with the Proposed Alternatives include the procedural steps outlined below:

- Describe existing resource conditions.
- Review existing Federal and State regulations and standards relevant to resource-specific management and/or protection.
- Identify critical resource conditions or areas that require specific analytical attention, such as designated endangered species critical habitat.
- Analyze the warfare areas and activities to determine what stressors may affect the particular resource.
- Review and analyze data sources for information on stressor impacts to the resource, including modeling efforts and scientific research.
- Determine specific impacts to the resource associated with the stressors that result from Navy activities.
- Adjust initial impact determinations to account for use of SOPs, BMPs, and other mitigations measures.
- Determine overall impacts to the resource associated with the Proposed Action and its alternatives, given the applicable regulatory framework.
- Summarize impact findings with respect to resource effects and compliance with regulations and Navy policies for each alternative.

Additional steps may be added to some resource evaluations to address unique resource characteristics or specific regulatory and public-issue concerns.

3.0.1 Stressors

The EIS/OEIS interdisciplinary team and Navy subject matter experts used a screening process to analyze the warfare areas and training activities to identify specific activities in the Alternatives that could act as stressors to resources. Other information that was evaluated to identify and evaluate stressors included public and agency scoping comments, previous environmental analyses, agency consultations, resource-specific information, and applicable laws, regulations, and executive orders. This process was used to focus the information presented and analyzed in the affected environment and environmental consequences sections of this EIS/OEIS. Table 3-1 summarizes warfare areas, the number of yearly test and training activities of each type that would be associated with each Alternative, and the stressors that potentially would occur within each warfare area because of those activities. The stressors and some of the mechanisms that would result in stress include:

- Vessel movements (disturbance and collisions);
- Low altitude aircraft overflights (disturbance and strikes);
- Land-based training (disturbance and habitat alteration);
- Sonar (disturbance);
- Weapons firing/non-explosive practice ordnance (disturbance, strikes, and habitat alteration);
- High-explosive ordnance (disturbance, strikes, and habitat alteration); and
- Expended materials (habitat alteration, entanglement, ingestion, and hazardous materials).

Table 3-2 shows the relationships between stressors and the physical and biological resources that are evaluated in this EIS/OEIS. These tables provide the organizational framework for the description of environmental impacts presented in the following sections.

Table 3-1: Summary of Potential Stressors

		Number of Activities			Stressors						
Warfare Area and Activity	**Training Area(s)**	**No Action Alternative**	**Alternative 1**	**Alternative 2**	**Vessel Movements**	**Aircraft Over flights**	**Land-based Training**	**SONAR**	**Weapons Firing/Non-Explosive Practice Ordnance**	**High-Explosive Ordnance**	**Expended Materials**
Anti-Air Warfare (AAW)											
Air Combat Maneuver (ACM)	Okanogan, Olympic, & Roosevelt Military Operating Areas (MOAs); Air Traffic Controlled Assigned Airspace (ATCAAs); Darrington Operating Area (OPAREA)	1,353	2,000	2,000		✓					✓
Air-to-Air Missile Exercise (A-A MISSILEX)	Warning Area 237 (W-237)	0	12	24		✓			✓	✓	✓
Surface-to-Air Gunnery Exercise (S-A GUNEX)	W-237, Pacific Northwest (PACNW) OPAREA	72	80	160	✓	✓			✓	✓	✓
Surface-to-Air Missile Exercise (S-A MISSILEX)	W-237, PACNW OPAREA	0	0	4	✓	✓			✓	✓	✓
Anti-Surface Warfare (ASUW)											
Surface-to-Surface Gunnery Exercise (S-S GUNEX)	W-237, PACNW OPAREA	90	100	180	✓				✓	✓	✓
Air-to-Surface Bombing Exercise (A-S BOMBEX)	W-237, PACNW OPAREA	24	30	30	✓	✓			✓	✓	✓
Sinking Exercise (SINKEX)	W-237, PACNW OPAREA	1	2	2	✓	✓			✓	✓	✓

Table 3-1: Summary of Potential Stressors (cont'd)

		Number of Activities			Stressors						
Warfare Area and Activity	**Training Area(s)**	**No Action Alternative**	**Alternative 1**	**Alternative 2**	**Vessel Movements**	**Aircraft Over flights**	**Land-based Training**	**SONAR**	**Weapons Firing/Non-Explosive Practice Ordnance**	**High-Explosive Ordnance**	**Expended Materials**
Anti-Submarine Warfare (ASW)											
Anti-Submarine Warfare Tracking Exercise – Maritime Patrol Aircraft (TRACKEX-MPA)	W-237, PACNW OPAREA	200	205	210	✓	✓		✓			✓
Anti-Submarine Warfare Tracking Exercise - Extended Echo Ranging (EER)	W-237, PACNW OPAREA	10	11	12		✓		✓		✓	✓
Anti-Submarine Warfare Tracking Exercise - Surface Ship (TRACKEX-Surface)	PACNW OPAREA	60	65	65	✓			✓			✓
Anti-Submarine Warfare Tracking Exercise – Submarine (TRACKEX-Sub)	W-237, PACNW OPAREA	96	100	100	✓	✓					✓
Electronic Combat (EC)											
Electronic Combat (EC) Exercises	W-237, PACNW and Darrington OPAREAs	2,330	2,500	5,000	✓	✓					✓
Mine Warfare (MIW)											
Mine Countermeasures (MCM)	Crescent Harbor, Indian Island	60	4	4	✓	✓				✓	✓
Land Demolitions	Bangor Demolition Training Range (DTR) & Seaplane DTR	102	110	110			✓			✓	✓
Mine Avoidance	W-237, PACNW	0	0	7	✓			✓			

Table 3-1: Summary of Potential Stressors (cont'd)

		Number of Activities			Stressors						
Warfare Area and Activity	**Training Area(s)**	**No Action Alternative**	**Alternative 1**	**Alternative 2**	**Vessel Movements**	**Aircraft Over flights**	**Land-based Training**	**SONAR**	**Weapons Firing/Non-Explosive Practice Ordnance**	**High-Explosive Ordnance**	**Expended Materials**
Naval Special Warfare (NSW)											
Insertion/Extraction	Seaplane Base, Outlying Landing Field (OLF) Coupeville & Crescent Harbor	108	120	120		✓	✓				✓
NSW Training	Indian Island	35	35	35			✓				
Strike Warfare											
HARM Missile Exercise (HARMEX)	Okanogan, Olympic, & Roosevelt MOAs, ATCAAs	2,724	3,000	3,000		✓					
Support Activities											
Intelligence, Surveillance, and Reconnaissance (ISR)	W-237, PACNW OPAREA, Seaplane Base Survival Area	94	100	100		✓	✓		✓		✓
Unmanned Aerial System (UAS) RDT&E and Training	Admiralty Bay (R-6701), W-237 & PACNW OPAREA	12	112	112		✓					

Table 3-2: Physical and Biological Resources that Could be Affected by Stressors Associated with the Alternatives

Potential Stressor	Geology and Soils	Water Resources	Marine Plants and Invertebrates	Marine Mammals	Sea Turtles	Fish and EFH	Birds	Terrestrial Resources
Vessel Movements								
Vessel Disturbance			✓	✓	✓	✓	✓	
Vessel Collisions			✓	✓	✓	✓	✓	
Aircraft Over flights								
Aircraft Disturbance				✓	✓	✓	✓	✓
Aircraft Strikes							✓	✓
Land-based Training								
Vehicle Movements								✓
Foot Traffic								✓
SONAR								
Mid- and High-Frequency Sonar				✓	✓	✓		
Weapons Firing/Non-Explosive Practice Ordnance								
Weapons Firing Disturbance				✓	✓	✓	✓	
Non-Explosive Ordnance Strikes			✓	✓	✓	✓	✓	
Non-Explosive Ordnance Disturbance			✓	✓	✓	✓	✓	
High Explosive Ordnance								
Land Detonations							✓	✓
Underwater Detonations	✓	✓	✓	✓	✓	✓	✓	
Explosive Ordnance			✓	✓	✓	✓	✓	
Expended Materials								
Ordnance Related Materials		✓	✓	✓	✓	✓		
MK-58 Marine Markers				✓	✓	✓	✓	
Target Related Materials			✓	✓	✓	✓	✓	
Expendable Mobile ASW Training Targets			✓	✓	✓	✓		
Sonobuoys		✓	✓	✓	✓	✓	✓	
Chaff	✓	✓						✓
Flares	✓	✓						✓

3.0.2 Data Sources

A systematic review of relevant literature, regulatory requirements, mitigation provisions, and data was conducted to complete the technical and compliance analysis for each resource category. Both published and unpublished documents were used, including journals, books, periodicals, bulletins, Department of Defense operations reports, theses, dissertations, endangered species recovery plans, species management plans, and other technical reports published by government agencies, private businesses, or consulting firms. The scientific literature was also consulted during the search for geographic location data (geographic coordinates) on the occurrence of marine resources within the Study Area.

3.1 Geology and Soils

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3.1 GEOLOGY AND SOILS

This section addresses geology, topography, and soils at locations within the Northwest Training Range Complex (NWTRC) Study Area that may be affected by the proposed alternatives. Marine water and sediment quality are discussed in Section 3.4 and terrestrial biological resources such as vegetation, wildlife, and threatened and endangered species are discussed in Section 3.11.

3.1.1 Affected Environment

3.1.1.1 Existing Conditions

Introduction

Topography within the NWTRC Study Area is a complex of mountains, fjords, and coastal lowlands that are the result of tectonic activity coupled with periods of glaciation, erosion, and deposition. The study area is located where the edge of the North American continental plate meets and overrides the Juan de Fuca oceanic plate along the tectonic boundary known as the Cascadia Subduction Zone. This zone is the most extensive fault system in the Pacific Northwest. The two tectonic plates converge at a rate of about 1 to 2 inches per year (3 to 4 centimeters) (Melbourne and Webb 2003, McGregor and Offield 1986). During the Pleistocene Epoch (1.8 million years ago to about 11,000 years ago), glaciers as much as 3,300 feet thick (1,100 meters) moved southward from the Coast Mountains of British Columbia and carved out the Strait of Juan de Fuca and greater Puget Sound. The deepest basins were created in North Puget Sound in and around the San Juan Islands. Approximately 15,000 years ago, the southern edge of the last glacier receded, leaving the lowland covered with glacial deposits and glacial lakes, and revealing the Puget Sound Basin (Burns 1985). Soils developed from the resulting glacial till that was moved by the glacier (e.g., clay, silt, sand and boulders), and subsequently sorted and transported by glacial meltwater runoff. Soil formation was also influenced by the moist marine climate and extensive coniferous forests that developed.

In terms of geology and soils, relevant areas in the NWTRC Study Area include Whidbey Island, Indian Island, and Naval Base Kitsap (NBK) Bangor, all in Puget Sound (Figure 3.1-1).

Geology, Topography, and Soils

Whidbey Island

Whidbey Island is characterized by gentle slopes, valleys, and ridges, with steep eroding cliffs along its shoreline (Figure 3.1-2). Most of the upland areas of Whidbey Island are covered by gravel and cobble in a clay-silt binder (known as “Vashon Till”) that covers older deposits from previous glacial advances and retreats. The cliffs are composed primarily of highly erodible, unconsolidated glacial material ranging from sand to boulders (DoN 2000a).

The parent material for much of the soil on Whidbey Island is coarse- to fine-textured glacial drift, material that often covers the ground underneath the lower half (down-gradient) of a glacier. These soils vary considerably in profile, texture, permeability, and consistency; some are loose and porous, while others are hard and cemented. Soil drainage is moderately good to somewhat excessive. When undisturbed, soils on Whidbey Island are not prone to erosion because of low annual precipitation, gentle topography, and lack of strong winds; thunderstorms and cloudburst are not common. However, the bluffs remain susceptible to erosion and have an estimated long-term erosion rate of six to eight inches per year (15 to 20 centimeters) (SCS 1958, DoN 1996, 2000a). Two facilities on Whidbey Island are relevant to prospective impacts from training activities – Seaplane Base at Naval Air Station Whidbey Island (NASWI) and Naval Outlying Landing Field (OLF) Coupeville (Figure 3.1-2).

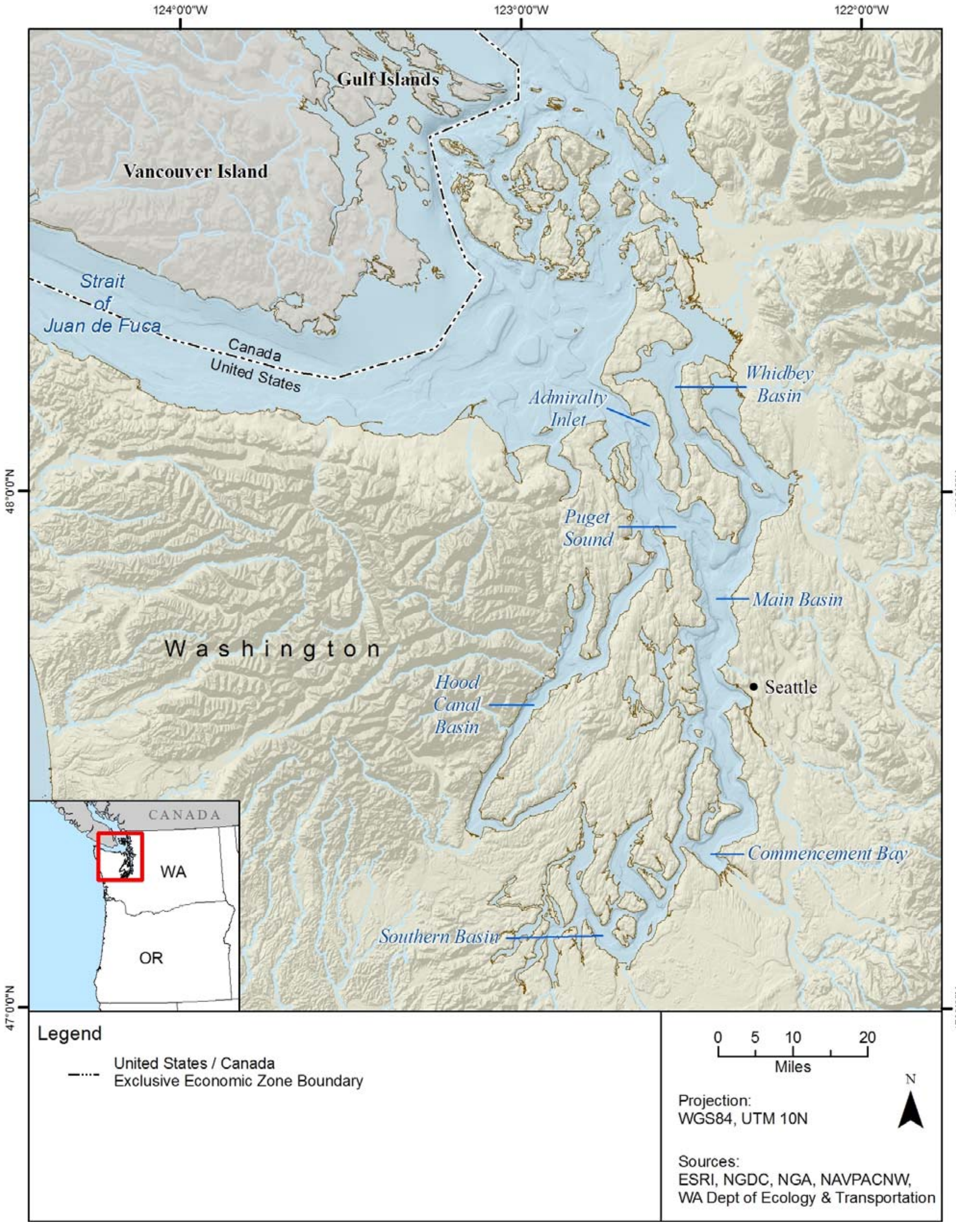

Figure 3.1-1: Puget Sound

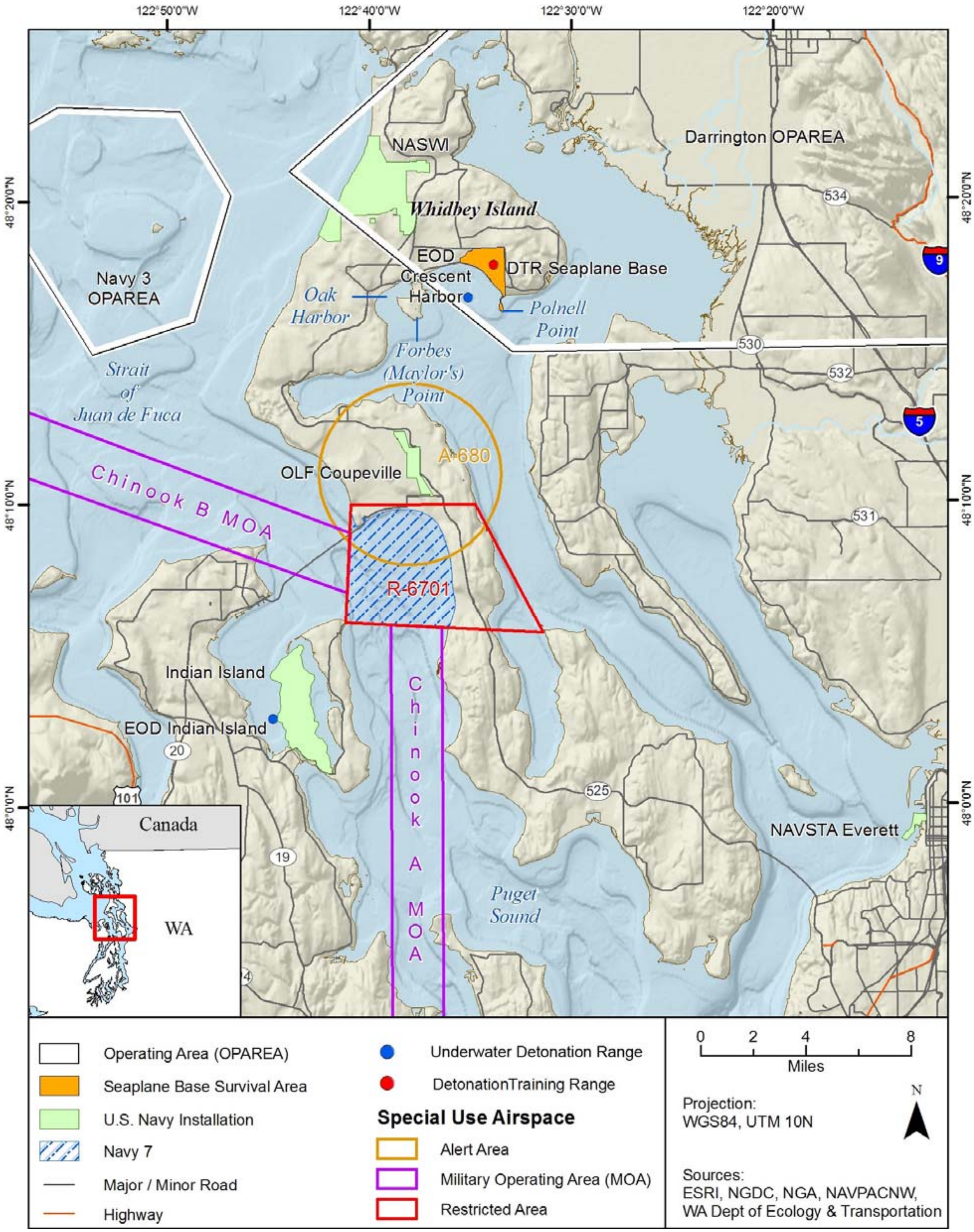

Figure 3.1-2: Whidbey Island

Seaplane Base at NASWI. Seaplane Base is located on Crescent Harbor within the town of Oak Harbor. The base has about 15 miles (24 kilometers [km]) of shoreline, including sandy beaches, tidal flats, salt marshes, steep bluffs, and modified and reinforced areas of rocks, boulders, and concrete (DoN 1996, 2000a). The demolition training range (DTR) at Seaplane Base is located on the eastern side of the base.

OLF Coupeville. OLF Coupeville covers about one square mile (2.7 square kilometers [km^2]) in a relatively flat area (0-5 percent slope) with no notable topographic features, no surface water bodies, and no shorelines. The only development on the facility consists of a mile-long runway, a taxiway, control tower, and other support buildings. Almost 70 percent of the land is cultivated or grassland. Soils are primarily loamy sands or sandy loams and are generally moderately to well-drained. Soil erosion is not a significant management concern at OLF Coupeville (DoN 1996, 2000a).

Indian Island

Indian Island is hilly and moderately sloped. The southern portion of the island reaches over 350 feet (100 meters) and has steeper slopes and bluffs (Figure 3.1-3). Indian Island and eastern Port Townsend Bay are dominated by well-drained, gravely soils derived from glacial till, and often underlain by compacted till or loamy sand. This material covers lower layers of glacial outwash sand and gravel, sandstone, and volcanic bedrock. Erosion is slight to moderate (1-4 inches per year [4-10 cm]). Much of the shoreline varies from mud flats to steep bluffs. The island shoreline is relatively free from armoring and consists of sand spits, tidal mudflats, and steep, slowly eroding bluffs. Beaches are composed of cobble, pea gravel, and sand. The island is separated from the mainland by the narrow Portage Canal and from neighboring Marrowstone Island by shallow tidal flats and a sand spit (SCS 1975, Johannesson 1999, DoN 2000a).

Naval Base Kitsap Bangor

NBK-Bangor is located on Hood Canal, a fjord-like glacial trough to the west (Figure 3.1-4). The base covers almost 12 square miles (30 km2), of which 2.3 square miles (6 km2) is developed and seven square miles (18 km2) is forest. The area is part of the Puget Sound Lowland, a broad trough filled with unconsolidated glacial sediments overlying volcanic bedrock. Glacial sediments are complex collections of clay, silt, sand, gravel, and hard, gray, heterogeneous glacial till consisting of gravels and boulders suspended in clay. Elevation ranges from 100 to 400 feet (30 to 120 meters). The southern part of the base consists of nearly level glacial till deposits (“till plain”), with several north-south trending hills (“drumlins”) formed by glaciers. The northern portion of the base is an upland plateau that has several drainages that discharge to Hood Canal and Puget Sound. Soils are moderate to well-drained, although often underlain by compacted or hardpan layers. Wetlands and ponds are common (SCS 1980, DoN 2001, 2000a).

Demolition Training Ranges

Demolition training ranges (DTRs) are designated areas and structures in which explosive ordnance disposal (EOD) training is conducted. EOD personnel must re-qualify on a monthly basis to use explosives. Per Navy requirements, the overall DTR area is relatively flat and 1,000 feet in diameter (152 meters) within which a 100-foot diameter area is cleared of all vegetation and combustible materials, and a detonation enclosure is constructed at the center. The enclosure is roughly 20 feet square with walls that are 8 feet (2.4 meters) high, 8 inches (20 centimeters) thick, and composed of wood or plastic lumber, concrete, and sandbags. The interior of the enclosure is lined with an impermeable material to prevent infiltration of constituents through the soil to water pathways. A 12-inch layer of sand (30 centimeters) is placed over this impermeable layer. DTRs are also covered when not in use to prevent water intrusion (DoN 2000b). These actions prevent the movement of ordnance constituents to soils beyond the impact area. Site access is usually controlled by a perimeter fence, with additional security patrols operating during training activities. DTRs are subject to routine testing and clearing actions. Because of the long-

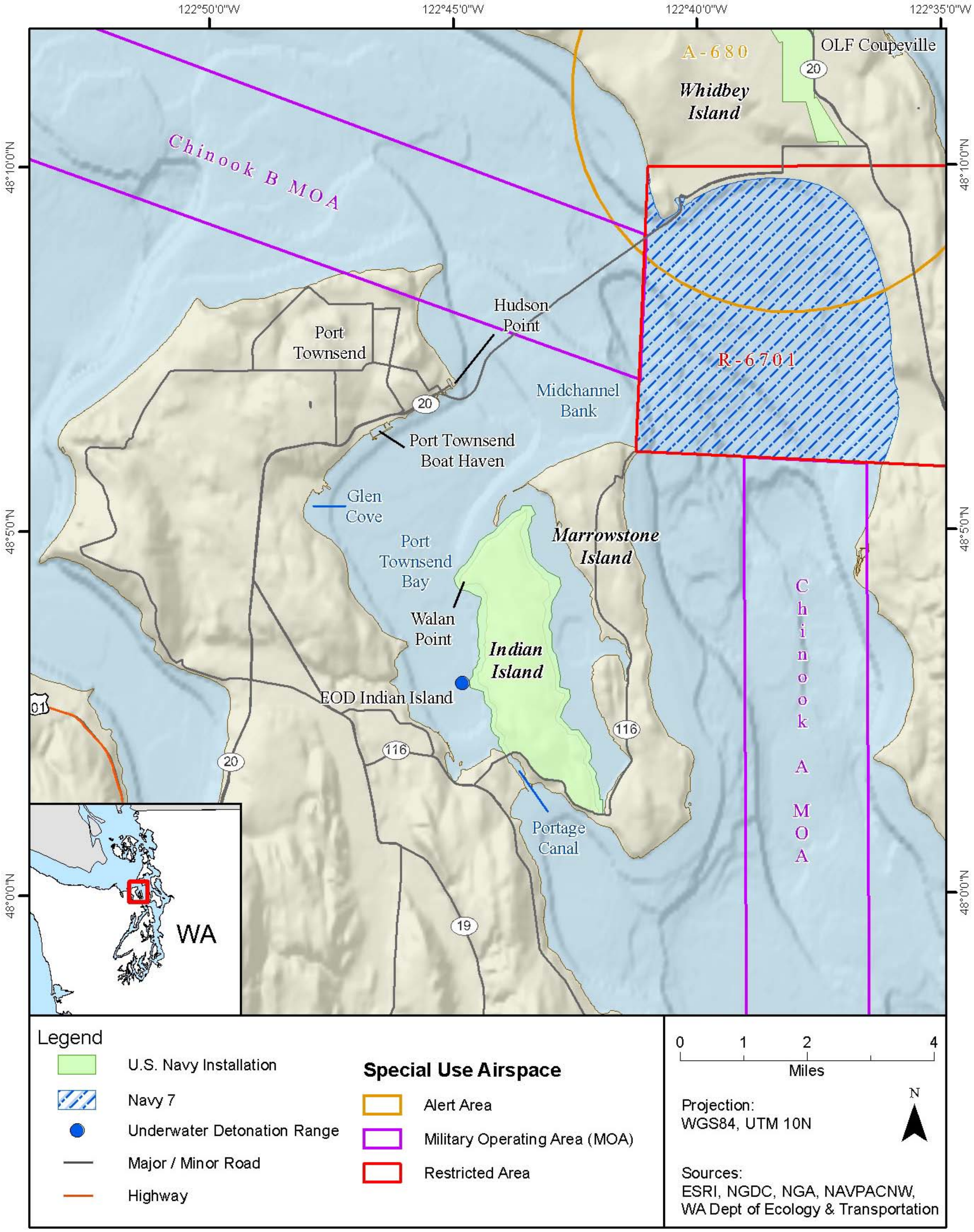

Figure 3.1-3: Indian Island and Surrounding Features

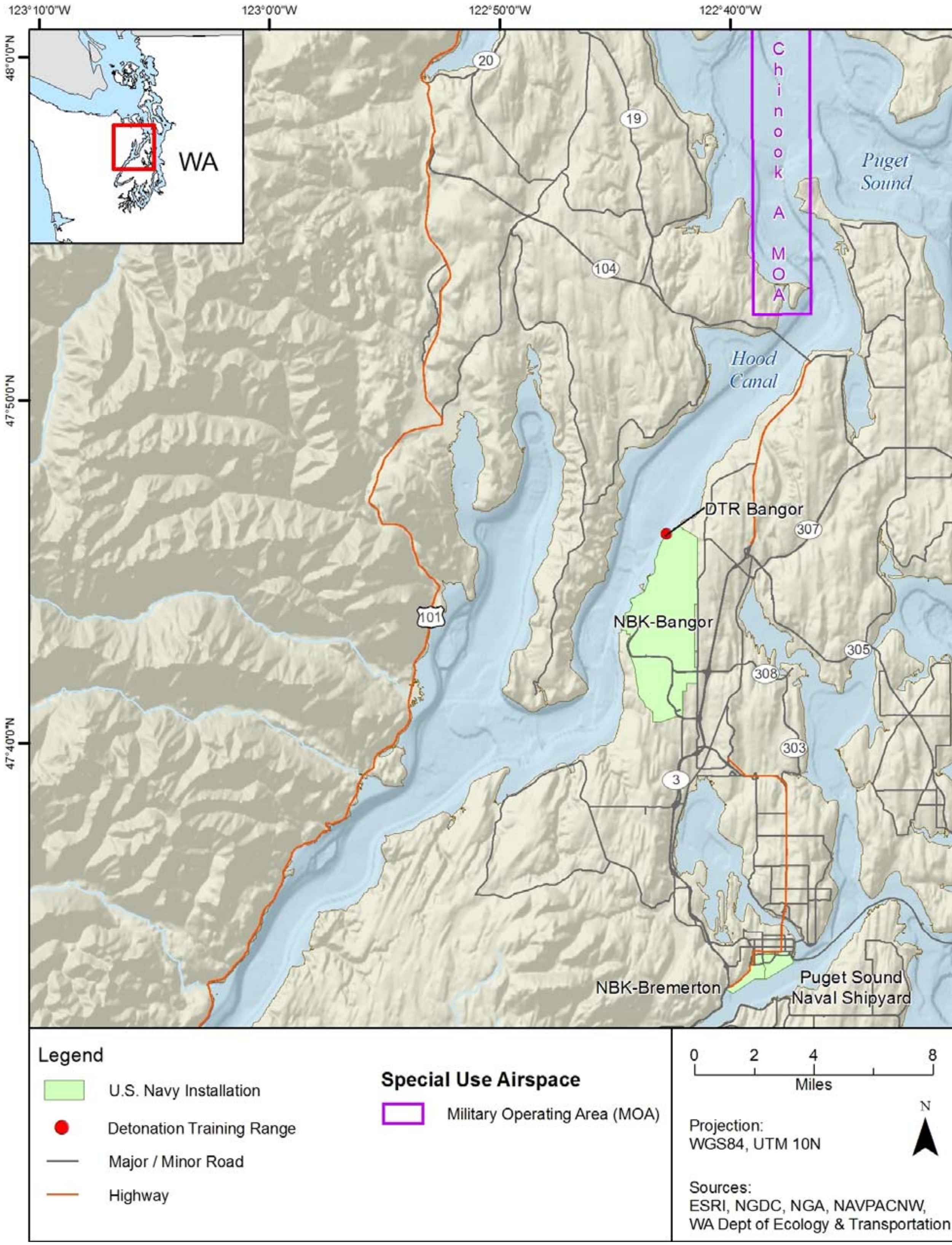

Figure 3.1-4: NBK-Bangor and Hood Canal

term use of the DTRs and repeated disturbances in these areas, little vegetation is present and the areas are considered disturbed.

3.1.1.2 Current Requirements and Practices

Environmental compliance policies and procedures related to terrestrial habitats are regulated by a variety of federal and state programs. For the Navy, these and other requirements are implemented by the *Navy Environmental and Natural Resources Program Manual* (OPNAVINST 5090.1C, 2007) and related Navy environmental guidance documents.

The Navy currently monitors and will continue to monitor the condition of soils and vegetation in its operating areas. It also employs adaptive management to control erosion associated with the existing roads and ranges (DoN 2007). In addition to the site-specific measures above, existing plans and policies are in place to limit the effects of training on the environment at Seaplane Base Whidbey Island (DoN 1996). Current Navy protective practices for geological and soil resources include:

- Locate ground-disturbing activities on previously disturbed sites whenever possible.
- Ensure that all project work areas, including transit routes necessary to reach sites, are clearly identified or marked. Restrict vehicular activities to designated/previously identified areas.
- Continue to manage erosion control through the Site Approval Process, whereby the Navy reviews each proposed project for its erosion potential, and involves the natural resource specialist in the process.
- Off-road vehicle use is not permitted except in designated off-road areas or on established trails.

3.1.2 Environmental Consequences

3.1.2.1 Approach to Analysis

Regulatory Framework

Federal properties and activities are required to comply with the Federal Soil Conservation Act (16 USC 590, et seq.). Specifically, federal land managers are required to control and prevent soil erosion by conducting surveys and implementing conservation measures. The Sikes Act (16 USC 670, et seq.) requires the Department of Defense to develop and implement natural resource management plans for all military installations with land and water resources suitable for wildlife habitat. For instance, see the NASWI natural resource management plan (DoN 1996). In addition, various Navy directives and manuals require the development of integrated natural resource management plans for installations with suitable habitat. Soils and soil conservation are included in these natural resource management plans.

Study Area

In terms of geology and soils, relevant portions of the NWTRC Study Area are those in which land-based training activities occur. These include Indian Island, OLF Coupeville, DTR Seaplane Base, and DTR Bangor.

Sources of Information

A systematic review of relevant literature was conducted to complete this analysis of geology and soils in the study area, including journals, technical reports published by government agencies, work conducted by private businesses and consulting firms, and Department of Defense reports, operational manuals, natural resource management plans, and current and prior environmental documents for facilities and activities in the NWTRC Study Area. The literature and other information sources cited are identified in Chapter 9, References.

Methods

Under all alternatives, military activities with potential impacts to soils may arise from: 1) direct disturbance from ordnance explosions; 2) materials from those explosions that may contaminate soils; and 3) vehicle and personnel movements that may disturb or compact soils.

Soil Erosion, Compaction. In terms of soil disturbance, the main concern is erosion, the physical displacement of soil, usually by rain, meltwater, runoff, and wind. Factors that contribute to erosion include the characteristics of the soil, the length and steepness of the slope of the land, local climate (especially wind and rain), and the type and extent of vegetative cover. Soils differ in the degree to which they allow water to move down through them (i.e., to infiltrate rather than run off), and the degree to which they hold together and resist being carried off ("erodibility"). Erosion is a natural process, but when natural rates of erosion are exceeded, both on-site and off-site habitats can be adversely affected. Disturbed surface layers and areas where vegetation is sparse or absent can expose soils to wind, rain, and runoff that may lead to increased erosion. Left unaddressed, small channels ("rills") can form into which additional runoff is channeled and which can lead to accelerated soil loss, the formation of larger gullies, and eventual habitat degradation. If areas are used frequently, damage to plants may become permanent as plants are repeatedly trampled and soils repeatedly disturbed or compacted, preventing recovery. Soil characteristics also influence their susceptibility to compaction, a condition than can also lead to degraded habitat. An example is the use of heavy equipment in wetlands (NRCS 2008, Haan et al. 1994). Under these conditions, a significant impact would result if training activities increase erosion to the point where habitat degradation is imminent.

Soil Contamination. Several federal and state laws control the use, disposal, and clean-up of hazardous materials. (See Section 3.3, Hazardous Materials, for more details regarding these laws.) In general, these laws use an approach based on risks to human health from direct exposure or consumption, or risk related to environmental degradation. For soils, a soil screening level (SSL) is established that combines toxicity and exposure information with site-specific conditions. The SSL is the threshold at which further investigation may be warranted (USEPA 1996). A significant impact would result if the SSL for a contaminant is exceeded.

3.1.2.2 Impacts of the No Action Alternative

Activities under the No Action Alternative that may affect the soils include: 1) direct disturbance from ordnance explosions; 2) materials from those explosions that may contaminate soils; and 3) vehicle and personnel movements that may disturb or compact soils.

Explosive Ordnance Disposal Training

Table 3.1-1 summarizes the amount and size of the ordnance used at DTR Seaplane and DTR Bangor under the No Action Alternative. Based on 102 training sessions per year, the total number of detonations would be about 29 detonations per session, over half of which are 1.25-pound charges. In addition to C-4, other explosives and explosive components include detonating cord, fuses, igniters, blasting caps, hand grenades, and smoke grenades.

EOD training is conducted at designated DTR facilities located in areas that have been cleared of vegetation and combustible materials (i.e., disturbed). EOD training would not occur outside of the DTRs. The use of live explosives during EOD training creates craters in the sand that lines the enclosure. Because the detonation area is contained within the structure, there would be no erosion in areas outside the enclosure. The majority of blast debris is contained by the structure walls. A 5-pound explosion could theoretically displace sand up to 1,075 feet (325 meters) beyond the structure in what is termed a "fragmentation arc" (DoN 2000b). However, the largest charge used in the DTRs would be two pounds and the vast majority of any displaced material is contained within the enclosure. As a result, there would be no measurable impact to soils outside of the immediate vicinity of the DTR.

Table 3.1-1: Size and Number of DTR Detonations – No Action Alternative

Training Location	Detonation Type	Number	Percent of Total*
DTR Seaplane Base	Detasheet C-2	800	27
	Detasheet 2.0 lbs	240	8
	C-4 – 1.25 lb block	1,476	50
	C-4 – 2.0 lbs block	240	8
	Subtotal	**2,756**	
DTR Bangor	Detasheet C-2	50	2
	Detasheet 2.0 lbs	15	0.5
	C-4 – 1.25 lb block	94	3
	C-4 – 2.0 lb block	15	0.5
	Subtotal	**174**	
	Total	**2,930**	

* Numbers may not sum due to rounding

Detonation By-Products

The by-products of C-4 detonation include the following substances in gaseous or liquid form: nitrogen, carbon dioxide, water, carbon monoxide, hydrogen, ethane, ammonia, propane, and methane (Renner and Short 1980). Table 3.1-2 details the amount of each of these by-products by weight based on a 1.25-pound charge. This size charge represents a little over half of all detonations under the No Action Alternative. By weight, 78 percent of these materials are not harmful (i.e., nitrogen, carbon dioxide, and water). In total, there would be 4.0 pounds (1.8 kg) released per activity at DTR Seaplane Base and 0.25 pound (0.1 kg) per activity at DTR Bangor. These materials could potentially contaminate the soils in the detonation enclosure. However, all of these by-products will dissipate or evaporate in the open air and would not be considered hazardous under those circumstances.

Table 3.1-2: Byproducts of C-4 Detonation – 1.25-Pound Charge

Byproduct of C-4 Detonation	Pounds Released	Percent
Nitrogen	0.463	37.0
Carbon dioxide	0.313	25.0
Carbon monoxide	0.230	18.4
Water	0.205	16.4
Ethane	0.020	1.60
Ammonia	0.011	0.90
Hydrogen	0.004	0.30
Propane	0.003	0.20
Methane	0.003	0.20

Land-Based Training

Land-based training may impact soils through vehicle and personnel movements that occur during three activities – EOD training, insertion and extraction exercises, and naval special warfare (NSW) training.

Table 3.1-3 summarizes the number of each type of training and the number of personnel at each location under the No Action Alternative.

Table 3.1-3: Number of Exercises and Personnel – No Action Alternative

Type of Training	Location	Number of Annual Exercises	Number of Personnel
EOD	DTR Seaplane Base	96	575
	DTR Bangor	6	37
	Total	**102**	**612**
Insertion-Extraction	OLF Coupeville (parachute)	31	479
	Seaplane Base (HRST, SAR)*	67	426
	Crescent Harbor (parachute)	10	160
	Total	**108**	**1,064**
NSW	Indian Island **Total**	**35**	**245**

* HRST – helicopter rope suspension training; SAR – search and rescue

EOD Training. EOD training occurs at DTR Seaplane Base and DTR Bangor. Each exercise lasts about eight hours, includes six personnel, and occasionally involves use of a small truck. As noted above, activities occur in an area previously cleared of vegetation, and detonations occur within a structure designed to contain the blast. Based on the ordinary conditions at the DTRs and the limited number of personnel and equipment involved, impacts to soils or vegetative cover would be negligible.

Insertion and Extraction Training. Insertion and extraction exercises involve delivery and withdrawal of personnel and equipment using unconventional methods, such as by helicopter and parachute. Within the NWTRC Study Area, insertion and extraction exercises occur at Seaplane Base, Crescent Harbor, and OLF Coupeville (Table 3.1-3). At Seaplane Base, helicopter rope suspension training (HRST) activities occur monthly throughout the base during which personnel are inserted into various areas from the air without the need for the helicopter to land. These training activities involve a low-hovering helicopter and approximately eight participants. All the participants maneuver briefly in the landing area; no vehicles are used. Parachute training places personnel into an area undetected in order to conduct clandestine activities such as surveillance or direct action. These activities occur at Crescent Harbor and OLF Coupeville. Search and rescue (SAR) activities are included in insertion and extraction exercises at the Seaplane Base Survival Area. In SAR, a helicopter lands and recovers a survivor, a role performed by one of five SAR personnel. The helicopter approaches the survivor, lands at a suitable location, recovers the survivor, and departs the area. Insertion and extraction training is infrequent, dispersed, and impacts to soils and vegetation are temporary and brief. Based on these conditions, impacts to soils or vegetative cover would be negligible.

Naval Special Warfare Training. Naval special warfare (NSW) training occurs on Indian Island and involves covert off-road movement by four to six personnel. Teams arrive at the island either by boat or by underwater craft, conduct training, and are retrieved two to three days later. Each exercise takes about 60 hours, occurs twice a year, and last two to three weeks each time. No vehicles are used on land. Because of the covert nature of these activities, they are designed to leave no trace of the participants and no impact on the terrain. Due to the low-impact, infrequent, and dispersed nature of these activities, no impacts to soils or vegetation are expected.

3.1.2.3 Impacts of Alternative 1

Explosive Ordnance Disposal Training

Under Alternative 1, there would be an eight percent increase in the number of explosions compared to the No Action Alternative (from 2930 to 3,161) (Table 3.1-4). The number of training sessions would increase from 102 to 110. As under the No Action Alternative, this equates to 29 detonations per exercise and, as with current activities, 54 percent of the detonations would be from 1.25-pound charges. The proposed increase in activity under Alternative 1 would not result in a measurable increase in impacts to soils because all ordnance training occurs within the DTRs. No additional DTRs would be required.

Table 3.1-4: Size and Number of DTR Detonations – All Alternatives

Training Location	Detonation Type	No Action	Alternatives 1 and 2	Percent Increase
DTR Seaplane Base	Detasheet C-2	800	862	8
	Detasheet 2.0 lbs	240	259	8
	C-4 – 1.25 lb block	1,476	1,591	8
	C-4 – 2.0 lb block	240	259	8
	Subtotal	**2,756**	2,971	8
DTR Bangor	Detasheet C-2	50	55	10
	Detasheet 2.0 lbs	15	17	13
	C-4 – 1.25 lb block	94	102	9
	C-4 – 2.0 lb block	15	16	7
	Subtotal	**174**	174	9
Total		**2,930**	**3,161**	**8**

Detonation By-Products

Under Alternative 1, there would be an eight percent increase in the number of detonations. However, as with the No Action Alternative, more than half of the detonations are 1.25-pound charges and the majority of the detonation by-products (78 percent) are not hazardous. Of the potentially hazardous by-products, there would be 4.0 pounds (1.8 kg) released per exercise at DTR Seaplane Base and 0.25 pound (0.1 kg) per exercise at DTR Bangor. However, because those by-products would evaporate or dissipate potential impacts to soils are considered negligible.

Land-Based Training

DTR Training. Compared to the No Action Alternative, the number of annual EOD exercises at DTR Seaplane Base and DTR Bangor under Alternative 1 would increase by 8 (eight percent) (Table 3.1-5). The number of personnel participating would increase by 48 (eight percent; Table 3.1-6), and the number of support vehicles would increase by one (from 12 to 13). Given the existing conditions at the DTRs, the impacts of personnel and equipment on soils within DTRs would be negligible.

Insertion and Extraction Training. Under Alternative 1, there would be an 11 percent increase over the No Action Alternative in the number of insertion and extraction exercises (Table 3.1-5) and a nine percent increase in the number of personnel participating (Table 3.1-6). These increases in the number of exercises and personnel would not result in measurable impacts to soils. As with the No Action Alternative, the small number of activities, the variety of locations at which the activities occur, the small number of personnel involved, the temporary and brief nature of the activities, and infrequent use of heavy equipment would not adversely impact soils or vegetation. Given local climate and conditions, any areas are expected to recover quickly from disturbance.

Table 3.1-5: Number of Training Exercises – All Alternatives

Type of Training	Location	No Action Alternative	Alternatives 1 and 2		
		Exercises	Exercises	Numerical Increase	% Increase over No Action
EOD	DTR Seaplane Base	96	103	7	7
	DTR Bangor	6	7	1	17
	Subtotal	102	110	8	8
Insertion-Extraction	OLF Coupeville (parachute)	31	36	5	16
	Seaplane Base (HRST, SAR)	67	72	5	8
	Crescent Harbor (parachute)	10	12	2	20
	Subtotal	108	120	12	11
NSW	Indian Island	35	35	0	0
	Total	**245**	**265**	**20**	**8**

Table 3.1-6: Number of Training Personnel – All Alternatives

Type of Training	Location	No Action Alternative	Alternatives 1 and 2		
		Personnel*	Personnel*	Numerical Increase	% Increase over No Action
EOD	DTR Seaplane Base	576	618	42	7
	DTR Bangor	36	42	6	17
	Subtotal	612	660	48	8
Insertion-Extraction	OLF Coupeville (parachute)	479	522	43	9
	Seaplane Base (HRST, SAR)	426	464	38	9
	Crescent Harbor (parachute)	160	174	14	9
	Subtotal	1,065	1,160	95	9
NSW	Indian Island	245	245	0	0
	Total	**1,922**	**2,065**	**143**	**8**

* Ground personnel only

Naval Special Warfare Training. Compared to the No Action Alternative, there would be no increase in the number of NSW training activities or any increase in the number of participants under Alternative 1 (Tables 3.1-5 and 3.1-6). Therefore, impacts to soils would be negligible.

3.1.2.4 Impacts of Alternative 2

Explosive Ordnance Disposal Training

There is no change in the number or size of detonations or the number of people involved between Alternatives 1 and 2 (Table 3.1-4), therefore impacts to soils would be negligible.

Detonation By-Products

There is no change in the number or size of detonations between Alternatives 1 and 2 (Table 3.1-4), therefore impacts to soils would be negligible.

Land-Based Training

There is no change between Alternatives 1 and 2 in the number of activities or the number of personnel involved in EOD training, insertion and extraction exercises, or naval special warfare training (Tables 3.1-5 and 3.1-6). Therefore, impacts to soils and vegetation would be negligible.

3.1.3 Mitigation Measures

As summarized in Section 3.1.4, impacts to soils and geology from the proposed actions analyzed in this EIS/OEIS would not measurably decrease soil productivity or affect geologic formations or functions. The Navy would continue to implement existing current requirements and protective measures, and no additional resource-specific mitigation measures would be required. See Chapter 5 for additional discussion of mitigation measures.

3.1.4 Summary of Effects by Alternative

The most likely sources of impacts to soils under all alternatives arise from explosions, the by-products of exploded materials, and the movement of personnel and equipment. However, impacts from these activities under the proposed actions would be negligible. Explosions are limited to DTRs specifically designed for such purposes, and the amount of potentially hazardous by-products from such explosions is small and quickly evaporates or dissipates. Personnel and equipment movements are infrequent, the numbers involved small, and the locations dispersed. Table 3.1-7 summarizes the effects of the alternatives.

Table 3.1-7: Summary of Effects – Geology and Soils

Alternative	NEPA (Land-Based Activities Only)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Activities would have temporary and spatially-limited, short-term impacts. • No measurable long-term effects would occur.	• Not Applicable
Alternative 1	• Impacts generally the same as No Action Alternative.	• Not Applicable
Alternative 2 (Preferred Alternative)	• Impacts generally the same as No Action Alternative.	• Not Applicable

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3.2 Air Quality

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3.2 AIR QUALITY

Air quality is determined with reference to ambient air concentrations of seven major pollutants determined by the U.S. Environmental Protection Agency (USEPA) to be of concern with respect to the health and welfare of the general public. These pollutants, called "criteria pollutants," are carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), suspended particulate matter less than or equal to 10 microns in diameter (PM_{10}), fine particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$), and lead.

Ambient air quality is measured by determining the atmospheric concentration of a specific compound that occurs at a particular geographic location. Ambient air quality data are generally reported as a mass per unit volume (e.g., micrograms per cubic meter of air) or as a volume fraction (e.g., parts per million [ppm] by volume). The USEPA has established National Ambient Air Quality Standards (NAAQS) for these pollutants. Areas that violate a Federal air quality standard are designated as non-attainment areas. The Clean Air Act (CAA) allows States to establish more stringent air quality standards. The NWTRC is located in the offshore and onshore areas of the States of Washington, Oregon, and California. Oregon has adopted the Federal standards and has adopted more stringent standards for SO_2. Washington has adopted the Federal standards and has adopted more stringent standards for SO_2 and NO_2. Washington has not yet rescinded the previous 1-hour standard for O_3, the annual standard for PM_{10}. Oregon has not rescinded the annual standard for PM_{10}. California has established ambient air quality standards for all criteria pollutants.

Table 3.2-1 shows both the Federal and State ambient air quality standards. The following notes apply.

- NAAQS (other than O_3, particulate matter, and those based on annual averages or annual arithmetic mean) are not to be exceeded more than once a year. The O_3 standard is attained when the fourth highest 8-hour concentration in a year, averaged over three years, is equal to or less than the standard. For PM_{10}, the 24-hour standard is attained when 99 percent of the daily concentrations, averaged over three years, are equal to or less than the standard. For $PM_{2.5}$, the 24-hour standard is attained when 98 percent of the daily concentrations, averaged over three years, are equal to or less than the standard. Contact the USEPA for further clarification and current Federal policies.
    - National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health.
    - National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.
- Washington Ambient Air Quality Standard (WAAQS) for SO_2 (1-hour) requires 0.4 ppm by volume for a one-hour period more than once per one-year period, and 0.25 ppm by volume average for a one-hour period more than twice in a consecutive seven-day period.
- Oregon Ambient Air Quality Standards (OAAQS) correspond to Federal standards.
- California Ambient Air Quality Standards (CAAQS) for O_3, CO (except Lake Tahoe), SO_2 (1- and 24-hour), NO_2, PM_{10}, and visibility reducing particles, are values that are not to be exceeded. All others are not to be equaled or exceeded.
- The California Air Resources Board (CARB) has identified lead and vinyl chloride as 'toxic air contaminants' with no threshold level of exposure for adverse health effects determined. These actions allow for the implementation of control measures at levels below the ambient concentrations specified for these pollutants.

Table 3.2-1: National and State Ambient Air Quality Standards

Pollutant	Averaging Time	NAAQS		CAAQS	OAAQS	WAAQS
		Primary	Secondary			
Ozone (O_3)	1-Hour	-	Same as Primary Standard	0.09 ppm (180 µg/m^3)	-	0.12 ppm (180 µg/m^3)
	8-Hour	0.08 ppm (157 µg/m^3)		0.070 ppm (137 µg/m^3)	0.08 ppm (157 µg/m^3)	0.08 ppm (157 µg/m^3)
Carbon Monoxide (CO)	8-Hour	9.0 ppm (10 mg/m^3)	None	9.0 ppm (10 mg/m^3)	9.0 ppm (10 mg/m^3)	9.0 ppm (10 mg/m^3)
	1-Hour	35 ppm (40 mg/m^3)		20 ppm (23 mg/m^3)	35 ppm (40 mg/m^3)	35 ppm (40 mg/m^3)
Nitrogen Dioxide (NO_2)	Annual Average	0.053 ppm (100 µg/m^3)	Same as Primary Standard	0.030 ppm (56 µg/m^3)	0.053 ppm (100 µg/m^3)	0.05 ppm (94 µg/m^3)
	1-Hour	-		0.18 ppm (338 µg/m^3)	-	-
Sulfur Dioxide (SO_2)	Annual Average	80 µg/m^3 (0.03 ppm)	-	-	52 µg/m^3 (0.020 ppm)	80 µg/m^3 (0.03 ppm)
	24-Hour	365 µg/m^3 (0.14 ppm)	-	0.04 ppm (105 µg/m^3)	260 µg/m^3 (0.10 ppm)	365 µg/m^3 (0.14 ppm)
	3-Hour	-	1300 µg/m^3 (0.5 ppm)	-	1300 µg/m^3 (0.50 ppm)	-
	1-Hour	-	-	0.25 ppm (655 µg/m^3)	-	0.25 ppm (655 µg/m^3)
Suspended Particulate Matter (PM_{10})	24-Hour	150 µg/m^3	Same as Primary Standard	50 µg/m^3	150 µg/m^3	150 µg/m^3
	Annual Arithmetic Mean	-		20 µg/m^3	50 µg/m^3	50 µg/m^3
Fine Particulate Matter ($PM_{2.5}$)	24-Hour	35 µg/m^3	Same as Primary Standard	-	35 µg/m^3	35 µg/m^3
	Annual Arithmetic Mean	15 µg/m^3		12 µg/m^3	15 µg/m^3	15 µg/m^3
Lead (Pb)	30-Day Average	-	-	1.5 µg/m^3	-	-
	Calendar Quarter	1.5 µg/m^3	Same as Primary Standard	-	1.5 µg/m^3	1.5 µg/m^3
Hydrogen Sulfide (HS)	1-Hour	No Federal Standards		0.03 ppm (42 µg/m^3)	-	-
Sulfates (SO_4)	24-Hour			25 µg/m^3	-	-
Visibility Reducing Particles	8-Hour (10 am to 6 pm, Pacific Standard Time)			Note 1	-	-
Vinyl chloride[note 6]	24 Hour			0.01 ppm (26 µg/m^3)	-	-

Note 1. Insufficient amount to produce an extinction coefficient of 0.23 per kilometer due to particles when the relative humidity is less than 70 percent.
Source: ODEQ 2007, WDOE 2007, CARB 2007a, USEPA 2005.

Areas in which ambient air concentrations of a pollutant exceed the State and/or Federal standard are considered to be non-attainment areas for that pollutant. Non-attainment areas may be classified as basic, serious, severe, or extreme non-attainment areas for a given criteria pollutant. Non-attainment areas are required to develop and execute plans, known as State Implementation Plans (SIPs) that show how the area will meet Federal and State air quality standards. Areas that have achieved attainment may be designated as "maintenance areas," which are subject to maintenance plans showing how the area will continue to meet Federal and State air quality standards. All areas affected by Northwest Training Range Complex (NWTRC) activities are in attainment of all NAAQS.

The ambient air quality levels measured at a particular location are determined by the interactions of emissions, chemical properties and reactions that occur in the atmosphere, and meteorology. Emission considerations include the types, amounts, and locations of pollutants emitted into the atmosphere. Chemical reactions can transform pollutant emissions into criteria pollutants. Meteorological considerations include wind and precipitation patterns affecting the distribution, dilution, and removal of pollutant emissions.

Pollutant emissions typically refer to the amount of pollutants or pollutant precursors introduced into the atmosphere by a source or group of sources. Pollutant emissions contribute to the ambient air concentrations of criteria pollutants, either by directly affecting the pollutant concentrations measured in the ambient air or by interacting in the atmosphere to form criteria pollutants. Pollutants such as CO, SO_2, lead, and some particulates that are emitted directly into the atmosphere from emission sources are referred to as primary pollutants. Some criteria pollutants such as O_3, NO_2, and some particulates, are formed through atmospheric chemical reactions that are influenced by meteorology, ultraviolet light, and other atmospheric processes. Criteria pollutants formed through these processes are referred to as secondary pollutants. Emissions that lead to formation of secondary pollutants are considered precursors. Thus, for example, Reactive Organic Gases (ROG) and oxides of nitrogen [NO_x] are considered precursors for O_3. In general, emissions that are considered precursors to secondary pollutants are evaluated and regulated to control the levels of associated criteria pollutants in the ambient air. PM_{10} and $PM_{2.5}$ are generated as primary pollutants by various mechanical processes (for example, abrasion, erosion, mixing, or atomization) or combustion processes. However, PM_{10} and $PM_{2.5}$ can also be formed as secondary pollutants through chemical reactions or by gaseous pollutants condensing into fine aerosols.

In addition to those pollutants that are designated criteria pollutants, additional pollutants that are considered to have the potential for health effects are categorized as hazardous air pollutants (HAPs) under Section 112 of the CAA. The USEPA has identified 188 substances as HAPs. Examples of HAPs include benzene, which is found in gasoline; perchloroethylene, which is emitted from some dry cleaning facilities; and methylene chloride, which is used as a solvent and paint stripper in some industries. HAPs are regulated under the Clean Air Act provisions, including the National Emission Standards for Hazardous Air Pollutants, which apply to specific sources of HAPs, and the Urban Air Toxics Strategy, which applies to area sources. The California EPA has also adopted rules governing HAPS, including the Air Toxics "Hot Spots" Information and Assessment Act (AB 2588), and local rules governing toxics new source review. Toxic air pollutants in Washington are covered by the Washington Department of Ecology (WDOE) under the State air toxics rule. The Oregon Department of Environmental Quality (ODEQ) has established the Oregon State Air Toxics Program to regulate emissions of air toxics.

3.2.1 Affected Environment

The EIS Study Area encompasses the Pacific Northwest Ocean surface and subsurface ocean operating area (PACNW OPAREA), over-ocean military airspace, the Darrington Area located within the Puget Sound, and onshore military operating areas (Okanogan, Roosevelt, and Olympic MOAs). The EIS Study Area includes areas that are under the jurisdiction of the Washington Department of Ecology (onshore MOAs and the Darrington Area). Coastal waters within 3 nautical miles (nm) (5.5 kilometers [km]) of a shoreline are part of the same air quality jurisdiction as the contiguous land area. Therefore, the waters within 3 nm (5.5 km) of the State of Washington are within the jurisdiction of the WDOE; the waters within 3 nm (5.5 km) of the State of Oregon are within the jurisdiction of the ODEQ, and the waters within 3 nm (5.5 km) of the State of California are within the jurisdiction of the CARB and the North Coast Unified Air Quality Management District. Portions of the OPAREAS that lie outside coastal waters and beyond 3 nm (5.5 km) of a coastline are not within any air quality jurisdiction.

3.2.1.1 Existing Conditions

The Pacific Northwest region has a mild and varied climate with only rare occurrences of severe weather such as thunderstorms or tornadoes. The normal movement of air masses is from west to east, so most of the systems moving across the region have been moderated by traveling over the Pacific Ocean. As a result, winter minimum temperatures and summer maximum temperatures in the region are greatly moderated. The Pacific Ocean also provides unlimited moisture to air masses traveling across the Pacific, so there is abundant rainfall in western Washington, Oregon, and northwestern California. The weather impacts air quality, as well as influences human activities.

The Washington portion of the NWTRC and the North Coast Air Quality Management District are classified as attainment/unclassified for the NAAQS for all pollutants. The Oregon coastal area, the area of concern to the NWTRC, is in attainment. Onshore portions of the State of Oregon are classified as nonattainment areas for the NAAQS for CO (Salem region) and PM_{10} (Eugene-Springfield and Lane County). The North Coast Air Quality Management District is considered a nonattainment area for the CAAQS for PM_{10}.

There are no stationary sources of emissions within the NWTRC.

3.2.1.2 Current Requirements and Practices

Equipment used by military organizations within the NWTRC, including ships and other marine vessels, aircraft, and other equipment, are properly maintained in accordance with applicable Navy and Marine Corps requirements, thus reducing potential impacts to air quality. Operating equipment meets Federal and State emission standards, where applicable.

3.2.2 Environmental Consequences

3.2.2.1 Approach to Analysis

The evaluation of potential air quality impacts includes two separate analyses. Effects of air pollutant emissions from NWTRC activities occurring within U.S. Territory (i.e., within 12 nm of the coastline) are assessed under National Environmental Protection Act (NEPA). Effects of air pollutant emissions from NWTRC activities occurring outside U.S. Territory are assessed under Executive Order (EO) 12114. For the purposes of assessing air quality effects under NEPA, all activities involving the use of aircraft, vessels, and ground equipment at or below 3,000 ft in those areas within U.S. territorial waters were included in the emissions estimates. For the purposes of assessing air quality effects under EO 12114, only those aircraft, vessels, and missiles/targets activities occurring at or below 3,000 ft and outside of U.S. territorial waters were considered in the evaluation.

The NEPA analysis involves estimating emissions generated from the proposed activities and assessing potential impacts on air quality, including an evaluation of potential exposures to toxic air pollutant emissions. Trace amounts of air toxics emissions would be generated from combustion sources and use of ordnance. Air toxics emissions include hazardous air pollutants not covered under the ambient air quality standards. Potential hazardous air pollutant sources are associated with missile and target activities and include rocket motor exhaust and unspent missile fuel vapors. These emissions would be minor and would not result in adverse impacts due to the distance from sensitive receptors that could be affected by air toxics and the negligible levels of emissions.

Because the proposed action does not involve activities within a nonattainment area, no CAA General Conformity Analysis pursuant to the General Conformity Rule (40 C.F.R. § 93[B]) is required. The EO-compliant analysis involves estimating emissions generated from the proposed activities and assessing potential impacts on air quality outside U.S. Territory (outside the 12 nm [22.2 km] limit). The General Conformity Rule does not apply because the CAA is not applicable to actions outside the United States.

The data for the air quality analysis is based, wherever possible, on parametric information from the NWTRC participants and training requirements. The primary source is the participants' data as supplemented by additional range data and interviews with subject matter experts (SMEs) on military activities. These data were used to estimate numbers and types of aircraft, surface ships and vessels, submarines, and ordnance that would be involved in each alternative. Each of these constitutes a potential source of air emissions. The approach used to characterize emissions from each of the emission source categories is summarized below. A discussion of emission sources and summary of the approach used to prepare emissions estimates for the No Action Alternative (baseline), Alternative 1, and Alternative 2 is presented below.

Aircraft Activities

The methodology for estimating aircraft emissions involves evaluating the type of activities for each type of aircraft, the number of hours of operation for each aircraft type, the type of engine in each aircraft, and the mode of operation for each type of aircraft engine. Emissions occurring or that would occur above 3,000 ft (915 m) were considered to be above the atmospheric inversion layer and therefore without impact on the local air quality. Aircraft flights, for the most part originate from onshore air stations, but some are from aircraft carriers offshore. It was assumed that all aircraft would be traveling from their home base to the locations within the NWTRC at an elevation above 3,000 ft (915 m), and that transit to the range would therefore not affect local air quality.

The types of aircraft and numbers of sorties for the No Action Alternative are derived from the historical data. For Alternatives 1 and 2, operational estimates of future aircraft use percentages were obtained based on evolutionary changes in the Navy force structure and mission assignments. Where there were no major changes in types of aircraft, future activities estimates were based on the percentage distribution of baseline activities.

Time on range for the No Action Alternative was based on calculations of average times derived from range records. To estimate times on range for each aircraft activity in Alternatives 1 and 2, an average time was extrapolated from the data during the baseline year. Estimated altitudes of activities for all aircraft were obtained from SMEs (aircrew members) in operational squadrons. To estimate times in the various air quality zones of interest, the locations of representative activities were analyzed, and their paths plotted. Time in the individual areas was then estimated based upon operational maneuvers and routine flight path analysis.

Emissions were estimated based on times in mode, using the Navy's Aircraft Emission Support Office (AESO) Memorandum Reports for individual aircraft categories (Aircraft Emission Estimates: Landing and Takeoff Cycle and Maintenance Testing, and Aircraft Emission Estimates: Mission Operations). For aircraft for which AESO emission factors were not available (such as the Learjet aircraft), emission factors were obtained from the Federal Aviation Administration's (FAA's) Emission and Dispersion Modeling System (EDMS), which is the FAA's approved model for military airfield and civilian airport operations.

Surface Ship Activities

Marine vessel traffic in the NWTRC is composed of military ship and boat traffic, including support vessels providing services for military training exercises and tests. A number of non-military commercial vessels and recreational vessels are also regularly present within the NWTRC. These vessels were not evaluated in the air quality analysis as they are not part of the Navy's action. The methodology for estimating marine vessel emissions involves evaluating the type of activity for each type of vessel, the number of hours of operation for each vessel type, the type of propulsion engine in each vessel, and the type of generator used onboard each type of vessel.

The types of surface ships and numbers of activities for the No Action Alternative are derived from the Participants data. For Alternatives 1 and 2, operational estimates of future ship use percentages were obtained based on evolutionary changes in the Navy force structure and mission assignments. Where there were no major changes in types of ships, future activities estimates were based on the percentage distribution of historical activities.

For surface ships, times for each activity were estimated by taking an average over the total number of activities for each type of training. Detailed estimates for baseline and future activities were obtained based on discussions with fleet SMEs.

To estimate times in the various air quality zones of interest, the locations of representative activities were analyzed, and their paths plotted. Time in the individual areas was then estimated based upon operational maneuvers. The resultant information provided an estimate for baseline and future activities of Navy vessels with respect to time operating on the range and the percentage of the time spent in each part of the NWTRC. In addition, information provided by fleet participants was used to develop a breakdown of time spent at each power level used during range activities in which marine vessels participated.

Emission factors for marine vessels were then obtained from the database developed for Naval Sea Systems Command (NAVSEA) by JJMA Consultants (JJMA 2001). Emission factors were provided for each marine vessel type and operational mode (i.e., power level). The resulting calculations provided information regarding the time spent at each power level in each part of the NWTRC, emission factors for that power level (in pounds [lb] of pollutant per hour), and total emissions for each marine vessel for each operational type and mode.

Submarine Activities

All tactical submarines in the U.S. Fleet are nuclear powered. Since no U.S. submarines burn fossil fuel, there would be no airborne emissions associated with their activities.

Naval Gunfire and Missile Ordnance

Ordnance emissions emanate from naval gunfire, missiles, bombs, and other types of ordnance used in the various activities. To estimate emissions from use of ordnance, the number and type of ordnance was totaled for each of the activities. Ordnance was classified by category and type. Where emission factors for specific types of ordnance were not available from this reference, the USEPA's AP-42 emission factor database was used, with assumptions regarding the type of ordnance. Ordnance emissions were assumed to occur within U.S. Territory.

Ground Vehicles and Ground Support Equipment (GSE)

Some ground vehicles (pickup trucks) participate in training activities within the NWTRC. Ground vehicle emissions were estimated based on emission factors from EMFAC 2007 (CARB 2007b) for light duty trucks. To estimate emissions for trucks, it was determined that on average each vehicle would operate with four starts per day and would travel 5 miles (8 km) per trip at an average speed of 25 miles per hour (40 km per hour).

Summary of Training Activities and Emission Sources Analyzed

Table 3.2-2 lists all the training activities that are included in the proposed action. The emissions sources analyzed for each activity are shown.

Table 3.2-2: Summary of Proposed Training Activities and Emission Sources

Range Activity	Emissions Sources			
	Aircraft	Ships / Boats	Ordnance	Ground Vehicles
ANTI-AIR WARFARE (AAW)				
Aircraft Combat Maneuvers	X			
Air-to-Air (A-A)Missile Exercise*	X		X	
Surface-to-Air (S-A) Gunnery Exercise	X	X	X	
S-A Missile Exercise**	X		X	
ANTI-SURFACE WARFARE (ASUW)				
Surface-to-Surface (S-S) Gunnery Exercise		X	X	
Air-to-Surface (A-S) Bombing Exercise	X		X	
HARM Exercise	X			
Sink Exercise	X	X	X	
ANTI-SUBMARINE WARFARE (ASW)				
Anti-Submarine Warfare (ASW) Tracking Exercise - MPA	X		X	
ASW Tracking Exercise - Extended Echo Ranging (EER)	X		X	
ASW Tracking Exercise - Surface Ship		X		
ASW Tracking Exercise - Submarine				
ELECTRONIC COMBAT (EC)				
Electronic Combat (EC) Exercises	X	X		
MINE WARFARE (MIW)				
Mine Countermeasures	X	X	X	
Land Demolitions			X	X
NAVAL SPECIAL WARFARE (NSW)				
Insertion/Extraction	X			
NSW Training		X		
STRIKE WARFARE (STW)				
HARM Exercise (Non-firing)	X			
SUPPORT OPERATIONS				
Intelligence, Surveillance, and Reconnaissance (ISR)	X			
Unmanned Aerial System(UAS) Research, Development, Test and Evaluation (RDT&E) and Training	X			

3.2.2.2 No Action Alternative

The No Action Alternative involves maintaining activities at the baseline levels. The baseline emissions estimates were calculated based on operational scenarios as described by SMEs. Table 3.2-3 lists the emissions by general source. More detailed emissions summaries are provided in Appendix C.

Under the No Action Alternative, there would be no increase in activities from baseline activities. The emissions levels would remain constant for those emission sources that are not affected by other Federal, State, or local requirements to reduce air emissions. Emissions associated with motor vehicles may decrease due to the implementation of Federal and State CAA requirements to reduce tailpipe emissions; however, motor vehicles do not constitute a large source of emissions in the EIS Study Area.

Emissions for the No Action Alternative reflect baseline levels that are currently occurring in the NWTRC. Emissions occurring in the offshore areas may be transported onshore and may affect the existing air basins. The impact of emissions occurring offshore is, however, small in comparison with onshore emission sources given the distance transported and the dispersion that occurs during transport. Any impacts to onshore air quality from NWTRC baseline training activities would be reflected only in background emissions in the affected air basins.

The total air emissions associated with the No Action Alternative are presented in Table 3.2-3 for emissions within the NWTRC. Table 3.2-3 presents a breakdown of emissions in the NWTRC subject to NEPA (within U.S. Territory) vs. those subject to EO 12114 (outside U.S. Territory). To evaluate whether the proposed action could have an adverse effect on air quality either within or outside U.S. Territory, emissions associated with the proposed action were evaluated versus the Clean Air Act Federal Operating Permit major source thresholds. These thresholds establish emission levels above which a source is regulated under the Federal Operating Permit Program, and is considered to have the potential to affect air quality. In attainment areas, the major source threshold for all pollutants is 100 tons per year. The net emissions described in the table are well below the major source thresholds for all criteria pollutants. Considering the No Action Alternative's low level of source pollutants, and the dispersion that occurs during transport, these sources would have no significant impact on the State's air quality. There is no increase in emissions above the baseline within U.S. Territory under the No Action Alternative.

Table 3.2-3: Summary of Annual Air Emissions for the No Action Alternative

Emission Source	Emissions, tons/year					
	CO	NOx	ROG	SOx	PM_{10}	$PM_{2.5}$
Within U.S. Territory						
Aircraft Activities	1.35	3.68	0.21	0.19	1.87	1.85
Marine Vessel Activities	3.80	4.50	0.34	0.95	0.16	0.16
Ordnance	0.92	0.06	0.00	0.00	0.09	0.09
Ground Vehicles	1.49	0.12	0.08	0.00	0.00	0.00
Total	**7.56**	**8.36**	**0.63**	**1.13**	**2.12**	**2.10**
Outside U.S. Territory						
Aircraft Activities	4.89	21.62	1.09	1.02	10.25	10.15
Marine Vessel Activities	137.98	85.70	12.43	22.57	4.65	4.60
Total	**142.87**	**107.32**	**13.52**	**23.59**	**14.90**	**14.75**

As discussed previously, the USEPA has listed 188 HAPs that are regulated under Section 112 of the Clean Air Act, and the State of California has identified additional substances that are regulated under State and local air toxics rule. HAPs are emitted from a variety of processes that are associated with the No Action Alternative, including combustion sources and ordnance use. Trace amount of HAPs are emitted from sources participating in NWTRC activities, including aircraft, marine vessels, ground vehicles, ground support equipment, and ordnance. The amounts that would be emitted are small in comparison with the emissions of criteria pollutants; emission factors for most HAPs from combustion sources are roughly three or more orders of magnitude lower than emission factors for criteria pollutants (CARB 2007c). Emissions of HAPs from ordnance use are smaller still, with emission factors ranging from roughly 10^{-5} to 10^{-15} lbs of individual HAP per item for cartridges to 10^{-4} to 10^{-13} lbs of individual HAPs per item for mines and smoke pots (USEPA 2006).

Emissions of HAPs would occur over the entire range and would be subject to deposition on the water and dispersion due to wind mixing and other dissipation factors. Because the majority of activities occur offshore where no sensitive receptors (i.e., residents, schools, hospitals, etc.) are located, no health effects would be anticipated from emissions of HAPs.

3.2.2.3 Alternative 1

Emissions from the offshore coastal areas also have the potential to affect air quality on shore. As shown in Section 1, the NWTRC OPAREAS are mainly located to the west of the mainland offshore of Washington, Oregon, and northwestern California. Due to the prevailing westerly winds in the region, emissions could be transported onshore from the NWTRC OPAREAS.

The total air emissions associated with Alternative 1 are presented in Table 3.2-4 for emissions within the NWTRC. Table 3.2-4 presents a breakdown of emissions in the NWTRC subject to NEPA (within U.S. Territory) vs. those subject to EO 12114 (outside U.S. Territory). The net emissions described in Table 3.2-4 are well below the major source thresholds for all criteria pollutants. Considering low level of Alternative 1 source pollutants, and the dispersion that occurs during transport, these sources would have no significant impact on the states' air quality.

Table 3.2-4: Summary of Annual Air Emissions for Alternative 1

Emission Source	Emissions, tons/year					
	CO	NOx	ROG	SOx	PM_{10}	$PM_{2.5}$
Within U.S. Territory						
Aircraft Activities	1.46	3.85	0.22	0.20	1.96	1.94
Marine Vessel Activities	4.12	4.91	0.37	1.03	0.17	0.17
Ordnance	1.29	0.07	0.00	0.00	0.10	0.10
Ground Vehicles	1.74	0.15	0.09	0.00	0.01	0.01
Total	**8.60**	**8.98**	**0.68**	**1.23**	**2.24**	**2.22**
Net Increase over Baseline	1.04	0.62	0.05	0.09	0.12	0.12
Outside U.S. Territory						
Aircraft Activities	5.17	23.13	1.14	1.09	11.01	10.90
Marine Vessel Activities	151.30	93.57	13.59	24.75	5.07	5.02
Total	**156.47**	**116.70**	**14.73**	**25.84**	**16.08**	**15.92**
Net Increase over Baseline	**13.60**	**9.38**	**1.21**	**2.25**	**1.17**	**1.17**

Trace amount of HAPs are emitted from sources participating in Alternative 1 activities, including aircraft, marine vessels, ground vehicles, ground support equipment, and ordnance. The amounts that would be emitted as a result of Alternative 1 activities are similar to those in the No Action Alternative and remain similarly small in comparison with the emissions of criteria pollutants.

3.2.2.4 Alternative 2

Alternative 2 includes increased levels of certain activities over the No Action Alternative. It also includes new activities associated with the use of the Portable Undersea Tracking Range (PUTR) and the underwater training minefield (see Sections 2.6.2.2 and 2.6.2.5). Slight increases of air emissions can be attributed to use of the PUTR, but because the minefield is used only by nuclear-powered submarines, its use will not cause any increase in emissions. To evaluate the potential for air quality impacts resulting from emission increases associated with increased activities under Alternative 2, the same thresholds were used as for Alternative 1.

The total air emissions associated with Alternative 2 are presented in Table 3.2-5 for emissions within the NWTRC. Table 3.2-5 presents a breakdown of emissions in the NWTRC subject to NEPA (within U.S. Territory) vs. those subject to EO 12114 (outside U.S. Territory).

Should emissions travel to the shore, emissions would be dispersed and would not affect a single location. Regardless, the net emissions described in Table 3.2-5 are well below the major source thresholds for all criteria pollutants. Considering low level of Alternative 2 source pollutants, and the dispersion that occurs during transport, these sources would have no significant impact on the states' air quality.

Table 3.2-5: Summary of Annual Air Emissions Alternative 2

Emission Source	Emissions, tons/year					
	CO	NOx	ROG	SOx	PM_{10}	$PM_{2.5}$
Within U.S. Territory						
Aircraft Activities	1.49	3.95	0.23	0.20	2.01	1.99
Marine Vessel Activities	10.11	9.80	1.00	2.89	0.56	0.56
Ordnance	1.60	0.10	0.00	0.00	0.12	0.12
Ground Vehicles	1.74	0.15	0.09	0.00	0.01	0.01
Total	**14.94**	**13.99**	**1.32**	**3.09**	**2.70**	**2.67**
Net Increase over Baseline	**7.38**	**5.63**	**0.69**	**1.96**	**0.58**	**0.57**
Outside U.S. Territory						
Aircraft Activities	5.74	23.83	1.25	1.12	11.37	11.26
Marine Vessel Activities	172.20	110.91	15.80	29.76	6.18	6.12
Total	**177.94**	**134.74**	**17.05**	**30.88**	**17.55**	**17.38**
Net Increase over Baseline	**35.07**	**27.42**	**3.53**	**7.29**	**2.65**	**2.63**

Trace amount of HAPs are emitted from sources participating in Alternative 2 activities, including aircraft, marine vessels, ground vehicles, ground support equipment, and ordnance. The amounts that would be emitted as a result of Alternative 2 activities are similar to those in the No Action Alternative and remain similarly small in comparison with the emissions of criteria pollutants.

3.2.3 Mitigation Measures

As described in Sections 3.2.2.4 and 3.2.3, emissions and hazardous pollutants produced as a result of the proposed action are well below any thresholds that could impact air quality in any of the affected States. Therefore, no mitigation measures are required to reduce air emissions.

3.2.4 Summary of Effects

As shown in Table 3.2-6 emissions associated with implementation of Alternatives 1 and 2 would result in increases in air emissions above baseline (No Action Alternative) conditions. Within U.S. Territory, emission increases are mainly associated with increased activities of aircraft, surface vessels, and ordnance use. Outside U.S. Territory, emission increases are mainly associated with increased surface vessel activities, with additional contributions from aircraft activities. In conclusion, although

Alternatives 1 and 2 would result in increases in emissions of air pollutants, it is not anticipated that they would result in exceedances of the air quality standards as discussed previously in this section.

Table 3.2-6: Summary of Effects – Air Quality

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• The No Action Alternative involves maintaining activities at the baseline levels. Emissions for the No Action Alternative reflect baseline levels that are currently occurring. There is no increase in emissions above the baseline within U.S. Territory under the No Action Alternative.	• The No Action Alternative involves maintaining activities at the baseline levels. Emissions for the No Action Alternative reflect baseline levels that are currently occurring. There is no increase in emissions above the baseline outside the U.S. Territory under the No Action Alternative.
Alternative 1	• Within U.S. Territory, emission increases are associated with increased marine vessel activities, aircraft activities, ground vehicles, and ordnance use. • Emission increases over baseline for Alternative 1 would result from increased activities. Emission increases would not be considered major and would not result in a significant impact on the air quality. Under Alternative 1, emissions within U.S. Territory would not be expected to result in an exceedance of an air quality standard.	• Outside U.S. Territory, emission increases are mainly associated with increased surface vessel activities, with additional contributions from aircraft activities. • Although Alternative 1 would result in increases in emissions of air pollutants over the No Action Alternative, emissions outside U.S. territorial waters would not be expected to adversely affect offshore air quality and emissions would not exceed air quality standards within U.S. Territory.
Alternative 2 (Preferred Alternative)	• Impacts generally the same as Alternative 1.	• Impacts generally the same as Alternative 1.

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3.3 Hazardous Materials

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3.3 HAZARDOUS MATERIALS

Hazardous materials addressed in this document are broadly defined as substances that pose a substantial hazard to human health or the environment by virtue of their chemical or biological properties. Hazardous materials may be solid, liquid, semi-solid, or gaseous materials that alone or in combination may: 1) cause or contribute to an increase in mortality or illness; or 2) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed. In general, the degree of hazard posed by these materials is related to their quantity, concentration, bioavailability, or physical state. Hazardous materials are regulated under a variety of federal and state laws (see "Regulatory Framework" in section 3.3.2.1).

In this section the phrase "hazardous materials" refers collectively to objects or individual components and constituents of objects that may be hazardous (e.g., missile warheads and fuel). Hazardous materials are often used in small amounts in high technology weapons, ordnance, and targets because they are strong, lightweight, reliable, long lasting, or low cost (e.g., heavy metals). Hazardous materials also are required for maintenance and operation of Navy vessels, aircraft, and equipment used during training. Except where specifically discussed, the term "hazardous materials" does not include "hazardous waste," a term specific to federal and state law (e.g., Resource Conservation and Recovery Act; see Section 3.3.2.1, Regulatory Framework). Table 3.3-1 below presents training activities and associated expended training materials that involve hazardous materials.

Nonhazardous expended material is defined as parts of a device that are made of nonreactive materials, including parts made of non-toxic metals (e.g., steel, iron, aluminum); polymers (e.g., nylon, vinyl, and various other plastics); as well as rubber, glass, fiber, and concrete. Sources of these materials include bombs, shells, and targets. While these items represent persistent seabed litter, their resistance to degradation and their chemical composition mean that they do not chemically contaminate the surrounding environment by leaching heavy metals or organic compounds (CFMETR 2005). Although these materials are not subject to further analysis in this section, they may cause other concerns that are discussed in other sections, such as benthic communities (Section 3.6), sea turtles (Section 3.8), or marine mammals (Section 3.9).

3.3.1 Affected Environment

In the Northwest Training Range Complex (NWTRC) Study Area, hazardous materials would be used in:

- the Pacific Northwest Operations Area (PACNW OPAREA), including specific offshore areas such as Warning Area W-237;
- inshore areas in Puget Sound where underwater detonation training occurs; and
- on-land areas designated for land-based explosives training. Please see the discussion and figures in Chapter 2 for more information.

Open ocean areas are typically considered relatively pristine with regard to hazardous materials. However, those materials are often present in varying amounts in the marine water and sediments, or on land from prior ocean dumping or land disposal, prior military activity (e.g., bombing ranges during World War II), prior commercial activity (e.g., paper mills), as a result of large spills, and as a result of ongoing activities. However, no information is available on the types and quantities of hazardous materials present in the Study Area at a given time or their distribution among the various categories of vessels and aircraft.

Table 3.3-1: Number of Activities or Expended Training Items – All Alternatives

Warfare Area and Location(s)	Platform	Training Items	Heavy Metals	Chemicals	Explosives	No Action Alternative	Alternative 1	% Change	Alternative 2	% Change
Air Combat Maneuvers (ACM) All MOAs/ATCAAs, W-237	EA-6B, F/A-18, F/16, EA-18G (future), and support aircraft	b/ c/								
Air-to-Air Missile Exercise [a/] (A-A MEX) W-237	EA/18G	Tactical air launched decoy (TALD, not recovered)	✓			0	11	–	22	–
		LUU-2B/B flare (not recovered)		✓		0	6	–	11	–
		AIM-7 Sparrow missile	✓	✓	✓	0	6	–	13	–
		AIM-9 Sidewinder missile	✓	✓	✓	0	5	–	9	–
		AIM-120 AMRAAM missile	✓	✓	✓	0	4	–	7	–
Surface-to-Air Gunnery Exercise [a/] (S-A GUNEX) W-237, PACNW OPAREA	DDG, FFG, AOE	Naval 5-inch 54 BLP gun shells		✓	✓	136	151	11.0	303	122.8
		20 mm cannon shells (CIWS)	✓			7,200	8,000	11.1	16,000	122.2
		7.62 mm shells				1,224	1,360	11.1	2,720	122.2
		TDU-34 towed target				72	80	11.1	160	122.2
Surface-to-Air Missile Exercise [a/] (SAMEX) W-237, PACNW OPAREA	P-3C, Learjet or C-130 (supporting), CVN	NATO Seasparrow missile	✓	✓	✓	0	0	–	8	–
		BQM-74E target	✓	✓		0	0	–	16	–
Surface-to-Surface Gunnery Exercise [a/] (S-S GUNEX) W-237, PACNW OPAREA	CVN, DDG (and Canadian DDH), FFH (and Canadian FFH), AOE	5-inch/54 caliber inert				1,716	2,351	37.0	3,463	101.8
		57 mm shells				630	700	11.1	1,260	100.0
		76 mm shells				560	800	11.1	1,120	100.0
		25 mm cannon shells				15,750	17,500	11.1	31,500	100.0
		.50 caliber rounds				58,500	65,000	11.1	117,000	100.0
		High speed maneuverable surface target (HSMST)		✓		0	5	–	9	–
		Trimaran target				0	11	–	20	–

Table 3.3-1: Number of Activities or Expended Training Items – All Alternatives (cont'd)

Warfare Area and Location(s)	Platform	Training Item	Heavy Metals	Chemicals	Explosives	No Action Alternative	Alternative 1	% Change	Alternative 2	% Change
S-S GUNEX (cont'd)		SPAR target				0	17	–	31	–
		Killer Tomato (FAST) target				60	67	11.7	120	100.0
Air-to-Surface Bombing Exercise (BOMB A-S) W-237, PACNW OPAREA	P-3 P-8 (future)	MK-82 live HE bomb (500 lb, 192 NEW*)		✓	✓	8	10	25.0	10	25.0
		BDU-45 (inert)				88	110	25.0	110	25.0
		MK-58 marine marker		✓		8	10	25.8	10	25.0
Sink Exercise (SINKEX) W-237, PACNW OPAREA	E-2, FA-18, P-3, SH-60B P-8 (future)	MK-82 live bomb (500 lb, 192 NEW)		✓	✓	4	8	100.0	8	100.0
		MK-83 live bomb (1,000 lb, 416 NEW)		✓	✓	4	8	100.0	8	100.0
		MK-84 live bomb (2,000 lb, 945 NEW)		✓	✓	4	8	100.0	8	100.0
		AGM-88 HARM missile	✓	✓	✓	2	4	100.0	4	100.0
		AGM-114 Hellfire missile	✓	✓	✓	1	2	100.0	2	100.0
		AGM-65 Maverick missile	✓	✓	✓	3	6	100.0	6	100.0
	CG, DDG, FFG, SSN (support)	AGM-84 Harpoon missile	✓	✓	✓	3	6	100.0	6	100.0
		SLAM ER missile	✓	✓	✓	1	2	100.0	2	100.0
		5-inch/62 mm shells				500	1,000	100.0	1,000	100.0
		76 mm shells				200	400	100.0	400	100.0
		MK-48 ADCAP torpedo	✓	✓	✓	1	2	100.0	2	100.0
		Decommissioned vessel				1	2	100.0	2	100.0

Table 3.3-1: Number of Activities or Expended Training Items – All Alternatives (cont'd)

Warfare Area and Location(s)	Platform	Training Item	Heavy Metals	Chemicals	Explosives	No Action Alternative	Alternative 1	% Change	Alternative 2	% Change
Antisubmarine Warfare Tracking Exercise (ASW TRACKEX – MPA) W-237, PACNW OPAREA	P-3 P-8 (future)	MK-39 EMATT (expendable mobile ASW training target)	✓	✓	✓	25	26	4.0	26	4.0
		SSQ-36 BT passive sonobuoy	✓	✓	✓	288	295	2.4	302	4.9
		SSQ-53 DIFAR passive sonobuoy	✓	✓	✓	7,283	7,503	3.0	7,661	5.2
		SSQ-62 DICASS active sonobuoy	✓	✓	✓	844	865	2.5	886	5.0
		SSQ-77 VLAD passive sonobuoy	✓	✓	✓	593	623	5.1	653	10.1
		MK-58 marine marker		✓		200	205	2.5	210	5.0
ASW Tracking Exercise – EER W-237, PACNW OPAREA	P-3C, P-8 MMA	SSQ-110A source explosive sonobuoy	✓	✓	✓	124	136	9.7	149	20.2
		SSQ-77 passive sonobuoy	✓	✓	✓	201	221	10.0	241	19.9
Surface Ship ASW	DDG, FFG	c/								
Submarine ASW TRACKEX PACNW OPAREA	SSBN, SSGN	MK-39 EMATT (not recovered)		✓		96	100	4.2	100	4.2
Electronic Combat (EC) Exercise W-237A, Darrington Area	P-3, EP-3, EA-6B, EA-18G (future) CVN, DDG, FFG, AOE, SSGN, SSBN	b/ c/								
Mine Countermeasure Training EOD Crescent Harbor, EOD Indian Island, and EOD Floral Point		< 2.5 lb charge NEW		✓	✓	3	0	0	0	0
		2.5 lb charge NEW		✓	✓	51	4	-92	4	-92
		5.0 lb charge NEW		✓	✓	1	0	-100	0	-100
		20.0 lb charge NEW		✓	✓	5	0	-100	0	-100

Table 3.3-1: Number of Activities or Expended Training Items – All Alternatives (cont'd)

Warfare Area and Location(s)	Platform	Training Item	Heavy Metals	Chemicals	Explosives	No Action Alternative	Alternative 1	% Change	Alternative 2	% Change
Land Demolitions DTR Bangor, DTR Seaplane Base	Pickup Trucks (support)	C-4 – 1.25 lb block		✓	✓	1,570	1,693	7.8	1,693	7.8
		Igniters		✓	✓	170	183	7.6	183	7.6
		MK-142 firing device		✓	✓	97	104	7.2	104	7.2
		Hand grenades		✓	✓	170	183	7.6	183	7.6
		MK-174 CTG cal .50 impulse		✓	✓	901	971	7.7	971	7.7
		DetaSheet 2.0 lb (M024)		✓	✓	255	276	8.2	276	8.2
		DetaSheet C-2 (0.083 in.)		✓	✓	850	917	7.9	917	7.9
		C-4 – 2.0 lb block		✓	✓	255	275	7.8	275	7.8
		Blasting cap, electric (M130)		✓	✓	1,870	2,017	7.9	2,017	7.9
		Detonation cord (M456)		✓	✓	34,000 ft	36,667 ft	7.8	36,667 ft	7.8
		Timed blasting fuse (M670)		✓	✓	17,340 ft	18,700 ft	7.8	18,700 ft	7.8
		Timed blasting fuse Igniter (M766)		✓	✓	340	367	7.9	367	7.9
		Blasting cap, non electric (M131)		✓	✓	1,020	1,100	7.8	1,100	7.8
		Red smoke (G950)		✓		238	256	7.6	256	7.6
		Green smoke (G940)		✓		97	104	7.2	104	7.2
		Violet smoke (G955)		✓		204	220	7.8	220	7.8

Table 3.3-1: Number of Activities or Expended Training Items – All Alternatives (cont'd)

Warfare Area and Location(s)	Platform	Training Item	Heavy Metals	Chemicals	Explosives	No Action Alternative	Alternative 1	% Change	Alternative 2	% Change
Insertion and Extraction Seaplane Base, OLF Coupeville, Crescent Harbor	C-130, H-60	b/								
HARMEX (non-firing) Okanogan, Olympic, and Roosevelt MOAs	EA-6B, E/A-18 (future)	CATM-88 missile (not released); a/				2,724	3,000	10.1	3,000	10.1
NSW Training Indian Island, Seaplane Base Survival Area	SEAL delivery vehicle, RHIB	c/								
Intelligence, Surveillance, and Reconnaissance (ISR) W-237, PACNW OPAREA	P-3C	SSQ-53 DIFAR passive sonobuoy	✓	✓	✓	980	1,043	6.4	1,043	6.4
UAV Activities R-6701, W-237, PACNW OPAREA	Scan Eagle, Global Hawk (future BAMS)	b/ c/				12	112	0.0	112	0.0

* NEW – "net explosive weight"

a/ Proposed range enhancements, including surface target services, would result in increased air-to-air missile exercises, surface-to-air gunnery, surface-to-air missile exercises, and surface-to-surface gunnery exercises in the NWTRC.

b/ <u>Aircraft activities</u>. Under the No Action Alternative, a total of 7,568 sorties (flights) would be flown by fixed-wing aircraft (98 percent), helicopters (one percent), and unmanned aerial vehicles (one percent). Compared to the No Action Alternative, sorties would increase 21 percent (to 9,204) under Alternative 1, and 55 percent under Alternative 2 (to 11,786). The relative proportion among the aircraft types remains largely the same. Existing Navy directives manage the storage, use, and proper disposal of materials that may be harmful to the environment.

c/ <u>Naval vessel activities</u>. Under the No Action Alternative, naval vessels would be underway and conducting exercises for 6,940 hours each year. Compared to the No Action Alternative, this would increase four percent (7,228 hours) under Alternative 1, and it would increase ten percent under Alternative 2. Vessels, aircraft, and other military equipment used in these activities carry and use hazardous materials for routine operation and maintenance. Existing Navy directives manage the storage, use, and proper disposal of materials that may be harmful to the environments. Please see the discussion of current requirements and practices below, as well as Table 3.4-1, Water Resources, for summary of water discharge restrictions for Navy vessels.

One study by Hoffsomer et al. (1972) analyzed seawater and ocean floor sediments and fauna at known ocean dumping sites for military ordnance. The sites were located 85 miles west of Cape Flattery, Washington, and 12 miles south-southeast of Charleston, South Carolina. Using a gas chromatograph, samples were tested for the explosives TNT (trinitrotoluene), RDX (Royal Demolition Explosive, cyclotrimethylene trinitramine), tetryl (nitramine), and the explosive oxidizing agent ammonium perchlorate. None of these materials were detected in any of the samples.

Navy vessels in the NWTRC Study Area represent a small fraction of the total watercraft and aircraft traffic entering and leaving Washington, Oregon, and northern California. Hazardous materials are present on all ocean-going vessels as cargoes, fuel, lubricants, and cleaning and maintenance materials, and as weapons and training materials on military vessels and aircraft.

3.3.1.1 Hazardous Materials

Table 3.3-1 provides the types and amounts of training items under each alternative that may present issues related to hazardous materials. These materials can be broadly categorized as heavy metals, chemicals, and explosives.

Heavy Metals

Some metals are necessary for biological organisms to function properly, such as iron, zinc, copper, and manganese in humans. Heavy metals commonly noted for concern include lead, cadmium, mercury, and chromium, but zinc, copper, and manganese may also be noted when exposure levels are too high. In the Study Area, heavy metals are present in vessels, manned and unmanned aircraft, bombs, shells, missiles, sonobuoys, batteries, electronic components, and as anti-corrosion compounds coating exterior metal surfaces. Most of these materials are inert, dense, and will settle to the bottom where they will lodge in deep sediments, eventually be covered by sediment, encrusted by chemical processes (e.g., rust), or covered by marine organisms (e.g., coral).

Chemicals

Hazardous chemicals include fuels and other propellants, and combustion byproducts of those fuels and propellants. These materials are present or may become present from the use of aircraft, vessels, and self-propelled machines such as torpedoes, high speed maneuverable surface targets (HSMSTs), expendable mobile anti-submarine warfare training target (EMATTs), and unmanned aerial vehicles. The batteries within these machines may also contain hazardous chemicals, as do smoke canisters and other markers. Toxic components of fuel oils include aromatic hydrocarbons such as benzene, toluene, xylene, and polycyclic aromatic hydrocarbons (PAHs) such as naphthalene, acenaphthene, and fluoranthene. Examples of shipboard materials necessary for normal activities and maintenance include lubricants and hydraulic fluids, paint, solvents, corrosion inhibitors, adhesives, coolants, and cleaning compounds. Like commercial and recreational watercraft, boat engines discharge petroleum products in their wet exhaust.

Explosives

Explosives are contained in live bombs, missiles, torpedoes, and sonobuoys, and are used in explosives training. Constituents of concern in explosives include nitroaromatics (e.g., TNT) and cyclonitramines, including RDX (Royal Demolition Explosive, cyclotrimethylene trinitramine) and HMX (High Melting Explosive, cyclotetramethylene tetranitramine) that are mixed with plastics or other polymer binders (Janes 2005, 2006). PETN (pentaerythritol tetranitrate) is used in blasting caps, detonation cord, and similar initiators of explosions. Under normal use, 99.997 percent of the explosive is converted to inorganic compounds (Table 3.3-2; USACE 2003, Renner and Short 1980).

Table 3.3-2: Chemical Byproducts of Underwater Detonations

Detonation Byproduct	Percent by Weight by Explosive Compound		
	TNT	RDX	Composition B*
nitrogen	18.2	37.0	29.3
carbon dioxide	27.0	24.9	34.3
water	5.0	16.4	8.4
carbon monoxide	31.3	18.4	17.5
carbon (elemental)	10.6	0	2.3
ethane	5.2	1.6	5.4
hydrogen	0.2	0.3	0.1
propane	1.6	0.2	1.8
ammonia	0.3	0.9	0.6
methane	0.2	0.2	0.2
hydrogen cyanide	<0.0	<0.0	<0.0
methyl alcohol	<0.0	<0.0	0
formaldehyde	<0.0	<0.0	<0.0
other compounds	<0.0	<0.0	<0.0

* 59.5% RDX, 39.5% TNT, 1% wax.

However, these explosives become a concern when the ordnance does not function correctly, that is, when they do not detonate or do not detonate completely (low-order detonation). In these cases, all or a portion of the explosive remain. Table 3.3-3 provides information on the failure and low-order detonation rates for various ordnance (Rand 2005, USACE 2007). These materials can release small amounts of hazardous materials into the water or soil as they degrade and decompose. Table 3.3-4 provides a list of these materials (DoN 2008c).

Table 3.3-3: Failure and Low-Order Detonation Rates of Military Ordnance

Ordnance	Failure Rate (Percent)	Low-Order Detonation Rate (Percent)
Guns / artillery	4.68	0.16
Hand grenades	1.78	–
High explosive ordnance	3.37	0.09
Rockets	3.84	–
Submunitions	8.23	–

These materials can release small amounts of hazardous materials into the water as they decompose. However, the hazardous constituents decompose slowly, so existing ocean and tidal currents would dissipate these materials to undetectable levels.

Table 3.3-4: Hazardous Material Components of Training Materials

Training Application, Ordnance Element	Hazardous Material Component
Pyrotechnics Tracers Spotting Charges	Barium chromate Potassium perchlorate Chlorides Phosphorus Titanium compounds Depleted uranium
Oxidizers	Lead oxide
Delay Elements	Barium chromate Potassium perchlorate Lead chromate
Propellants	Ammonium perchlorate
Fuses	Potassium perchlorate
Detonators	Fulminate of mercury Potassium perchlorate
Primers	Lead azide

Close-in weapons systems (CIWS) use 20 mm cannon shells composed of both depleted uranium (DU) and tungsten. DU is “depleted” in that is has one-third less of the isotopes of U-234 and U-235, making it nearly 60 percent less radioactive than natural uranium. Each 20mm round weighs 9 ounces (253 grams) of which 2.5 ounces (70 grams) is depleted uranium. The Nuclear Regulatory Commission (NRC) approved the Navy's license application which clearly stated that CIWS DU rounds would be fired at sea and not recovered. Consultations with the NRC and the U.S. Environmental Protection Agency determined that this practice was acceptable because of the absence of environmental risk. The Navy is currently phasing out use of DU rounds because of the superior flight characteristics of tungsten and its performance against missile casings. The Navy’s transition to tungsten began in 1989 and most rounds with depleted uranium have been replaced.

Uranium is a naturally occurring, slightly radioactive heavy metal found in many parts of the world. Normal uranium concentration in seawater is three parts per billion. According to Hanson (1974), uranium is soluble in oxygen-rich water, such as those found in the surface of the ocean. However, after firing, DU rounds and fragments would fall into to the ocean bottom. Where DU rounds remain at the seawater-bottom interface, the metal alloy would dissolve slowly over many years. Between mixing through water movement and natural background levels, impacts would not be detectable. Where DU rounds lodge in bottom sediments, the electro-chemical conditions common in such layers tends to change uranium to a form that “has a high affinity for organic material.” Although saltwater would corrode DU rounds, Hanson (1974) indicated that the resulting impacts would not be noticeable from normal uranium levels in seawater. Whether at the sediment surface or lodged more deeply, exposure of DU to marine life would be low.

Hanson (1974) indicated that bioaccumulation of uranium up through the food chain did not appear to occur. A recent report investigated the presence of depleted uranium in marine waters off the southern coast of England in an area used for test firing of DU rounds (Toque 2006). Approximately 68,340 pounds (31 metric tonnes) of DU was fired off the southern coast of England between 1982 and 2003.

Sampling was done of intertidal and ocean bottom sediments, as well as seaweed, mussels, and locally-caught lobster and scallops. Results did not indicate the presence of depleted uranium.

Fate of Hazardous Materials

Three things generally happen to materials that come to rest on the ocean floor: 1) they lodge in sediments where there is little or no oxygen (below four inches [10 cm]); 2) they remain on the ocean floor and begin to react with seawater; or 3) they remain on the ocean floor and become encrusted by marine organisms. Rates of deterioration depend on the material and conditions in the immediate marine and benthic environment. Buried deep in ocean sediments, materials tend to decompose at much lower rates than when exposed to seawater (Ankley 1996). With the exception of torpedo guide wires and sonobuoy parts, sediment burial appears to be the fate of most ordnance used in marine warfare (CFMETR 2005).

Metals. When exposed to seawater, metals begin to corrode. This process creates a layer of corroded material around the object. This removes the material from direct exposure to the corrosiveness of seawater, a process that further slows movement of the metals into the adjacent sediments and water column. This is particularly true of aluminum. In a similar fashion, as materials become covered by marine creatures, the direct exposure of the material to seawater decreases and the rate of corrosion decreases. Dispersal of these materials in the water column is controlled by physical mixing and diffusion, both of which tend to vary with time and location. A recent study of similar Canadian military activities in the Strait of Georgia found few chemical or biological impacts as a result of debris released during activities (CFMETR 2005).

Explosives. TNT degrades to dinitrotoluene (DNT) and subsequent degradation products from exposure to sunlight (photolysis) or bacteria (biodegradation). RDX is also subject to photolysis and biodegradation once exposed to the environment. When exposed on the ocean floor, RDX breaks down within a few hours (DoN 2001). Military-grade explosives have low water solubility, meaning that they do not readily dissolve in water and are, therefore, relatively immobile in water (Table 3.3-5). The degradation and dissolution of these materials may be further slowed by the physical structure and composition of blended explosives, which contain multiple chemical compounds and binding agents. Because of these factors, explosives in the marine environment appear to pose little risk to the environment.

Based on the preceding discussion and the location of military activities under the various alternatives, the following habitats may be impacted by hazardous materials: 1) open ocean habitat – surface and subsurface (pelagic) areas; 2) open ocean habitat – bottom dwelling (benthic) communities; and 3) nearshore habitat, including bottom-dwelling algaes (e.g., kelp forests) and seagrass beds Specific impacts to specific resources are detailed in other sections: geology and soils – Section 3.1; water resources – Section 3.4; and marine invertebrates and plants – Section 3.6.

3.3.1.2 Current Requirements and Practices

Discharges of hazardous materials are regulated by a variety of federal and state programs that are explained in more detail below. In addition, the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) prohibits certain discharges of oil, garbage, and other substances from vessels. The MARPOL convention is implemented by national legislation, including the Act to Prevent Pollution from Ships (33 USC 1901, et seq.) and the Federal Water Pollution Control Act ("Clean Water Act"; 33 USC 1321, et seq.). These and other requirements are implemented by the *Navy Environmental and Natural Resources Program Manual* (OPNAVINST 5090.1C, 2007) and related Navy guidance documents that require hazardous materials to be stored and handled appropriately, both on shore and afloat.

Table 3.3-5: Water Solubility of Common Explosives and Degradation Products

Compound	Water Solubility*
salt (sodium chloride) [for comparison]	357,000
ammonium perchlorate	249,000
picric acid	12,820
nitrobenzene	1,900
dinitrobenzene	500
trinitrobenzene	335
dinitrotoluene (DNT)	160-161
trinitrotoluene (TNT)	130
tetryl	51
pentaerythritoltetranitrate (PETN)	43
RDX	38
HMX	7
white phosphorus	4
* Units are milligrams per liter (mg/L) at 20°C	

Source: DoN 2008c

At sea, Navy vessels are required to operate in a manner that minimizes or eliminates any adverse impacts to the marine environment. Environmental compliance policies and procedures applicable to shipboard activities afloat are defined in the *Navy Environmental and Natural Resources Program Manual* (OPNAVINST 5090.1C, 2007), Chapter 4, "Pollution Prevention," and Chapter 22, "Environmental Compliance Afloat"; DoD Instruction 5000.2-R (§C5.2.3.5.10.8, "Pollution Prevention") (DoN 2003). In addition, provisions in Executive Order (EO) 12856, *Federal Compliance With Right-To-Know Laws and Pollution Prevention Requirements*, and EO 13101, *Greening the Government through Waste Prevention, Recycling, and Federal Acquisition*, reinforce Clean Water Act prohibition against discharge of harmful quantities of hazardous substances into U.S. waters out to 200 nm (371 km), and mandate stringent hazardous waste discharge, storage, dumping, and pollution prevention requirements. Table 3.4-1 in the Water Resources section provides information on Navy current requirements and practices for shipboard management, storage, and discharge of hazardous materials and wastes, and on other pollution protection measures intended to protect water quality. Onshore policies and procedures related to spills of oil and hazardous materials are detailed in OPNAVISNT 5090.1C, Chapter 12. These are discussed in more detail in Chapter 5.

The Navy has also implemented hazardous materials management programs to ensure compliance and to provide guidance on handling and disposing of such materials. Navy instructions include stringent discharge, storage, and pollution prevention measures and require facility managers to reduce, to the extent possible, quantities of toxic substances released into the environment. All Navy vessels and facilities have comprehensive programs in place that implement responsible stewardship, hazardous materials management and minimization, pollution prevention, recycling, and spill prevention and response. These and other programs allow Navy ships to retain used and excess hazardous material on board for shore offload within five working days of arrival at a Navy port. All activities can return excess and unused hazardous materials to the Navy's Hazardous Material Minimization Centers. Additional information regarding water discharge restrictions for Navy vessels is provided in Table 3.4-1, Water Resources.

3.3.2 Environmental Consequences

3.3.2.1 Approach to Analysis

Regulatory Framework

Hazardous materials are regulated by several federal laws and regulations, including the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Toxic Substances Control Act, the Hazardous Materials Transport Act, the Emergency Planning and Community Right to Know Act, and the Oil Pollution Act. Together, these laws and the accompanying regulations govern the storage, use, and transportation of hazardous materials from their origin to their disposal, including recovery and cleanup of environmental contamination.

Federal Laws and Regulations

Resource Conservation and Recovery Act

RCRA defines a hazardous waste as a solid waste that can kill or incapacitate due to its quantity, concentration, or physical, chemical, or infectious characteristics, or which can pose a hazard to human health or the environment when improperly treated, stored, or disposed of (42 USC 6901, et seq.).

Military ordnance includes confined gaseous, liquid, and solid propellants, explosives, pyrotechnics, chemical and riot agents, and smoke canisters. The military munitions rule (40 CFR 260, et seq.) directs that conventional and chemical military ordnance are not considered hazardous materials according to RCRA under two conditions:

1) when they are used for their intended purpose, including training of military personnel and explosive emergency response specialists, research and development activities, and when recovered, collected, and destroyed during range clearance events; and
2) when they are unused and being repaired, reused, recycled, reclaimed, disassembled, reconfigured, or subjected to other material recovery activities.

These two conditions cover most uses of missiles, ordnance, and targets in the Study Area. Under the rule, wholly inert items and non-ordnance training materials are not considered military ordnance. Military ordnance become subject to RCRA when: 1) transported off-range for storage, reclamation, treatment, disposal; 2) they are buried or placed in a land filled on- or off-range; or 3) they land off-range and are not immediately rendered safe or retrieved.

Comprehensive Environmental Response, Compensation, and Liability Act

CERCLA – the Superfund program – defines hazardous material as any substance that, due to its quantity, concentration, or physical and chemical characteristics, poses a potential hazard to human health and safety or to the environment. CERCLA has established national policies and procedures to identify and clean up sites contaminated by hazardous substances. CERCLA provisions apply to closed military installations, but not active military ranges.

Toxic Substances Control Act

The Toxic Substances Control Act requires that a facility must file with the USEPA a pre-manufacture notice that characterizes the toxicity of a substance prior to its manufacture (15 USC 2601, et. seq.).

Hazardous Materials Transportation Law

For air, sea, or land transportation, the U.S. Department of Transportation defines a hazardous material as a substance or material that is capable of posing an unreasonable risk to health, safety, and property when transported in commerce (49 USC 5101, et seq.; 49 CFR 172.101, Appendix B).

Emergency Planning and Community Right-to-Know Act

The Emergency Planning and Community Right to Know Act requires federal, state, and local governments and industry to report their use of hazardous and toxic chemicals (42 USC 116, et seq.).

Oil Pollution Act

The Oil Pollution Act requires oil storage facilities and vessels to submit plans to the federal government describing how they will respond to the unplanned release of oil and other hazardous materials (33 USC 2701, et seq.). Oil and hazardous releases are also reported and remediated according to current Navy policies.

State Laws and Regulations

The Navy complies with applicable state regulations under Executive Order 12088, *Federal Compliance with Pollution Control Standards*; Department of Defense Directive 4165.60, *Solid Waste Management*; and Navy guidelines for hazardous materials and wastes management.

Washington

The Washington State Department of Ecology regulates the disposal of solid waste (Revised Code of Washington [RCW] Chapter 36.58), hazardous wastes (RCW Chapter 70.105), and radioactive waste (RCW Chapter 70.98). The state has also adopted the military munitions rule, except for certain transportation exemptions and the management of closed ranges (Washington Administrative Code 173-303). NBK-Bangor is one of 29 entities in Washington authorized to treat, store, dispose, or recycle hazardous materials or to process used oil. NBK-Bangor processes used oil and oily materials; performs heat, chemical, and mechanical processing in tank systems; and is a hazardous waste broker. The base only accepts used oil from Navy vessels and facilities.

Oregon

The Oregon Department of Environmental Quality is authorized by the USEPA to regulate hazardous materials. Oregon has adopted the military munitions rule, except for the chemical ordnance provisions (Oregon Administrative Rules [OAR] 340-100-0002[1]). A facility that generates or processes hazardous materials must be certified, notify the department of its activities, and follow all applicable regulations. These requirements are imposed under RCRA and several federal and state regulations (40 CFR Parts 124, 260-266, 268, 270, 273, and 279; and OAR 340-100 through 109, 111, 113, 124, and 142).

California

California state laws and regulations generally implement federal requirements, but broaden their application or impose additional regulatory requirements in some areas (Table 3.3-6). The California Environmental Protection Agency (CEPA) has general authority over hazardous materials, although much of this responsibility is delegated to local governments under the Certified Unified Program Agency program. In the NWTRC Study Area, this is generally county governments in northern California. Within CEPA, the Department of Toxic Substances Control is responsible for the use, storage, transport, and disposal of hazardous materials.

Study Area

The Study Area for the analysis of hazardous materials is the Northwest Training Range Complex (NWTRC), specifically PACNW OPAREA, nearshore areas such as underwater detonation areas in Puget Sound, and on-land training areas. Greater detail regarding these areas is provided in Section 2.1.

Table 3.3-6: State of California Laws Related to Hazardous Materials

Law	Description
Hazardous Materials Release Response Plans and Inventory Act	Requires facilities using hazardous materials to prepare hazardous materials plans
Hazardous Waste Control Act	Regulates the generation, transportation, storage, treatment, and disposal of hazardous materials
Safe Drinking Water and Toxic Enforcement Act	Regulates the discharge of contaminants to ground water
Emergency Services Act	Similar to the Federal Emergency Planning and Community Right-to-Know Act

Sources of Information

A systematic review of relevant literature was conducted to complete this analysis of hazardous materials in the Study Area, including journals, technical reports published by government agencies, work conducted by private businesses and consulting firms, and Department of Defense reports, operational manuals, natural resource management plans, and current and prior environmental documents for facilities and activities in the NWTRC Study Area. The literature and other information sources cited are identified in Chapter 9, References.

Methods

For each alternative, this document characterizes and quantifies the items and activities that may contribute hazardous materials to various areas within the Study Area, and analyzes those items and activities in terms of the federal and state laws intended to protect public health and the environment. An adverse impact would result if the use of hazardous materials results in a violation of any of the laws cited above.

3.3.2.2 No Action Alternative

Table 3.3-1 summarizes the types and amounts of training items and activities under each alternative that may present issues related to hazardous materials. The amounts and types of specific training materials under the No Action Alternative are analyzed below.

Bombs

Typically, bombing exercises involve one or more aircraft bombing a target at sea that simulates a hostile surface vessel. Bomb bodies are made of steel with fins of steel or aluminum. The bombs used may be live (with explosives) or inert (as called “practice” or “bomb dummy units”). Zinc, lead, antimony, copper, manganese, and iron are found in shell casings and various projectile components. Lead is found in warhead primers in live bombs. All of these metals are found at some natural background levels in the environment. Inert bombs are comprised mainly of iron and steel casings filled with sand, concrete, or vermiculite, and configured to have the same weight, size, center of gravity, and ballistics as a live bomb (DoN 2006a).

Under the No Action Alternative, 108 bombs would be used, of which 88 are inert (81 percent) (Table 3.3.7). With an ocean area of approximately 122,400 square nautical miles (nm^2) (420,163 km^2) and assuming even distribution of activities, this amounts to 0.001 items per nm^2 (0.0003 per km^2).

Table 3.3-7: Types and Number of Bombs – No Action Alternative

Type of Bomb	Number
MK-82 – Live	12
BDU-45 – Inert	88
MK-83 – Live	4
MK-84 – Live	4
Total	**108**

Practice bombs entering the water do not contain combustion chemicals found in the warheads of live bombs. Unrecovered ordnance and fragments of detonated bombs settle to the sea floor that is over 200 feet (60 m) at the continental shelf and several thousand feet beyond the continental shelf. On the bottom, the bombs and fragments are exposed to seawater or lodge in sediments. Once settled, metal components slowly corrode in seawater. Over time, natural encrustation of exposed surfaces occurs and reduces the rate of corrosion. Elemental aluminum in seawater tends to be converted by hydrolysis to aluminum hydroxide, which is relatively insoluble, and scavenged by particulates and transported to the bottom sediments (MBARI 2008). Practice bombs are made of materials similar to those used to construct artificial reefs. The steel and iron, though durable, corrode over time, with no noticeable environmental impacts. The concrete is also durable and offers a beneficial substrate for benthic organisms (DoN 2006b). Due to the large size of the PACNW OPAREA, expended ordnance on the ocean floor would be widely scattered and have negligible adverse impacts and possibly some slight benefits.

Missiles

Missiles are fired by aircraft and ships at a variety of airborne and surface targets. Missiles used in most aviation exercises are inert versions and do not explode on contact with the target or sea surface. Exploding warheads may be used in air-to-air missile exercises, but to avoid damaging aerial targets, the missile explodes in the air, disintegrates, and falls into the ocean. Live missiles used in air-to-surface exercises explode near the water surface (DoN 2006b).

Under the No Action Alternative, 10 missiles would be used, eight during air-to-air missile exercises (AAMEX) and vessel-sinking exercises (SINKEX), and two during high-speed anti-radiation missile exercises (HARMEX) (Table 3.3-8). About half of the missiles used for AAMEX and SINKEX have live warheads and the remainder are inert and do not explode on contact with the target. During AAMEX, the target is usually a TALD or LUU-2B/B illumination flare. During SINKEX, the target is a cleaned, decommissioned vessel. Launched missiles are not recovered. During HARMEX, a flight crew receives and identifies an electronic signal from simulated enemy radar. The aircrew positions itself for the optimum firing solution and simulates firing a HARM missile designed to destroy enemy radar. Only non-firing, “captive” HARM missiles are used.

In general, the single largest hazardous constituent of missiles is solid propellant, such as solid double-base propellant, aluminum and ammonia propellant grain, and arcite propellant grain. The solid propellant is primarily composed of rubber (polybutadiene) mixed with ammonium perchlorate. Hazardous constituents are also used in igniters, explosive bolts, batteries (e.g., potassium hydroxide and lithium chloride), and warheads (e.g., PBX-N high explosive components, PBXN-106 explosive, and PBX (AF)-108 explosive). Table 3.3-9 describes the types of propellants for selected types of missiles proposed for use under the No Action Alternative.

Table 3.3-8: Types and Number of Missiles Under the No Action Alternative

Type of Missile	Number
AIM-7 Sparrow	0
AIM-9 Sidewinder	0
AIM-120 AMRAAM	0
NATO Sea Sparrow	0
AGM-88 HARM	2
AGM-114 Hellfire	1
AGM-65 Maverick	3
AGM-84 Harpoon	3
SLAM ER	1
Total	**10**

Table 3.3-9: Propellant in Selected Missiles

Type of Missile	Type of Propellant
AIM-7 Sparrow	Propellant is dual-thrust, solid-fuel rocket motor (Hercules MK-58); warhead is an 88-lb (40 kg) WDU-27/B blast-fragmentation device
AIM-9 Sidewinder	Propulsion system contains up to 44 lb (20 kg) of solid double-base propellant; warhead contains approximately 10 lb (4.5 kg) of PBX-N HE
AIM-114 Hellfire	Propellant is solid-fuel rocket motor (Thiokol TX-657 (M120E1); warhead contains approximately 17 lb (8 kg) of HE
AIM-120 AMRAAM	Propellant is solid-fuel rocket motor (ATK WPU-6B booster and sustainer with RS HTPB solid propellant fuel); warhead contains 40 lb (18 kg) of HE

Solid propellant fragments would sink to the ocean floor and undergo changes in the presence of seawater. Testing has also demonstrated that water penetrates only 0.06 inches into the propellant during the first 24 hours of immersion, and that fragments will very slowly release ammonium and perchlorate ions (DoN 2008c). These ions will be expected to be rapidly diluted and disperse in the surrounding water such that local concentrations will be extremely low. Section 3.4, Water Resources, discusses missile propellant in the marine environment in further detail.

Table 3.3-10 lists chemical materials associated with missile launches as well as exposure limits for those materials (USAF 1999). Chromium or cadmium may also be found in anticorrosion compounds coating exterior missile surfaces. A discussion of batteries in the marine environment is provided below.

Exploding warheads may be used in air-to-air missile exercises, but to avoid damaging the aerial target, the missile explodes in the air, disintegrates, and falls into the ocean. For these and inert missiles, the main environmental impact would be the physical components of the missile itself entering the water (DoN 2006a). However, the impact of these components is expected to be minimal. More detailed discussion is included in Section 3.4, Water Resources.

Table 3.3-10: Chemical Compounds Associated With Missile Launches

Resource	Chemical Compound	Maximum Exposure (mg/m^3)
Air	Al_2O_3 – alumina	0.021
	CO – carbon monoxide	39.11
	HCl – hydrochloric acid	0.012
	NOx – oxides of nitrogen	0.009
Water	Jet propulsion fuel, Type 8	0.023

Naval Gunfire

Under the No Action Alternative, a total of 25,856 naval gunshells would be would be expended over an ocean area of approximately 122,400 nm^2 (420,163 km^2) (Table 3.3-11). This amounts to 0.2 items per nm^2 (0.06 per km^2), assuming an even distribution of activities.

Table 3.3-11: Types and Number of Naval Gunshells – No Action Alternative

Type of Gunshells	Number	Percent of Total
20mm – live (CIWS)	7,200	28
25mm – live	15,750	61
57mm – live	630	2
76mm – live	560	2
5 inch – live	1,716	7
Total	**25,856**	

Except for the 20mm shells, this ordnance is composed of steel, brass, copper, tungsten, and other metals. Live 5-inch shells are typically fused to detonate within three feet of the water surface. Shell fragments, unexploded shells, and non-explosive ordnance rapidly decelerate in the water and settle to the sea floor. Steel may contain boron, chromium, cobalt, molybdenum, nickel, selenium, titanium, tungsten, or vanadium to improve its strength or corrosion resistance. The steel and metal alloys are relatively insoluble, but seawater will eventually oxidize the expended training material into benign by-products (DoN 2008c). The impact of naval shells on the environment under the No Action Alternative would be negligible given that their fate on the ocean bottom is similar to bombs, that the objects are relatively small, and that they will likely be evenly distributed across the PACNW OPAREA.

The 20-mm cannon shells used in close-in weapons systems (CIWS) are composed of tungsten or depleted uranium, although the latter is being phased out. Please see Section 3.3.1.1 above for a more detailed discussion of depleted uranium.

Targets and Countermeasures

Table 3.3-12 summarizes the number and types of targets and countermeasures anticipated under the No Action Alternative. More detail regarding these training items is provided below. Under all alternatives under most conditions, only the LUU-2B/B illuminating flares, TALDs (tactical air-launched decoy), marine markers, EMATTs (expendable mobile anti-submarine warfare training target), and the sunken vessel(s) are not be recovered.

Table 3.3-12: Types and Number of Targets and Countermeasures – No Action Alternative

Type of Target or Countermeasure		Number	Percent of Total
Aerial	LUU-2B/B*	0	0.0
	TALD*	0	0.0
	BQM-74E	0	0.0
	TDU-34	72	15.6
Surface	HSMST	0	0.0
	Trimaran	0	0.0
	SPAR	0	0.0
	Killer Tomato	60	13.0
	MK-58 Marine Marker*	208	45.0
Subsurface	EMATT*	121	26.2
Sinking Exercise	Decommissioned Vessel*	1	0.2
	Total	**462**	

* Not recovered

Aerial targets. The tactical air-launched decoy (TALD) is a non-powered, air-launched, aerodynamic vehicle that emits signals to confuse air defense systems during aircraft strike warfare training. It is constructed of aluminum, weighs about 400 pounds, and is not recovered. The BQM-74E is a remote-controlled, subsonic, jet-powered aerial target that can be launched from the air or surface and recovered on land or at sea. The target generates signals for tracking purposes. It is powered by a jet engine and thus contains fuel, oils, hydraulic fluid, batteries, and explosive cartridges. The TDU-34 ("towed drone unit") is a passive radar target towed by a variety of aircraft. It is constructed of aluminum, plastic, fiber glass, and lead ballast and weighs about 75 pounds. Both the BQM-74E and the TDU-34 are recovered.

Surface targets. A typical surface target is a remotely-controlled boat such as the high speed maneuverable surface targets (HSMST), a self-propelled, remote-controlled 24-foot platform that is used to tow other targets, such as the trimaran. The HSMST is recovered after use. The trimaran is a three-hulled boat with a four-foot-square sail that provides a moving target. A "Killer Tomato" is a large, inflatable, plastic target that can be towed or left stationary.

Underwater targets. Expendable mobile anti-submarine warfare training targets (EMATTs) are air or surface-launched vehicles that maneuver in the ocean and emit magnetic or acoustic signals that are monitored by airborne and surface vessels for training purposes. The duration of operation is about three hours at which time the vehicle is usually retrieved. EMATTs contain fuel and use lithium sulfur dioxide batteries.

Sinking exercise. A decommissioned ship is used during a vessel-sinking exercise (SINKEX). These ships are selected from a list of U.S. Navy-approved vessels that have been cleaned in accordance with U.S. Environmental Protection Agency (USEPA) guidelines. The target is towed to a designated location where various weapons fire at the vessel. By rule, SINKEX is conducted at least 50 nautical miles offshore (92 km^2) and in water at least 6,000 feet deep (1,830 m) (40 CFR 229.2). Only minimal concentrations of hazardous chemicals have been detected in water and sediments around Navy ships that were sunk to create artificial reefs (SPAWAR Systems Center 2006).

Markers and flares. The LUU-2B/B is a flare that illuminates targets by burning magnesium at high temperature while suspended from a parachute. The LUU-2B is constructed of aluminum and weighs about 30 pounds (13.6 kg). The entire assembly is usually consumed during flight (Global Security 2008).

Marine markers are pyrotechnic devices dropped on the water's surface used in training exercises to mark a surface position on the ocean surface. The chemical flame of a marine marker burns like a flare but also produces smoke. The MK-58 marker is a tin tube that weighs about four pounds (1.8 kg) and produces a yellow flame and white smoke for 10 to 20 minutes. It contains a red phosphorous compound that is ignited by a seawater-activated battery (Ordnance Shop 2008). Any remaining materials from marine markers would sink into bottom sediments or become encrusted by chemical processes or by marine animals.

The major constituents of flares are aluminum and magnesium. Some flares also contain chromium and lead. Elemental aluminum in seawater tends to be converted by hydrolysis to aluminum hydroxide, which is relatively insoluble, and scavenged by particulates and transported to the bottom sediments (MBARI 2008). Combustion products from flares are mostly non-hazardous, including magnesium oxide, sodium carbonate, carbon dioxide, and water. Small amounts of metals are used to give flares and other pyrotechnic materials bright and distinctive colors. The amounts of flare residues are negligible, and the chemical constituents do not substantially affect water quality resources (DoN 2008c).

Illuminating flares and marine markers are consumed during use. Smoke from marine markers rapidly diffuses by air movement. The marker itself is not designed to be recovered and would eventually sink to the bottom and become encrusted or incorporated into the sediments (Q&S Engineering 2007). Phosphorus contained in the marker settles to the sea floor, where it reacts with the water to produce phosphoric acid until all phosphorus is consumed by the reaction. Phosphoric acid is a variable, but normal, component of seawater. Combustion of red phosphorus produces phosphorus oxides, which have a low toxicity to aquatic organisms and is not anticipated to have a significant effect on the marine environment (DoN 2006a). Seawater-activated batteries would be expended during their normal service life and would not present a significant impact to the environment.

Most target fragments would sink quickly in the sea. Expended material that sinks to the sea floor would gradually degrade, be overgrown by marine life, or be incorporated into the sediments. Floating, non-hazardous expended material may be lost from target boats and would either degrade over time or wash ashore as flotsam. An extensive study conducted at Canadian Forces Maritime Experimental and Test Ranges near Nanoose, British Columbia, concluded that in general, the direct impact of debris accumulation on the sea floor appeared to be minimal and had no detectable effects on wildlife or sediment quality (CFMETR 2005).

Under the No Action Alternative, no measurable impact on the environment from targets and countermeasures will occur within the PACNW OPAREA because: 1) the majority of targets (62 percent) are marine markers that are consumed by chemical reactions that produce smoke; 2) most of the remaining targets and countermeasures are recovered after use; and 3) the majority of weighting and anchoring materials used for proposed range enhancements are inert and are buried in bottom sediments.

For vessel-sinking exercises (SINKEX), the vessels used as targets are selected from a list of U.S. Navy-approved vessels that have been cleaned in accordance with USEPA guidelines. By rule, SINKEX is conducted at least 50 nautical miles offshore and in water at least 6,000 feet deep (1,830 m) (40 CFR 229.2). USEPA considers the contaminant levels released during the sinking of a target to be within the standards of the Marine Protection, Research, and Sanctuaries Act (16 USC 1341, et seq.). As with other inert materials discussed in the text, the vessel would become encrusted by chemical processes and biological organisms and not pose a hazard to ocean water resources.

Infrequently, a recoverable target may be lost. In those cases, the hazardous materials of concern include propellant, petroleum products, metals, and batteries. Small concentrations of fuel and ionic metals released during battery operation could enter the water and contaminate limited areas. However, they do not represent a source of substantial environmental degradation. The potential impact of batteries on water quality is discussed in Section 3.4, Water Resources. The potential impact of the vessel-sinking exercise on marine communities is discussed in Section 3.6, Invertebrates and Plants.

Torpedoes

The MK-48 ADCAP torpedo is the Navy's only torpedo used for engagement of other submarine and surface targets in the Study Area. The ADCAP torpedo is an acoustic homing torpedo used in force protection. It is 19 feet long (5.8m) with a 21-inch diameter and weighs roughly 3,700 pounds (1,680 kg). It is not recovered after use. Although the hazardous materials list for the MK-48 is classified, it uses Otto fuel II as a propellant. Otto fuel II is composed of propylene glycol dinitrate and nitro diphenylamine (76 percent), dibutyl sebacate (23 percent) and 2-nitrodiphenylamine as a stabilizer (2 percent). The exhaust products of the combustion are nitrogen oxides (NOx), carbon monoxide (CO), carbon dioxide (CO_2), hydrogen (H_2), nitrogen (N_2), methane (CH_4), ammonia (NH_3), and hydrogen cyanide (HCN) (DoN 2008a). During normal venting of excess pressure or upon failure of the torpedo's buoyancy bag, the following are discharged: CO_2, water, H_2, N_2, CO, methane, ammonia, hydrochloric acid (HCl), hydrogen cyanide (HCN), formaldehyde (CH_2O), potassium chloride (KCl), ferrous oxide (FeO), potassium hydroxide (KOH), and potassium carbonate (K_2CO_3) (DoN 1996). Each torpedo also deploys a guidance wire during each run that can be up to 15 miles long (28 km). It is composed of copper and cadmium within a plastic coating and is about 0.04 inches in diameter (0.1 cm) (DoN 2008b).

Under the No Action Alternative, one MK-48 ADCAP torpedo would be used. This will have no measurable impact on the PACNW OPAREA environment.

Small Caliber Rounds

Under the No Action Alternative, a total of 59,724 small caliber rounds would be used in the PACNW OPAREA (Table 3.3-13). This amounts to 0.5 items per nm^2 (0.2 per km^2), assuming an even distribution of activities.

Table 3.3-13: Types and Number of Small Caliber Rounds – No Action Alternative

Type of Ordnance	Number	Percent of Total
7.62 mm projectile	1,224	2
.50 caliber rounds	58,500	98
Total	**59,724**	

All of these materials would come to rest on the bottom of the ocean exposed to seawater or lodge in bottom sediments. The .50 caliber rounds are composed of steel with small amounts of aluminum and copper and brass casings that are 70 percent copper and 30 percent zinc. As they corrode, these materials would release small amounts of iron, aluminum, and copper into the sediments and the overlying water column. All three elements are widespread in the natural environment, although elevated levels can cause toxic reactions in exposed plants and animals. Any elevation of metals in sediments would be restricted to a small zone around the bullet, and any release to the overlying water column would be diluted. The 7.62mm projectiles have lead cores and lead has been identified as a toxic contaminant under Section 307 of the Clean Water Act. However, lead is nearly insoluble in water, particularly at the near-neutral pH levels. While it is reasonable to assume some dissolution of lead could occur, such releases into the water column would be small and would be diluted (DoN 2006a). Given these observations and the widespread distribution of the items across the PACNW OPAREA, small caliber rounds would have negligible impacts on the environment.

Sonobuoys

Sonobuoys are expendable metal cylinders launched from aircraft and ships that collect and generate information about the marine environment and potential threats and targets. Sonobuoys are about five inches in diameter (13 cm) and 36 inches in length (one meter), weigh 14 to 39 pounds (6 to 18 kilograms). They consist of two main sections, a surface unit that contains a seawater battery and a metal subsurface unit. The seawater battery becomes energized following contact with the water. The subsurface assembly descends to a selected depth, the metal case falls away, and sea anchors deploy to stabilize the hydrophone (underwater microphone). At this point, an active sonobuoy emits a sound pulse to generate an echo from a potential threat or target, and a passive sonobuoy listens for sound from a potential threat or target. Other sonobuoys (e.g., SSQ-36 BT) gather information about conditions in the water, such as temperature and ambient noise, that improve accuracy of detection or that may assist in avoiding detection. In addition to the sonobuoy’s power source, expendable materials include a parachute assembly (12- to 18-inch diameter nylon chute), nylon cord, plastic casing, antenna float, metal clips, and electrical wires).

Under the No Action Alternative, a total of 9,132 sonobuoys would be expended in the PACNW OPAREA (Table 3.3-14). With an ocean area of approximately 122,400 nm^2 (420,163 km^2) and assuming even distribution of activities, this amounts to 0.07 sonobuoys per nm^2 (0.02 per km^2). In terms of the inert components of sonobuoys, this level of deposition would have a negligible impact on ocean water resources. Sonobuoy components of potential concern for hazardous materials are the seawater batteries, lithium batteries, battery electrodes, metal housing, lead solder, copper wire, and lead used for ballast (NFEC 1993).

Table 3.3-14: Types and Number of Sonobuoys – No Action Alternative

Type of Sonobuoy	Number	Percent of Total
SSQ-53 DIFAR (passive)	7,283	80
SSQ-62 DICASS (active)	844	9
SSQ-77 VLAD (passive)	593	7
SSQ-36 BT (passive)	288	3
SSQ-110A (explosive)	124	1
Total	**9,132**	

Sonobuoy Batteries – Potential Impacts

Regardless of type, each sonobuoy contains a seawater battery housed in the upper, floating portion and which supplies power to the sonobuoy. These seawater batteries contain about 300 grams of lead, in addition to battery electrodes composed of lead chloride, cuprous thiocyanide, or silver chloride (Green et al. 1996). In cases where the upper portion of the sonobuoy is lost to the seabed, the lead batteries are also lost (CFMETR 2005). Silver chloride, lithium, or lithium iron disulfide thermal batteries are used to power subsurface units. The lithium-sulphur batteries used typically contain lithium sulphur dioxide and lithium bromide, but may also contain lithium carbon monofluoroxide, lithium manganese dioxide, sulphur dioxide, and acenitrile (a cyanide compound). During battery operation, the lithium reacts with the sulfur dioxide to form lithium dithionite. Lithium iron disulfide thermal batteries are used in DICASS sonobuoys. An important component of the thermal battery is a hermetically-sealed casing of welded stainless steel 0.03 to 0.1-inches thick that is resistant to the battery electrolytes.

The evaluation of the potential effects associated with seawater batteries includes comparing the expected concentrations of potentially toxic battery constituents with USEPA water quality criteria that have been established for the protection of aquatic life (USEPA 2006) or the best available literature values that established conservative toxicity thresholds. USEPA recommends application of a one-hour acute limit and four-day chronic limit (Table 3.3-15). Either limit cannot be exceeded more than once every three years on the average.

Table 3.3-15: Threshold Values for Safe Exposure to Selected Metals

Metal	Acute Criteria (µg/L, 24-hr exposure)	Chronic Criteria (µg/L, 4-hr mean exposure)
Lead	210	8.1
Silver	1.9	n/a
Copper	4.8	3.1
Lithium	6,000	n/a

n/a = no chronic value is available; µg/L = micrograms per liter; hr = hour
No USEPA criteria available; values shown are based on literature (Kszos et al. 2003)

Chemical reactions with sonobuoy batteries proceed almost to completion once the cell is activated, and only a small amount of reactants remain when the battery life ends. These residual materials will slowly dissolve and become diluted by ongoing ocean and tidal currents. Given the mobility characteristics for the most soluble battery constituent, lead chloride, there is low potential for substantial accumulation of such material in sediments. In addition, the outside metal case can become encrusted from seawater processes and marine organisms, thus slowing the rate of further corrosion. Also, many of the components of concern are coated with plastic to reduce corrosion, providing an effective barrier to water exchange. In instances where seawater causes the body of the sonobuoy to corrode, that corrosion will take at least 40 years (Klassen and Roberge 2005).

Lithium always occurs as a stable mineral or salt, such as lithium chloride or lithium bromide (Kszos et al. 2003). Lithium is naturally present in freshwater, soil, and sediment, and has an average concentration of 150 parts per million (ppm) in the water column, 35 ppm in sediments at Dabob Bay (Crecelius 2001), and 57 ppm in marine pelagic sediments in the Strait of Georgia (CFMETR 2005). A study conducted by Kszos et al. (2003) demonstrated that sodium ions in saltwater mitigate the toxicity of lithium to sensitive aquatic species. Fathead minnows (*Pimephales promelas*) and the water flea (*Ceriodaphnia dubia*) were unaffected by lithium concentrations as high as 6 mg/L in the presence of tolerated concentrations of sodium. Therefore, it is expected that, in the marine environment where sodium concentrations are at least an order of magnitude higher than tolerance limits for the tested freshwater species, lithium would be essentially nontoxic. One estimate concluded that 99 percent of the lithium in a battery would be released to the environment over 55 years (Klassen and Roberge 2005). The release will result in a dissolved lithium concentration of 83 mg/L in the immediate area of the breech in the sonobuoy housing. At a distance of 5.5 mm from the breech, the concentration of lithium will be about 15 mg/L, or 10 percent of typical seawater lithium values (150 ppm); thus it would be difficult to discern the additional concentration due to the lithium leakage from the background concentration (Klassen and Roberge 2005). Because of these factors, lithium batteries would not adversely affect marine water quality.

Several studies have evaluated the potential impacts of batteries expended in seawater (NFEC 1993, USCG 1994, Borener and Maugham 1998, and CFMETR 2005). Sediment samples were taken adjacent to and near the navigation sites and analyzed for all metal constituents in the batteries. Results indicated that metals were either below or consistent with background levels or they compared favorably with National Oceanic and Atmospheric Administration (NOAA) sediment screening levels (NOAA 2008), reportable quantities under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) §103(a), or USEPA toxicity procedures (USEPA 2008).

A study by the Department of the Navy examined the impact of materials from activated seawater batteries in sonobuoys that dissolve in the water column (e.g., lead, silver, and copper), as well as nickel-plated steel housing, lead solder, copper wire, and lead shot used for sonobuoy ballast (NFEC 1993). The study concluded that constituents released from saltwater batteries as well as the decomposition of other sonobuoy components did not exceed state and federal standards and that the reaction products are short-lived in seawater.

The sonobuoy battery experiment employed lead chloride batteries in a 17-gallon seawater bath for eight hours (NFEC 1993). Under these conditions, the dilution assumptions are conservative relative to normal ocean bottom conditions. The concentration released from the battery was diluted to 0.2 mg/L or 200 micrograms per liter (µg/L) in two seconds, which is less than the acute criteria of 210 µg/L, a criteria applied as a 24-hour mean. Further, since lead chloride tends to dissolve more readily ($K_{sp} = 1.0 \times 10^{-4}$) than either silver chloride ($K_{sp} = 1.56 \times 10^{-10}$) and copper thiocyanate ($K_{sp} = 1.64 \times 10^{-11}$) (IUPAC/NIST 2008), this assures that the potential effects from batteries employing silver chloride or copper thiocyanate are substantially lower than those for the lead chloride battery. While the copper thiocyanate battery also has the potential to release cyanide, a material often toxic to the marine environment, thiocyanate is tightly bound and can form a salt or bind to bottom sediments. Therefore, the risk associated with thiocyanate is very low.

A study of the impacts of lead and lithium (among other materials) was conducted at the Canadian Forces Maritime Experimental and Test Ranges near Nanoose Bay, British Columbia, Canada (CFMETR 2005). These materials are common to EMATTs, acoustic device countermeasures (ADCs), sonobuoys, and torpedoes. The study noted that lead is a naturally-occurring heavy metal in the environment. Typical concentrations of lead in seawater in the test range are between 0.01 and 0.06 ppm, and from 4 to 16 ppm in sediments (Crecelius 2001). Factors that are generally understood to reduce risks associated with contaminated sediments include acid-volatile sulfide concentrations and organic carbon. Both act to reduce the bioavailability of metals (EPA 2001). Cores taken of marine sediments in the test range show a steady increase in lead concentration from the bottom of the core to a depth of approximately 8 inches (20 cm). This depth corresponds to the late 1970s and early 1980s and was attributed to atmospheric deposition from lead as a gasoline additive. The sediment cores showed a general reduction in concentration to the present time, coincident with the phasing out of lead in gasoline by the mid-1980s. The study also noted that studies at other ranges have shown minimal impacts of lead ballasts because they are usually buried deep in marine sediments where they are not biologically available. The study concluded that there would be no effects from the lead ballasts due to the low probability of mobilization (CFMETR 2005).

Regarding lithium, cores taken of marine sediments in the test range showed fairly consistent lithium concentrations with depth, indicating little change in lithium deposition with time. Given ambient lithium concentrations taken outside the range, the report concluded that “it is difficult to demonstrate an environmental impact of lithium caused by CFMETR.”

Explosive Sonobuoys – Potential Impacts of Detonation Byproducts

Only one type of explosive sonobuoy is proposed for use in the PACNW OPAREA, the SSQ-110A. This sonobuoy is composed of two sections, an active – explosive – section and a passive section. The upper section is similar to the upper electronics package of the SSQ-62 DICASS sonobuoy, while the lower section consists of two explosive payloads of Class A explosive weighing 4.2 pounds each (1.9 kg). This explosive is composed of cyclo-1,3,5-tetramethylene-2,4,6-tetranitramine (HLX), which is 90 percent RDX, plus small amounts (less than 0.3 grams) of plastic-bonded explosive (PBXN) and hexanitrostilbene, a detonator component. Once in the water, the charges explode, creating a loud acoustic signal.

The explosion creates an air bubble of gaseous byproducts that travels to the surface and escapes into the atmosphere. A small amount of the gas, however, dissolves into the water column. Explosive byproducts using the Cheetah 4 computational program are summarized on Table 3.3-16. The byproducts with the greatest toxicity are hydrogen fluoride compounds (H_xF_x), a reaction byproduct associated with the binding agent used to stabilize the HLX (DoN 2008b).

Table 3.3-16: Detonation Byproducts from Explosive Sonobuoys

Detonation Byproducts	Initial Detonation State		Ambient	
	Grams per charge	Percent of total	Grams per charge	Percent of total
Hydrogen fluoride compounds (H_xF_x)	24.6	1.23%	12.5	0.63%
Nitrogen (N_2)	634		675	
Carbon dioxide (CO_2)	669		565	
Water (H_2O)	211		332	
Ammonia (NH_3)	61		13.4	
Formic acid (CH_2O_2)	156		1.7	
Ethylene (C_2H_6)	84.6		2.1	

Laboratory studies with freshwater species indicate a probable no effect concentration of 0.9 and 0.4 mg/L for hard and soft water, respectively. These values are apparently close to background levels measured in many natural water bodies. Characterization of natural exposure levels and effects in saltwater are needed to provide further basis for the assessment of risks in marine systems. However, only a small percentage (0.63 percent) of the available hydrogen fluoride explosion byproduct is expected to dissolve in the water prior to reaching the surface, and the dilution that would occur upon mixture with ambient water would be rapid (DoN 2008b). Given this dilution, the size of the PACNW OPAREA across which the sonobuoys will be deployed, and the relatively few explosive sonobuoys used under the No Action Alternative, adverse impacts from detonation byproducts would be negligible.

Underwater Detonations

Mine countermeasure training (MCT) involves underwater explosive ordnance disposal (EOD) at three locations – Crescent Harbor, Floral Point in Hood Canal at NBK-Bangor, and west of Indian Island in Port Townsend Bay. These are the Navy's designated locations for MCT and have been used consistently for this purpose for several years. The sites at EOD Crescent Harbor and EOD Indian Island are between 1,000 to 7,200 feet (330 to 2200 m) from the nearest shoreline and the detonations typically occur in 50 to 60 feet (15 to 20 m) of water over sandy or muddy bottoms. EOD Floral Point is about 600 feet (183 m) offshore and charges are placed on a training structure that is 3 to 8 feet (1 to 3 m) above the bottom (NMFS 2008).

MCT familiarizes personnel with the destruction of mines, unexploded ordnance, obstacles, and other structures. Table 3.3-17 summarizes the materials and the level of activity at each site. The number of charges proposed for Crescent Harbor represents 88 percent of the total.

The mines involved are inert shapes similar in composition to practice bombs in that they are pieces of concrete or steel cases formed in the shape of a mine. Underwater detonation training involves detonation of charges at or near the surface and the bottom. The explosive charges are typically raised above the seafloor prior to detonation in order to minimize impact to the seafloor. Each exercise entails placement of the dummy mine in the training area, location of the mine by EOD personnel, placement of the charge on or near the mine, attachment of detonating equipment, detonation, debris retrieval, and in-water inspection of the detonation site. In some of the exercises, a disabled mine is raised and moved ashore for dismantling and inspection. However, the disabled mines are eventually recovered. Typically two blocks of C-4 are used per activity, with each activity consisting of one surface and one subsurface detonation. The total duration of the exercise is five hours (NMFS 2008).

Table 3.3-17: Mine Countermeasure Training – No Action Alternative

Location	Charge Size	Number
EOD Crescent Harbor	< 2.5 lbs	3
	2.5 lbs	45
	5.0 lbs	1
	20.0 lbs	4
EOD Floral Point	2.5 lb	3
EOD Indian Island	2.5 lbs	3
	20.0 lbs	1
	Total	**60**

After the detonation, both boats return to the detonation site. All surface debris, consisting mainly of floats and attached equipment, is retrieved. The divers retrieve debris from the seafloor, which consists mainly of pieces of the mine and the explosive housing (i.e., pieces of aluminum, plastic, or copper). The majority of the explosive itself is consumed. In cases where the mine is only disabled, not destroyed, the mine is either loaded into the primary boat, if the mine is small enough, or suspended below the boat. The mine is then taken to a remote beach for dismantling and inspection. Again, this is a dummy mine (lacking explosive), so an explosion is not possible at this point (NMFS 2008).

Two issues are of potential concern for hazardous materials – solid debris and the byproducts of the underwater detonations.

Adverse impacts from solid debris resulting from mine countermeasure training at each site under the No Action Alternative would be negligible because of standard site investigation, and clean up procedures.

The explosive used is C-4, composed of RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine) (approximately 95 percent), plus a plastic binder (polyisobutylene). Most of the charges are linear “shaped” charges contained in copper, aluminum, or plastic housing. Some of these charges are intended to disable “limpet” mines on the hulls of ships, while others are designed to disable moored or bottom mines (NMFS 2008).Table 3.3-18 details the byproducts of underwater detonation of C-4.

High-order detonations result in almost complete conversion of explosives (99.997 percent; USACE 2007). The majority of these byproducts are commonly found in seawater, that is, water, carbon dioxide (CO_2), hydrogen (H_2), carbon monoxide (CO), nitrogen (N_2), and ammonia (NH_3) (Renner and Short 1980, DoN 2000). These byproducts represent 98 percent of all byproducts produced. The remaining byproducts are either gases or liquids that will dissipate, evaporate, or dilute to undetectable or insignificant levels, or they react with constituents of salt water in the existing currents to form harmless substances. During mine countermeasure training under the No Action Alternative, the prospects of adverse impacts from low-order or no detonation are minimal because procedures require EOD personnel to return to and inspect the detonation site, to clean up debris, and to retrieve unexploded materials for further examination. Therefore, the overall impact of these constituents would be negligible.

Table 3.3-18: Byproducts of Underwater Detonation of RDX

Byproducts	Percent of Total, by Weight
Nitrogen	37.0
Carbon dioxide	24.9
Water	16.4
Carbon monoxide	18.4
Ethane	1.6
Hydrogen	0.3
Propane	0.2
Ammonia	0.9
Methane	0.2
Hydrogen cyanide	< 0.01
Methyl alcohol	< 0.01
Formaldehyde	< 0.01
Other compounds	< 0.01

Land Detonations

Land detonations occur at demolition training ranges (DTRs) at Seaplane Base and at Naval Base Kitsap-Bangor. Each DTR is a designated area and structure in which EOD training is conducted. EOD personnel must re-qualify on a monthly basis to use explosives. Per Navy requirements, the overall DTR area is relatively flat and 1,000 feet in diameter (152 m) within which a 100-foot-diameter area is cleared of all vegetation and combustible materials. A detonation enclosure is constructed at the center. The enclosure is roughly 20 feet square with walls that are 8 feet (2.4 m) high, 8 inches (20 cm) thick, and composed of wood or plastic lumber, concrete, and sandbags. The interior of the enclosure is lined with an impermeable material to prevent infiltration of constituents through the soil to water pathways. A 12-inch (30 cm) layer of sand is placed over this layer. DTRs are also covered when not in use to prevent water intrusion [OPNAVINST 8027.6B]. These actions prevent the movement of ordnance constituent contamination to soils beyond the impact area. Site access is usually controlled by a perimeter fence, with additional security patrols operating during training activities. DTRs are subject to routine testing and clearing actions. Because of the long-term use of the DTRs and repeated disturbances in these areas, little vegetation is present and the areas are considered disturbed.

Table 3.3-19 summarizes the amount and size of the ordnance used at DTR Seaplane and DTR Bangor under the No Action Alternative. Based on 102 training sessions per year, there would be about 29 detonations per session, over half of which are 1.25-pound charges. In addition to C-4, other explosives and explosive components include detonating cord, fuses, igniters, blasting caps, hand grenades, and smoke grenades.

The byproducts of C-4 detonation are the following substances in gaseous or liquid form: nitrogen, carbon dioxide, water, carbon monoxide, hydrogen, ethane, ammonia, propane, and methane (Renner and Short 1980). Table 3.3-20 details the amount of each of these byproducts by weight based on a 1.25-lb charge. By weight, 78 percent of these materials are not harmful (i.e., nitrogen, carbon dioxide, and water). In total, there would be 4.0 pounds (1.8 kg) released per activity at DTR Seaplane Base and 0.25 pound (0.1 kg) per activity at DTR Bangor. These materials could potentially contaminate the soils contained in the detonation enclosure. However, all of these byproducts will dissipate or evaporate in the open air and would not be considered hazardous under those circumstances.

Table 3.3-19: Size and Number of DTR Detonations – No Action Alternative

Training Location	Detonation Type	Number	Percent of Total*
DTR Seaplane Base	Detasheet C-2	800	27.3
	Detasheet 2.0 lbs	240	8.2
	C-4 – 1.25 lb block	1,476	50.4
	C-4 – 2.0 lbs block	240	8.2
	Subtotal	**2,756**	
DTR Bangor	Detasheet C-2	50	1.7
	Detasheet 2.0 lbs	15	0.5
	C-4 – 1.25 lb block	94	3.2
	C-4 – 2.0 lb block	15	0.5
	Subtotal	**174**	
	Total	**2,930**	

* Numbers may not sum due to rounding

Table 3.3-20: Byproducts of C-4 Detonation – 1.25-Pound Charge

Byproduct of C-4 Detonation	Pounds Released	Percent
Nitrogen	0.463	37.0
Carbon dioxide	0.313	25.0
Carbon monoxide	0.230	18.4
Water	0.205	16.4
Ethane	0.020	1.6
Ammonia	0.011	0.9
Hydrogen	0.004	0.3
Propane	0.003	0.2
Methane	0.003	0.2

Aviation Fuel and Other Propellants

Under the No Action Alternative, a total of 7,586 sorties would be flown by fixed-wing aircraft, helicopters, and unmanned aerial vehicles (Table 3.3-21).

Table 3.3-21: Aircraft Sorties per Year – No Action Alternative

Type of Aircraft	Number of Sorties	Percent of Total
Fixed-wing aircraft	7,478	98.5
Helicopter	96	1.3
Unmanned aerial vehicles	12	0.2
Total	**7,586**	

Issues associated with aviation fuel arise with the need to jettison fuel from a manned aircraft or with the loss of an unmanned aircraft. Both situations are infrequent and occur only in emergency situations. Aircraft with offshore in-flight emergencies that require the craft to weigh less will jettison stores, not fuel. Aircraft operating from an aircraft carrier prefer to divert to a land-based airfield rather than a carrier landing. Fuel that is jettisoned is discarded above 8,000 feet (2,500 m) over water west of Naval Air Station Whidbey Island just prior to landing. At that elevation, the fuel dissipates in the air before any liquid reaches the ground. Given the small number of such incidents and the wide area across which they might occur, neither increase would have a measurable impact on the environment.

Other Expended Training Materials

Under the No Action Alternative, a total of 539 smoke canisters would be used during DTR exercises. These canisters are sheet metal cylinders that contain an oxidizer, a fuel, a dye, and a substance to keep the subsequent chemical reaction from getting too hot. Burning of this mixture evaporates the dye and forces it out of the device, where it condenses in the atmosphere to form a smoke of finely dispersed particles. Smoke canisters are not recovered. The primary pollutants from smoke canisters are carbon dioxide and particulates (smoke). Other pollutants are emitted at low levels. These materials were dismissed from further analysis because the majority of the constituents are consumed by heat and smoke, both of which dissipate in the air.

3.3.2.3 Alternative 1

Table 3.3-1 summarizes the types and amounts of training items under each alternative that may present issues related to hazardous materials. The text below compares the amounts and types of training materials under the No Action Alternative with Alternative 1.

Bombs

Under Alternative 1, a total of 144 bombs would be expended in the PACNW OPAREA, a 33 percent increase over the No Action Alternative (Table 3.3-22). Over 75 percent of the bombs would be inert. With an ocean area of approximately 122,400 nm^2 (420,163 km^2) and assuming even distribution of activities, this amounts to 0.001 items per nm^2 (0.0003 per km^2). Given the potential impacts of bombs as described for the No Action Alternative, this increase under Alternative 1will not have a measurable impact on the PACNW OPAREA environment.

Table 3.3-22: Types and Number of Bombs – No Action and Alternative 1

Type of Bomb	No Action	Alternative 1		
	Number	Number	Numerical Increase	Percent Increase
MK-82 – Live	12	18	6	50
BDU-45 – Inert	88	110	22	25
MK-83 – Live	4	8	4	100
MK-84 – Live	4	8	4	100
Total	**108**	**144**	**36**	**33**

Missiles

Under Alternative 1, an additional 25 missiles would be used over the No Action Alternative (Table 3.3-23). Of these additional missiles, 15 (43 percent) would be new models – Sparrow, Sidewinder, and AMRAAM – that would support target training with new equipment. No new types of exercises would be planned. Given the number of missiles and the wide area across which they would be used, there would be no measurable impact on the PACNW OPAREA environment.

Table 3.3-23: Types and Number of Missiles – No Action and Alternative 1

Type of Missile	No Action	Alternative 1	
	Number	Number	Numerical Increase
AIM-7 Sparrow	0	6	6
AIM-9 Sidewinder	0	5	5
AIM-120 AMRAAM	0	4	4
NATO Sea Sparrow	0	0	0
AGM-88 HARM*	2	4	2
AGM-114 Hellfire	1	2	1
AGM-65 Maverick	3	6	3
AGM-84 Harpoon	3	6	3
SLAM ER	1	2	1
Total	**10**	**35**	**25**

* Not fired

Naval Gunfire

Under Alternative 1, 14 percent more shells (3,495) would be used compared to the No Action Alternative (Table 3.3-24). With an ocean area of approximately 122,400 nm^2 (420,163 km^2) and assuming even distribution of activities, this amounts to less than 0.2 gunshells per nm^2 (0.07 per km^2). Almost 60 percent of the shells are 25mm. Given the inert nature of these materials and the wide dispersion across the PACNW OPAREA, Alternative 1 would not have a measurable impact on the environment.

Table 3.3-24: Types and Number of Naval Gunshells – No Action and Alternative 1

Type of Gunshell	No Action	Alternative 1	
	Number	Number	Percent Increase
20mm – live (CIWS)	7,200	8,000	11
25mm – live	15,750	17,500	11
57mm – live	630	700	11
76mm – live	560	800	43
5 inch – live	1,716	2,351	37
Total	**25,856**	**29,351**	**14**

The 20-mm cannon shells used in close-in weapons systems (CIWS) are composed of tungsten or depleted uranium, although the latter is being phased out. Please see Section 3.3.1.1 above for a more detailed discussion of depleted uranium.

Targets and Countermeasures

Under Alternative 1, there would be a 17 percent increase in the number of targets and countermeasures over the No Action Alternative (Table 3.3-25).

Table 3.3-25: Summary of Targets and Countermeasures – No Action and Alternative 1

Type of Target or Countermeasure		No Action	Alternative 1		
				Change from No Action	
		Number	Number	Numerical Increase	Percent Increase
Aerial	LUU-2B/B*	0	6	6	–
	TALD*	0	11	11	–
	BQM-74E	0	0	0	–
	TDU-34	72	80	8	11
Surface	HSMST	0	5	5	–
	Trimaran	0	11	11	–
	SPAR	0	17	17	–
	Killer Tomato	60	67	7	12
	MK-58 Marine Marker*	208	215	7	3
Subsurface	EMATT*	121	126	5	4
Sinking Exercise	Decommissioned vessel*	1	2	1	100
	Total	**462**	**540**	**78**	**17**

* Not recovered

Almost half of the targets and countermeasures under Alternatives 1 would be marine markers that are consumed by chemical reactions that produce smoke. Most of the remaining targets and countermeasures are constructed of inert materials and are recovered after use. Should they be lost at sea, they will become buried in bottom sediments or wash up onshore. Under Alternative 1, no measurable impact on the PACNW OPAREA environment would occur.

Torpedoes

Under Alternative 1, two torpedoes would be used, an increase of one over the No Action Alternative. This increase in ordnance will not have a measurable impact on the PACNW OPAREA environment.

Small Caliber Rounds

Under Alternative 1, 11 percent more small caliber rounds would be used compared to the No Action Alternative (from 59,724 to 66,360), of which 98 percent would be .50 caliber rounds (Table 3.3-26). With an ocean area of approximately 122,400 nm^2 (420,163 km^2) and assuming even distribution of activities, this amounts to about one-half round per nm^2 (0.2 per km^2). Given the inert nature of these materials, their small size, and the wide dispersion across the PACNW OPAREA, this increase would not have a measurable impact on the environment.

Table 3.3-26: Types and Number of Small Caliber Rounds – No Action and Alternative 1

Type of Ordnance	No Action	Alternative 1		
	Number	Number	Numerical Increase	Percent Increase
7.62 mm projectiles	1,224	1,360	136	11.1
.50 cal munitions	58,500	65,000	6,500	11.1
Total	**59,724**	**66,360**	**6,636**	**11.1**

Sonobuoys

Under Alternative 1, there would be a three percent increase in the number of sonobuoys compared to the No Action Alternative (Table 3.3-27). With an ocean area of approximately 122,400 nm^2 (420,163 km^2) and assuming even distribution of activities, this amounts to less than 0.08 items per nm^2 (0.02 per km^2).

Table 3.3-27: Types and Number of Sonobuoys – No Action and Alternative 1

Type of Sonobuoy	No Action	Alternative 1		
	Number	Number	Numerical Increase	Percent Increase
SSQ-36 BT (passive)	288	295	7	2.4
SSQ-53 DIFAR (passive)	7,283	7,503	220	3.0
SSQ-62 DICASS (active)	844	865	21	2.5
SSQ-77 VLAD (passive)	593	623	30	5.1
SSQ-110A (explosive)	124	136	12	9.7
Total	**9,132**	**9,422**	**290**	**3.2**

In terms of the inert components of sonobuoys, this level of deposition would not have a measurable impact on the PACNW OPAREA environment. As previously discussed for the No Action Alternative, sonobuoy batteries and explosive components would not result in adverse hazardous material impacts. This remains true for the three percent increase in sonobuoys proposed under Alternative 1.

Underwater Detonations

In April 2008, the Navy decided to relocate Explosive Ordnance Disposal Mobile Unit Eleven (EODMU Eleven) forces out of the NWTRC Study Area to Imperial Beach, CA. This move is planned to be completed in the fall of 2009. Two EOD Shore Detachments (Bangor and Northwest) will remain in the NWTRC. These Shore Detachments report to Commander, Navy Region Northwest and respond to regional Navy taskings and incidents. As a result of the EODMU Eleven relocation, mine warfare underwater detonation training will significantly decrease from a yearly maximum of 60 underwater detonation as analyzed in the No Action Alternative (the baseline) to no more than four annual underwater detonation as analyzed in Alternatives 1 and 2. The maximum charge size for these four explosions will be 2.5 pounds. Adverse impacts would not be measurable because of low level of activity, the benign nature of the majority of explosion byproducts, and standard site investigation and clean up procedures.

Land Detonations

Under Alternative 1, there would be an eight percent increase in the number of DTR explosions compared to the No Action Alternative (Table 3.3-28). Training sessions would increase from 102 to 110, resulting in about 29 detonations per session, over half of which would be 1.25-pound charges. In addition to C-4, other explosives and explosive components include detonating cord, fuses, igniters, blasting caps, hand grenades, and smoke grenades.

The majority of the detonation byproducts (78 percent) are not hazardous. Of the potentially hazardous byproducts, there would be 4.0 pounds (1.8 kg) released per exercise at DTR Seaplane Base and 0.25 pound (0.1 kg) per exercise at DTR Bangor. However, because those by-products would evaporate or dissipate, potential impacts are considered negligible.

Table 3.3-28: Size and Number of DTR Detonations – All Alternatives

Training Location	Detonation Type	No Action	Alternatives 1 and 2	Percent Increase
DTR Seaplane Base	Detasheet C-2	800	862	8
	Detasheet 2.0 lbs	240	259	8
	C-4 – 1.25 lb block	1,476	1,591	8
	C-4 – 2.0 lb block	240	259	8
	Subtotal	**2,756**	**2,971**	8
DTR Bangor	Detasheet C-2	50	55	10
	Detasheet 2.0 lbs	15	17	13
	C-4 – 1.25 lb block	94	102	9
	C-4 – 2.0 lb block	15	16	7
	Subtotal	**174**	**190**	9
Total		**2,930**	**3,161**	8

Aviation Fuel

Under Alternative 1, sorties would increase 21 percent compared to the No Action Alternative (Table 3.3-29). The relative proportion among the aircraft types would remain unchanged. Issues associated with aviation fuel arise with the need to jettison fuel from a manned aircraft or with the loss of an unmanned aircraft. Both situations are infrequent. Given the small number of such incidents and the wide area across which they might occur, the 8 percent increase would not have a measurable impact on the environment.

Table 3.3-29: Aircraft Sorties – No Action and Alternative 1

Type of Aircraft	No Action	Alternative 1		
	Number of Sorties	Number of Sorties	Numerical Increase	Percent Increase
Fixed-wing aircraft	7,478	8,983	1,505	20
Helicopter	96	109	13	14
Unmanned aerial vehicles	12	112	100	833
Total	**7,586**	**9,204**		**21**

Other Expended Training Materials

Under Alternative 1, an additional 42 smoke canisters would be used, an eight percent increase over the No Action Alternative. Given the relatively small increase in canisters used and the speed with which the majority of pollutants would dissipate, there will be no measurable impact on the environment.

3.3.2.4 Alternative 2, The Preferred Alternative

Table 3.3-1 summarizes the types and amounts of training items under each alternative that may present issues related to hazardous materials. The text below compares the amounts and types of training materials under the No Action Alternative with Alternative 2, the Preferred Alternative.

Bombs

Under Alternative 2, an additional 36 bombs would be used, a 33 percent increase over the No Action Alternative (Table 3.3-30), the same as Alternative 1. Over 75 percent of the bombs would be inert. With an ocean area of approximately 122,400 nm^2 (420,163 km^2) and assuming even distribution of activities, this amounts to 0.001 items per nm^2 (0.0003 per km^2). Given the negligible impacts of bombs as described for the No Action Alternative, this increase under Alternative 2 will not have a measurable impact on the PACNW OPAREA environment.

Table 3.3-30: Types and Number of Bombs – No Action and Alternative 2

Type of Bomb	No Action	Alternative 2	
	Number	Number	Percent Increase
MK-82 – Live	12	18	50
BDU-45 – Inert	88	110	25
MK-83 – Live	4	8	100
MK-84 – Live	4	8	100
Total	**108**	**144**	**33**

Missiles

Under Alternative 2, an additional 47 missiles would be used compared to the No Action Alternative (Table 3.3-31). Of these additional missiles, 37 (65 percent) would be new models – Sparrow, Sidewinder, AMRAAM, and Sea Sparrow – to support target training with new equipment. No new types of exercises would be planned. Given the number of missiles and the wide area across which they would be used, there would be no measurable impact on the PACNW OPAREA environment.

Table 3.3-31: Types and Number of Missiles – No Action and Alternative 2

Type of Missile	No Action	Alternative 2	
	Number	Number	Numerical Increase
AIM-7 Sparrow	0	13	13
AIM-9 Sidewinder	0	9	9
AIM-120 AMRAAM	0	7	7
NATO Sea Sparrow	0	8	8
AGM-88 HARM	2	4	2
AGM-114 Hellfire	1	2	1
AGM-65 Maverick	3	6	3
AGM-84 Harpoon	3	6	3
SLAM ER	1	2	1
Total	**10**	**57**	**47**

Naval Gunfire

Under Alternative 2, a doubling of the gun shells used would occur (from 25,856 to 53,343; Table 3.3-32). With an ocean area of approximately 122,400 nm^2 (420,163 km^2) and assuming even distribution of activities, this amounts to about 0.4 shells per nm^2 (0.1 per km^2). Given the largely inert nature of these materials and the wide dispersion across the PACNW OPAREA, this increase would not have a measurable impact on the environment.

Table 3.3-32: Types and Number of Naval Gunshells – No Action and Alternative 2

Type of Gunshell	No Action	Alternative 2	
	Number	Number	Percent Increase
20mm – live (CIWS)	7,200	16,000	122
25mm – live	15,750	31,500	100
57mm – live	630	1,260	100
76mm – live	560	1,120	100
5 inch – live	1,716	3,463	102
Total	**25,856**	**53,343**	**106**

The 20-mm cannon shells used in close-in weapons systems (CIWS) are composed of tungsten or depleted uranium, although the latter is being phased out. Please see Section 3.3.1.1 above for a more detailed discussion of depleted uranium.

Targets and Countermeasures

Table 3.3-33 compares proposed changes in the numbers and types of targets and countermeasures under Alternative 2 with the No Action Alternative.

Table 3.3-33: Summary of Targets and Countermeasures – No Action and Alternative 2

Type of Target or Countermeasure		No Action	Alternative 2		
				Change from No Action	
		Number	Number	Numerical Increase	Percent Increase
Aerial	LUU-2B/B*	0	11	11	–
	TALD*	0	22	22	–
	BQM-74E	0	16	16	–
	TDU-34	72	160	88	122
Surface	HSMST	0	9	9	–
	Trimaran	0	20	20	–
	SPAR	0	31	31	–
	Killer Tomato	60	120	60	100
	MK-58 Marine Marker*	208	220	12	6
Subsurface	EMATT*	121	126	5	4
Sinking Exercise	Decommissioned vessel*	1	2	1	100

* Not recovered

The largest increase is in towed drone units (TDU-34) which are recovered after use, and more than one-third of the total increase is marine markers that would be consumed by chemical reactions that produce smoke. Most of the remaining targets and countermeasures are recovered after use. Those that are not are constructed mostly of inert materials. This increase of targets and countermeasures proposed under Alternative 2 would not have a measurable impact on the environment.

Torpedoes

Under Alternative 2, two torpedoes would be used, an increase of one over the No Action Alternative, and the same as Alternative 1. This increase would have no measurable impact on the PACNW OPAREA environment.

Small Caliber Rounds

Under Alternative 2, a doubling of the small caliber rounds would occur (from 59,724 to 119,720; Table 3.3-34). With an ocean area of approximately 122,400 nm^2 (420,163 km^2) and assuming even distribution of activities, this amounts to one round per nm^2 (0.3 per km^2). Given the inert nature of these materials, their small size, and the wide dispersion across the PACNW OPAREA, this increase would have no measurable impact on the environment.

Table 3.3-34: Types and Number of Small Caliber Rounds – No Action and Alternative 2

Type of Ordnance	No Action	Alternative 2	
	Number	Number	Percent Increase
7.62 mm projectiles	1,224	2,720	122
.50 cal munitions	58,500	117,000	100
Subtotal	**59,724**	**119,720**	**101**

Other Expended Training Materials

Under Alternative 2, an additional 41 smoke canisters would be used compared to the No Action Alternative (8 percent increase; same as Alternative 1). Given the relatively small increase in canisters used and the speed with which the majority of pollutants would dissipate, there will be no measurable impact on the environment.

Sonobuoys

Under Alternative 2, a total of 9,651 sonobuoys would be used, an increase of six percent (519) over the No Action Alternative (Table 3.3-35). With an ocean area of approximately 122,400 nm^2 (420,163 km^2) and assuming even distribution of activities, this amounts to less than 0.08 items per nm^2 (0.2 per km^2).

Table 3.3-35: Types and Number of Sonobuoys – No Action and Alternative 2

Type of Sonobuoy	No Action Alternative	Alternative 2	
	Number	Number	Percent Increase
SSQ-36 BT (passive)	288	302	4.9
SSQ-53 DIFAR (passive)	7,283	7,661	5.2
SSQ-62 DICASS (active)	844	886	5.0
SSQ-77 VLAD (passive)	593	653	10.1
SSQ-110A (explosive)	124	149	20.2
Total	**9,132**	**9,651**	**5.7**

In terms of the inert components of sonobuoys, this level of deposition would have a negligible impact on ocean water resources. As previously discussed for the No Action Alternative and Alternative 1, sonobuoy batteries and explosive components would not result in adverse hazardous material impacts, therefore, the proposed increase in sonobuoy use under Alternative 2 would not have a measurable impact on the PACNW OPAREA environment.

Underwater Detonations

Like Alternative 1, the Navy has decided to relocate Explosive Ordnance Disposal Mobile Unit Eleven (EODMU Eleven) forces out of the NWTRC Study Area to Imperial Beach, CA. This move is planned to be completed in the fall of 2009. Two EOD Shore Detachments (Bangor and Northwest) will remain in the NWTRC. These Shore Detachments report to Commander, Navy Region Northwest and respond to regional Navy taskings and incidents. As a result of the EODMU Eleven relocation, mine warfare underwater detonation training will decrease from a yearly maximum of 60 underwater detonation as analyzed in the No Action Alternative (the baseline) to no more than four annual underwater detonation as analyzed in Alternatives 1 and 2, a decline of over 90 percent. The maximum charge size of would be 2.5 pounds. Adverse impacts would not be measurable because of low level of activity, the benign nature of the majority of explosion byproducts, and standard site investigation and clean up procedures.

Land Detonations

Under Alternative 2, there would be an eight percent increase in the number of DTR explosions compared to the No Action Alternative (Table 3.3-28). This is the same as Alternative 1. Therefore, hazardous material impacts would be negligible.

Aviation Fuel and Other Propellants

Under Alternative 2, overflights would increase 55 percent (4,200) over the No Action Alternative (Table 3.3-36). Hazardous material issues associated with aviation fuel arise with the need to jettison fuel from a manned aircraft or with the loss of an unmanned aircraft. Given how infrequent such events are, that they occur above 8,000 feet (2,500 m), and the wide area across which they might occur, the increase would not have a measurable impact on water resources.

Table 3.3-36: Aircraft Sorties – No Action and Alternative 2

Type of Aircraft	No Action	Alternative 2		
	Number of Sorties	Number of Sorties	Numerical Increase	Percent Increase
Fixed-wing aircraft	7,478	11,565	4,087	55
Helicopter	96	109	13	14
Unmanned aerial vehicles	12	112	100	833
Total	**7,586**	**11,786**	**4,200**	**55**

3.3.3 Mitigation Measures

As summarized in Section 3.3.4, the alternatives would contribute low amounts of hazardous material to the environment of the NWTRC Study Area. Given the large size of the Study Area and the fate and transport of the constituents, it is unlikely that hazardous materials resulting from the proposed actions could be detectable. Standard Navy protective measures would be employed and no additional mitigation measures would be needed. See Chapter 5 for additional discussion of mitigation measures.

3.3.4 Summary of Effects by Alternative

The overall amount of hazardous materials generated during training under Alternatives 1 and 2 would be more than that generated under the No Action Alternative, due primarily to the increased number of training activities.

All hazardous materials would continue to be managed in compliance with applicable federal and state regulations, and Department of Defense guidelines. No substantial changes in hazardous materials management practices are anticipated under any of the alternatives. The anticipated amounts of hazardous materials generated are well within the capacity of the Navy's afloat and ashore hazardous waste management systems.

As summarized in Table 3.3-37, less than significant overall impacts from hazardous materials are anticipated under the No Action Alternative, Alternative 1, or Alternative 2, the Preferred Alternative. Discarded training materials would be deposited in offshore areas or become buried in the sea floor sediments, and would have no substantial environmental effects. The overall volume of expended training items would increase in Alternative 1 and Alternative 2, the Preferred Alternative, in correlation to changes in activities.

Table 3.3-37: Summary of Effects – Hazardous Materials

Alternative and Stressor	Summary of Effects and Impact Conclusion	
	NEPA (Territorial Waters, 0 to 12 nm)	**Executive Order 12114 (Non-territorial Waters, >12 nm)**
No Action		
Expended Materials	Long-term, minor, and localized accumulation of expended materials on the ocean floor.	Long-term, minor, and localized accumulation of expended materials on the ocean floor.
Hazardous Materials	Negligible effects.	Negligible effects.
Alternative 1		
Expended Materials	Increase in expended materials compared to No Action. Long-term, minor, and localized accumulation of expended materials on the ocean floor. Most materials inert.	Increase in expended materials compared to No Action Alternative. Long-term, minor, and localized accumulation of expended materials on the ocean floor. Most materials inert.
Hazardous Materials	Negligible effects.	Negligible effects.
Alternative 2 (Preferred Alternative)		
Expended Materials	Increase in expended materials compared to No Action. Long-term, minor, and localized accumulation of expended materials on the ocean floor. Most materials inert.	Increase in expended materials compared to No Action. Long-term, minor, and localized accumulation of expended materials on the ocean floor. Most materials inert.
Hazardous Materials	Negligible effects.	Negligible effects.

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3.4 Water Resources

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3.4 WATER RESOURCES

In general, water resources include the following components:

- the topography of the ocean bottom – bathymetry – that influences currents and sediment movement;
- water processes, including ocean currents, seasonal changes precipitation and resulting runoff, infiltration from the ground surface into aquifers, and biological, physical and chemical changes that occur as water moves through the hydrologic cycle;
- water bodies, including lakes, ponds, rivers, groundwater, the ocean, and transitional areas such as wetlands and estuaries;
- water uses, including drinking, recreation, plant and animal habitat, and commerce (e.g., fishing and transportation); and
- water quality, including the chemical and physical composition of groundwater and fresh and marine surface waters as affected by natural conditions and human activities.

3.4.1 Affected Environment

In the Northwest Training Range Complex (NWTRC) Study Area, water bodies that could be affected by the Proposed Action include:

- marine waters off the coasts of Washington, Oregon, and northern California, the Strait of Juan de Fuca, coastal waters, and estuaries;
- northern portions of Puget Sound; and
- natural and man-made water features on Whidbey Island, Indian Island, and at NBK-Bangor (northern Kitsap Peninsula).

The discussion of the Columbia River is included in the marine section because of the river's influence on the ocean environment through delivery volumes of sediments and fresh water.

3.4.1.1 Ocean Water Resources

Marine water resources in the Study Area are affected by ocean currents, climate and weather patterns, and ocean bottom topography ("bathymetry"). Ocean currents influence conditions in the Study Area by altering surface water temperatures, sediment transport and deposition, and concentrating or diluting the resources on which marine life depends. Similarly, seasonal prevailing winds alter the movement of surface waters. For example, southerly winds during spring and summer push surface waters away from the coast and bring cold, nutrient-rich waters from deeper areas, a phenomenon known as upwelling (Hickey and Banas 2003, Huyer 1983, van Geen et al. 2000). These factors sustain active fisheries for a variety of fish and marine invertebrates, influence weather patterns and the hydrologic cycle of much of the western United States, and play a vital role in the economy of many coastal communities.

The character of the Pacific Ocean in the Northwest United States is largely controlled by: 1) Pacific-wide circulation of water, especially the California Current System; 2) major inputs of fresh water and sediment from the Columbia River; 3) the formation of large eddies such as that at the mouth of the Strait of Juan de Fuca; and 4) seasonal prevailing winds (Barth and Smith 1997, Hickey and Banas 2003).

<u>Pacific Ocean</u>

The NWTRC Study Area is located where the edge of the North American continental plate meets and overrides the Juan de Fuca oceanic plate. The resulting tectonic activities, coupled with periods of glaciation, erosion, and deposition, created the mountains, canyons, fjords, and coastal lowlands prominent in the Study Area (Melbourne and Webb 2003, McGregor and Offield 1986). During the Pleistocene Epoch, massive Piedmont glaciers, as much as 3,600 feet thick (1,100 m), moved southward from the Coast Mountains of British Columbia and carved out the Strait of Juan de Fuca and greater Puget Sound. The deepest basins were created in North Puget Sound in and around the San Juan Islands. Approximately 15,000 years ago, the southern edge of the last glacier receded, leaving the lowland covered with glacial deposits and glacial lakes, and revealing the Puget Sound Basin (Burns 1985).

The tectonically-active continental margin in the NWTRC Study Area has created a fairly narrow continental shelf 15 to 50 miles wide (25 to 80 km). The shelf is widest along the Washington coast and becomes gradually narrower along Oregon and northern California (Figure 3.4-1). Water depths along the shelf are typically less than 650 feet (200 m) and the bottom is largely flat due to a long history of sediment accumulation (Shepard and Emery 1941, Strickland and Chasan 1989).

Undersea Ridges and Seamounts

Prominent undersea ridges in the Study Area include the Juan de Fuca Ridge and Gorda Ridge. Both ridges are created where the floor of the Pacific Ocean is spreading apart, forming new ocean crust. The Juan de Fuca Ridge is approximately 300 miles long (500 km) and rises from 1,300 to 3,300 feet (400 to 1,000 m) above the surrounding abyssal plains (Kulm and Fowler 1974, Kulm et al. 1986, Porter et al. 2000). The smaller Gorda Ridge is located to the south of the Juan de Fuca Ridge. Both ridges have localized volcanic activity, lava flows, and hot springs that provide good conditions for deep-sea habitats (Fox and Dziak 1998).

Seamounts are isolated mountains rising 3,000 to 10,000 feet (900 to 3,000 m) above the surrounding ocean bottom. Seamounts are found in all oceans, but are more numerous in the Pacific Ocean, with over 2,000 having been identified (Thompson et al. 1993). Seamounts provide a unique habitat for both deep-sea and shallow water organisms due to the large ranges of depth, hard substrate, steep vertical gradients, convoluted surfaces, variable currents, clear oceanic waters, and geographic isolation (Rogers 1994). For additional discussion of deep-sea communities, see Section 3.6, Marine Plants and Invertebrates.

Submarine Canyons

The shelf along the Pacific Northwest Coast is cut by several deep submarine canyons oriented perpendicular to the shore (Strickland and Chasan 1989; see Figure 3.4-2). Submarine canyons have steep walls, winding valleys, narrow V-shaped cross-sections, steps, and considerable irregularity along the sea floor (Kennett 1982, Thurman 1997). They represent the flooded remains of terrestrial canyons cut by large rivers fed by glacial meltwater. The floors of submarine canyons are primarily mud with isolated sandy patches. Turbidity currents associated with submarine canyons transport sediment to the deep sea, forming sediment fans where they open to the abyssal plain (Thurman 1997).

Cascadia Abyssal Plain

The Cascadia Abyssal Plain off the Pacific Northwest Coast is a flat area of the deep ocean floor between the foot of a continental slope and the Juan de Fuca Ridge to the west. Depths vary between 7,300 and 18,150 feet (2,200 to 5,500 m). The plain’s flatness and lack of features is a result of the blanketing of an originally uneven surface of oceanic crust by fine-grained sediments, mainly clay and silt. Much of this sediment is deposited from turbidity currents that have been channeled from the continental margins along submarine canyons. The remainder of the sediment is chiefly dust blown out to sea from land, and the remains of small marine plants and animals that sink from the upper layer of the ocean, known as pelagic sediment (Nittrouer 1978).

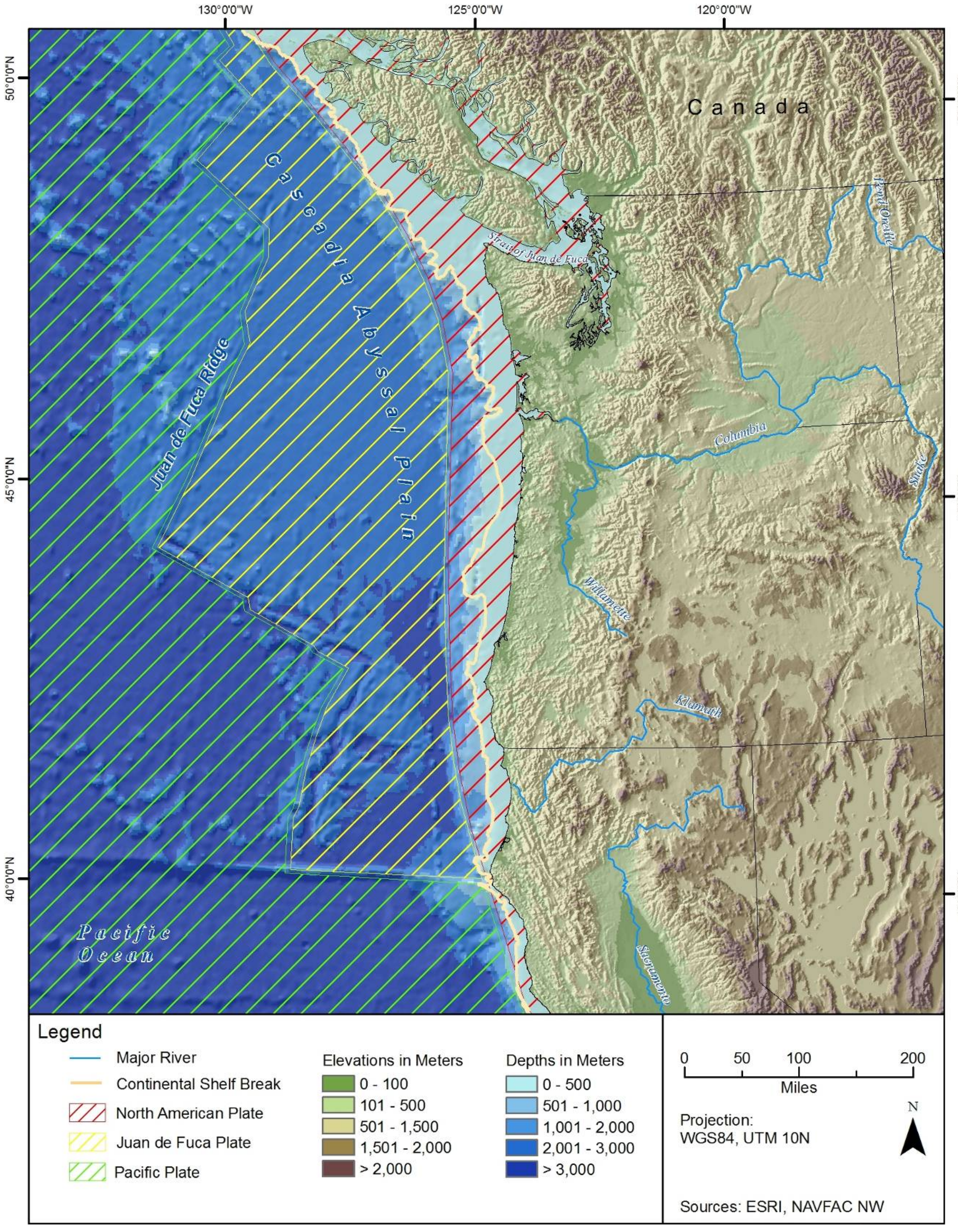

Figure 3.4-1: Bathymetry of the NWTRC EIS/OEIS Study Area

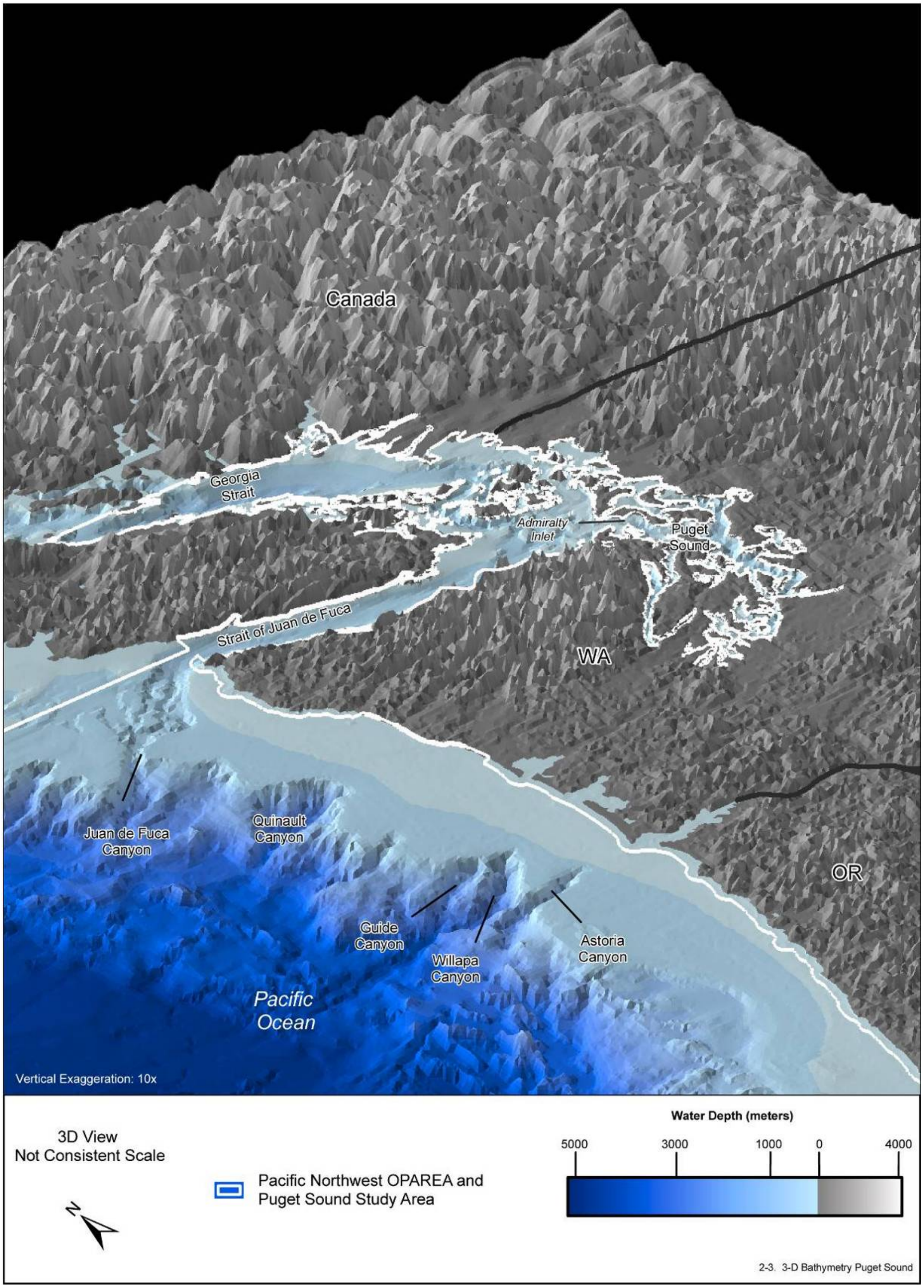

Figure 3.4-2: Pacific Northwest Submarine Canyons

Strait of Juan de Fuca

The Strait of Juan de Fuca is a 160-km-long channel that connects the Pacific Ocean with Puget Sound. It is 14 to 38 miles wide (22 to 60 km) with an average depth of less than 650 feet (200 m) (Ott and Garrett 1998) (Figure 3.4-3). The sides of the channel are relatively straight and it has few distinctive bathymetric features. Northward-traveling coastal currents interact with the subsurface topography at the mouth of the strait to create the Juan de Fuca Eddy, a 30-mile-wide surface feature (50 km) most pronounced in summer. The strait exhibits a typical estuary circulation pattern with fresher surface water flowing seaward above the colder, saltier seawater flowing landward (Holbrook et al. 1980, Ebbesmeyer et al. 1991, Thomson 1994, Ott and Garrett 1998). The mixing of these currents varies with time and location. For instance, the surface outflow is stronger on the northern, Canadian side of the channel and surface inflow is stronger on the southern, U.S. side (Pease et al. 1979, Hickey et al. 1991, Thomson 1994). The circulation pattern is highly seasonal, and tidal flow and eddies can strongly influence circulation in the strait, as can coastal winds (Holbrook et al. 1980, Ebbesmeyer et al. 1991, Gramling 2000, Ott and Garrett 1998).

Columbia River

The Columbia River forms the boundary between Oregon and Washington State and heavily influences the local characteristic of the Pacific Northwest marine environment (Barnes et al. 1972, Barth et al. 2005). The structure and magnitude of the Columbia River plume has significant annual variability (Hickey and Banas 2003). The discharge rate from the Columbia River varies between 88,000 cubic feet per second (cfs) in summer (2,500 cubic meters per second) to 600,000 cfs in spring (17,000 cubic meters per second), but can exceed one million cfs (30,000 cubic meters per second) (Bottom et al. 2005). These flows represent almost 60 percent of the freshwater entering the Pacific Ocean between San Francisco and the Strait of Juan de Fuca during the winter and more than 90 percent throughout the remainder of the year. Changes in climate also affect the discharge of the Columbia River. During warm years, discharge of the Columbia River is decreased by approximately 14 percent compared to cool years (Mantua et al. 1997).

The freshwater plume tends to travel north in fall and winter and to the south in spring and summer. The Columbia River plume changes direction, depth, and width in response to local wind strength and direction (Hickey et al. 1998, Berdeal et al. 2002, Hickey and Banas 2003). During years with high snowmelt, freshwater from the plume can flood saltwater estuaries for prolonged periods of time and change local salinity levels in the ocean from 32 to 35 parts per thousand (ppt) to as low as 8 ppt (Hickey and Banas 2003).

California Ocean Current

The coasts of Washington and Oregon are located in an eastern boundary current system where the North Pacific Current divides into the northward flowing Alaskan Current and the southward flowing California Current (Hickey 1998, Gramling 2000). The current is a major force in shaping local ecosystems by affecting upwelling, downwelling, local climate, and, through those mechanisms, the biological productivity of coastal areas (Airamé et al. 2003).

The California Current extends up to 620 miles offshore (1,000 km) and varies from 370 to 620 miles wide (600 to 1000 km). The current carries the cold, nutrient-rich waters of Oregon southward toward California (Hickey 1979, Miller 1996, Hickey 1998). It also has north-trending undercurrents and surface countercurrents. The main surface current follows the edge of the continental shelf along the coast, and is located closer to the shoreline during the summer and farther off the shelf in winter (Strickland and Chasan 1989). The current is strongest in the summer and early fall, and weakest in the winter. Flow is strongest at the surface, but the current extends through the water column to a depth of approximately 1,650 feet (500 m) (Gramling 2000, Hickey and Banas 2003).

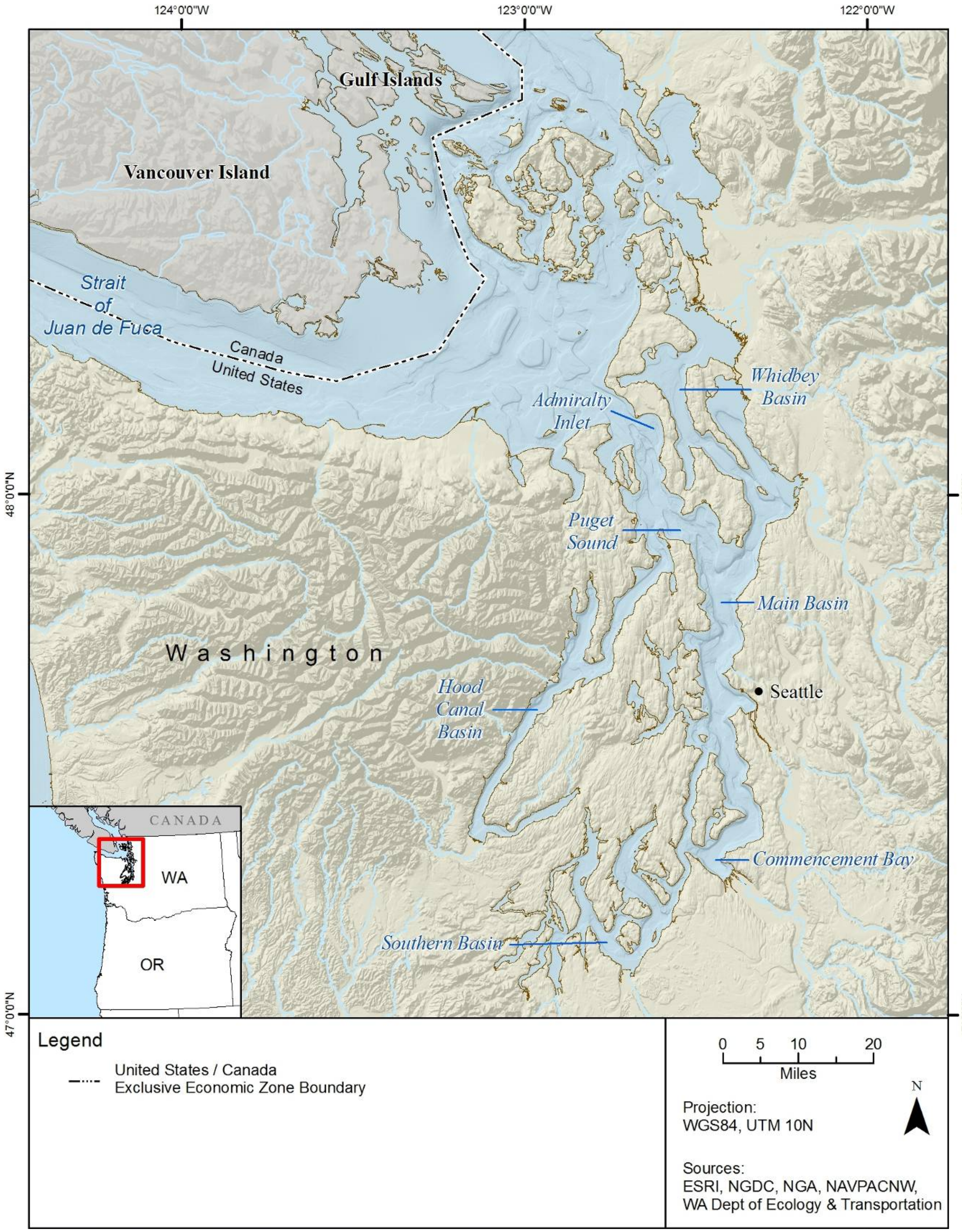

Figure 3.4-3: Strait of Juan de Fuca and Puget Sound

Shifts in regional climate can have dramatic effects on the flow of the California Current. For instance, during El Niño events, the flow of the California Current is unusually weak. Changes in the current, such as occurs during La Niña, can strengthen upwelling along the coast and bring more nutrients to the surface. Changes in the strength of the current usually lead to changes in coastal weather patterns (Hickey 1979, Gramling 2000).

Prevailing Weather Patterns

The Pacific Northwest has distinctive ocean-influenced seasons, with pronounced coastal upwelling April through September, and extended periods of calm winds October through March. Strong winter storms can arise between November and March (Airamé et al. 2003). Winds are generally from the west-northwest during spring and summer and from the south-southwest during fall and winter (NMFS 2008). Broader changes in ocean circulation such as El Niño and La Niña may dramatically alter temperatures, wind direction, precipitation, and upwelling for several months to over a year. Most of the precipitation falls as rain during October through March (WDOE 2002).

Ocean Water Parameters

Ocean water parameters of interest include temperature, salinity, and dissolved oxygen, nutrients, and pH. These conditions affect water quality by influencing the rate of chemical and biological processes and the mobility of various substances like dissolved metals.

Temperature

The Pacific Northwest experiences relatively cool water temperatures due to the southerly flow of the California Current through the region. Coastal temperatures tend to be colder due to the upwelling of cold waters from depth along the coast (Burger 2003, Yen et al. 2005). Winter water temperatures range from 8ºC in the northern regions to 10ºC to the south. During the summers, water temperatures increase to 17ºC offshore and 11ºC along the coast (Greenland 1998). These temperatures have fluctuated considerably over the past 50 years in response to cyclical and longer-term climate changes (Douglas et al. 1982, Trenberth 1990, Tanimoto et al. 1993, Airamé et al. 2003).

Salinity

In general, salinity increases southward along the coast, ranging between 32 and 35 ppt (McGowan et al. 1998, Huyer et al. 2002). As noted previously, the extent of the freshwater plume from the Columbia River can dramatically affect local salinity levels.

Dissolved Oxygen, Nutrients, and pH

The major chemical parameters of marine water quality include pH, dissolved oxygen, and nutrient concentrations. The major ions present in seawater include sodium, chloride, potassium, calcium, magnesium, and sulfate (Dailey et al. 1993).

Surface waters are usually saturated or supersaturated with dissolved oxygen as a result of photosynthetic activity and wave mixing. Below the surface, dissolved oxygen remains more constant between 0.4 and 0.6 mL/L. Anaerobic (no oxygen) conditions are found in bottom sediments and at the water-sediment interface in deep ocean basins (Dailey et al. 1993).

Nutrients are chemicals or elements necessary to produce organic matter. In marine systems, basic nutrients include dissolved nitrogen, phosphates, and silicates. Dissolved inorganic nitrogen occurs in ocean water as nitrates, nitrites, and ammonia, with nitrates as the dominant form. The nitrate concentration of water near shore varies from 0.1 to 10.0 micrograms per liter (µg/L). The lowest concentrations typically occur in summer. At a depth of 33 feet (10 m), the concentration of phosphate ranges from 0.25 to 1.25 µg/L, while the concentration of silicate ranges from 2.0 to 15 µg/L (Dailey et al. 1993).

The marine environment has relatively stable pH between 7.5 and 8.5 due to the presence of dissolved elements, particularly carbon and hydrogen. Most of the carbon in the sea is present as dissolved inorganic carbon that originates from the complex interaction of dissolved carbon dioxide (CO_2) in seawater. This CO_2-carbonate equilibrium system is the major pH buffering system in seawater.

Existing Ocean Water Quality

There is little information on open ocean water quality, but some studies suggest that deep water is generally of higher quality than surface waters. Water quality in the marine environment is determined by complex interactions between physical, chemical, and biological processes. Physical processes include region-wide currents and tidal flows, seasonal weather patterns and temperature, sediment characteristics, and unique local conditions, such as those created by the volume of freshwater delivered by the Columbia River. Chemical processes involve salinity, pH, dissolved minerals and oxygen, nutrient levels, and pollutants. Biological processes involve the influence of living things on the physical and chemical environment, such as the uptake, conversion, and excretion of materials during growth, reproduction, and decomposition. These processes operate and interact continuously, creating a dynamic system in which the Proposed Action will occur. Changes in these conditions alter the viability of habitat at certain locations and water depths to various organisms. For instance, excessive nutrients (eutrophication) can lead to algal blooms, subsequent die-offs, and declines in dissolved oxygen (hypoxia) to the point where fish can no longer survive (Boesch et al. 1997).

Contaminants found in marine environments include suspended solids, sediment, nutrients and organic debris, metals, synthetic organic compounds such as pesticides and plastics, and pathogens. The sources of these contaminants include commercial and recreational vessels, oil spills, industrial and municipal discharges (point source pollution), legal and illegal ocean dumping, poorly- or untreated sewage, and runoff from urban and agricultural areas (nonpoint source pollution). Conduits for contamination include streams, rivers, and air currents that carry materials from inland areas to the ocean. Estuarine waters can directly or indirectly affect coastal water quality. The National Water Quality Inventory by the U.S. Environmental Protection Agency (USEPA) found that just over half of the estuarine areas assessed on the West Coast were polluted to the extent that their use was compromised, either for aquatic life, drinking water, swimming, boating, or fish consumption. Estuarine waters can directly or indirectly affect coastal water quality (USEPA 2007). A recent coastal condition report rated the waters along the West Coast as fair (USEPA 2004).

Potential pollutants should be viewed in the context of their "bioavailability," that is, the capacity of material to be taken up by living organisms through physical contact or ingestion. If a pollutant is not bioavailable to the organisms in the ecosystem, then potential environmental impacts are greatly reduced. Factors that influence bioavailability in seawater include temperature, salinity, dissolved oxygen, nutrients, and pH. In sediments, bioavailability is influenced by oxygen levels, particle size, organic carbon content, the presence of iron oxyhydroxides and iron sulphides, and the presence of other metals (CFMETR 2005).

Ocean Sediment Parameters

The majority of rivers along the Pacific Coast typically drain small, steep watersheds that produce large amounts of sand-size sediment. A major source for sediment along the Pacific Northwest Coast is the Columbia River. The sediment is first deposited near the mouth of the river and then transported by tides and currents northward along the coast (Nittrouer 1978, Baker and Hickey 1986, Hickey and Banas 2003). Currents associated with submarine canyons serve as major conduits for sediment transport to the deep sea (Thurman 1997). The remainder of the sediment comprises chiefly dust blown out to sea from land, and the remains of small marine plants and animals that sink from the upper layer of the ocean.

Existing Ocean Sediment Quality

Several factors influence the extent and severity of sediment contamination in aquatic systems. Fine-grained (less than 0.63 micrograms [µg]), organic-rich sediments bind some toxicants, such as heavy metals, so strongly that the threat to organisms is greatly reduced (NEP 2007). Conversely, these fine-grained sediments are also easily re-suspended and can be transported to distant locations. Thus, silty sediments high in total organic carbon (TOC) are potential sources of contamination. But such statements do not apply equally to all potential pollutants. For instance, metals such as lead, and large organic molecules such as polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) tend to remain in sediments, and more soluble chemicals tend to remain as ions in the pore water surrounding the sediments (CFMETR 2005).

3.4.1.2 Nearshore Water Resources

For the NWTRC Study Area, the term “nearshore areas” includes the littoral zone and estuaries. The littoral zone refers to areas of the Pacific Coast where the impacts of waves, tides, and longshore currents – those that move parallel to the shore – are most pronounced. The dimensions of the littoral zone vary depending on local conditions, such as how steeply the ocean bottom falls away from the shore. Because of the abundant dissolved oxygen, sunlight, and nutrients, the littoral zone supports a wide variety of plants, animals, and habitat types. Because of direct exposure to wind, waves, tides, and currents, the littoral zone is also subject to a variety of forces that make the local environments dynamic. Estuaries are locations where oceans and rivers meet. In the Study Area, Puget Sound is considered an estuary because it is largely separated from the higher-energy environment of the coast, and is less dynamic than the coast, although it is still influenced by wind, freshwater inflows, and extreme tides (NMFS 2008).

Tides, Currents, and Freshwater Inputs

Circulation patterns in Puget Sound are driven by tides, winds, and freshwater inflows. North of Seattle, the main basin of Puget Sound exhibits an estuary pattern of tide-dominated seaward flow near the surface and a landward flow at depth (Cannon 1983, Thomson 1994). The more inland waters of Puget Sound have restricted water exchange with the main basin and currents in these areas are more tidally driven (Boesch et al. 1997). Sills at various locations also tend to segregate certain portions of the sound (e.g., Hood Canal) and to moderate the influence of tides and currents (NEP 2007).

The Stillaguamish, Snohomish, and Skagit rivers account for 75 percent of the freshwater inflows into the sound. Other sources include direct precipitation, surface runoff, and groundwater inflows (NOAA and WDOE 2002). Still, tidal flows dominate in the sound, in contrast to the Columbia River estuary which is heavily influenced by seasonal river flows. During high river-flow periods, the Columbia River estuary is almost entirely composed of fresh water that is well connected to the ocean. During low-flow periods, however, discharge is insufficient to maintain a good connection with the ocean, and tidal action along the shoreline tends to affect the entrance to the estuary (NEP 2007).

Prevailing Weather Patterns

Prevailing weather patterns in Puget Sound occur within the larger constraints of oceanic and regional influences, such as winds from the south-southwest during winter and from the northwest during the summer. Because winds are stronger during the winter and temperatures cooler, the water column tends to be less stratified compared to summer. Stratification is the formation of pronounced layers of water that form because of differences in salinity (density stratification) and temperature. Stratification can lead to isolation and worsening of water quality problems, especially those involving excess nutrients in deeper waters (USEPA 2008a).

Nearshore Water Parameters

The parameters of interest for nearshore waters are much the same as those for the ocean – temperature, salinity, and dissolved oxygen, nutrients, and pH, although the factors that influence them are different. Examples include the extent of freshwater inputs from rivers and streams and substantially reduced mixing by waves and tidal flows.

Temperature

Water temperatures within Puget Sound vary considerably, ranging from 37ºF (3ºC) during the winter to 73ºF (23ºC) during the summer (NMFS 2008). Deep, well-mixed water areas show less seasonal variation than shallow, more stratified areas. Local influences include water from rivers and streams which tends to be colder in the winter and warmer in the summer than marine waters (WDOE 2002).

Salinity

Salinity in Puget Sound ranges from 25 to 30 PSU ("practical salinity units" which are analogous to parts per thousand), while in other estuaries salinity can range from 10 to 25 PSU (Grays Harbor) and 20 to 30 PSU (Willapa Bay) (WDOE 2002).

Dissolved Oxygen, Nutrients, and pH

Dissolved oxygen (DO) concentrations in surface waters of estuaries in Oregon and Washington ranged from 3.4 mg/L to 11.5 mg/L (average = 8.2 mg/L). DO concentrations in the bottom water for these estuaries ranged from 0.12 mg/L to 11.5 mg/L (average = 7.4 mg/L) (Hayslip et al. 2006). DO concentrations below about 2 mg/L can be stressful to estuarine organisms (USEPA 2000). Dissolved oxygen levels in Puget Sound vary seasonally, with lowest levels at depth during the summer, and highest levels near the surface during the winter. The main basin of the sound is generally stratified in the summer, due to river discharge and solar heating, and is often well mixed in the winter due to winter cooling and increased mixing by wind (Stout et al. 2001). Total dissolved inorganic nitrogen concentrations ranged from 0 to 2045 µg/L for estuaries in Oregon and Washington (average = 238 µg/L). Nitrogen values above 1000 µg/L are considered poor (USEPA 2004). Soluble phosphorus concentrations ranged from 0 to 106.5 µg/L (average = 51.3 µg/L) (Hayslip et al. 2006). Phosphorus values greater than 100 µg/L are considered poor (NOAA 1998).

Existing Nearshore Water Quality

The main difference between coastal areas and estuaries is the extent of mixing. Tidal and wave influences in the ocean and nearshore ocean environment continually mix the water column, preventing the stratification more common in calmer areas such as Puget Sound. Although water quality in the sound is rated "relatively good" (WDOE 2002) to fair (NEP 2007), proximity to urban areas, intensive agricultural land use, and major rivers create localized water quality problems, mostly in the southern portion.

Water resource issues of concern in nearshore areas, especially in Puget Sound, involve excess nutrients (eutrophication), low levels of dissolved oxygen, and fecal coliform (NOAA 1998, PSWQMP 2000, WDOE 2008a). In the Study Area, similar concerns have been noted for Crescent Harbor, Port Townsend Bay, and Hood Canal (NMFS 2008, USEPA 2008b). Locally high levels of urban runoff, treated effluent, and agriculture, coupled with lower levels of mixing and flushing, often cause and exacerbate these conditions. These conditions usually worsen in late summer when water temperature and salinity are highest, mixing of the water column lessens and, as a result, stratification increases. Most of the areas with these concerns are located in developed areas in South Puget Sound, that are several miles removed from specific activities or facilities included in this study (WDOE 2002).

Puget Sound

Puget Sound is a fjord-like estuary that extends southward 54 nm (100 km) to Commencement Bay (Cannon 1983) (Figure 3.4-3). The sound is a complex system of landmasses, interconnected channels, bays, and islands that covers approximately 900 square miles (2,330 km^2), including 2,300 miles of coastline (3,700 km). In general, the major geologic and topographic features of these areas were formed by tectonic activity, glacial advance and retreat, erosion, and deposition. South of Admiralty Inlet, depths range from 380 to 460 feet in the central part of the basin (100 to 140 m), and 30 to 330 feet (10 to 100 m) in the waterways west of Bainbridge and Vashon islands (NOAA and WDOE 1999, NMFS 2008). Important bottom features of the main basin are the sills at the northern and southern ends. The sill at the north end of Admiralty Inlet is over 18 miles wide (30 km) and is 215 feet below the surface (65 m) at its shallowest point. The sill at Tacoma Narrows is 150 feet below the surface (45 m). These sills tend to block the free movement of water between the two sides which can affect water conditions such as temperature, salinity, and nutrient availability (Burns 1985). Specific locations relevant to this EIS/OEIS include Crescent Harbor at Naval Air Station Whidbey Island (NASWI), Floral Point in Hood Canal near Naval Base Kitsap (NBK)-Bangor, and Port Townsend Bay.

Crescent Harbor

Seaplane Base is located on Crescent Harbor, an arch-shaped bay between Forbes Point and Polnell Point on Whidbey Island (Figure 3.4-3). Seaplane Base has approximately 10 miles (16 km) of shoreline, including man-made structures, depositional beach, high bank bluffs, and extensive freshwater and saltwater marshes. The bay itself varies from shallow subtidal flats to gently sloping areas 10 to 20 feet deep (3 to 6 m) to relatively deep water (80 ft/25 m) bordered by sandy beaches, mud flats, rocks and boulders, and reinforced shorelines (DoN 1996, 2000b).

Tidal currents are relatively low in Crescent Harbor, typically not exceeding 1.5 knots (80 cm per second). Wind-generated, longshore currents transport sediments from the south to the north along the eastern shore of the Maylor Peninsula. Surface water temperatures average 53ºF (12ºC) and salinity averages 20.4 ppt. Winds are an important driver of water circulation and transport. The prevailing direction near Whidbey Island is from the south or southwest in the fall and winter and from the west or northwest in spring and summer. Wind velocities are generally less than ten miles per hour (16 kph). A maximum fetch length – the distance that waves travel without obstruction – approaching Crescent Harbor from the south-southeast was 14 miles (23 km). Wave heights for Crescent Harbor range from 0 to 5 feet (0-1.5 m). Although water column profile data are not available, circulation and transport patterns suggest that waters in the bay are probably well mixed (NMFS 2008).

Water quality data, such as dissolved oxygen and fecal coliform, indicate that water quality in and around Crescent Harbor is fair. However, water testing has indicated that harbor waters are susceptible to low dissolved oxygen levels and that fecal coliform concentrations occasionally reach levels of concern. Samples indicate the presence of arsenic, lead, silver, cadmium, copper, and mercury in surface and subsurface sediments at levels at or above background concentrations, but well below sediment management standard (SMS) criteria. With the exception of PCB (polychlorinated biphenyls) Aroclor-1254, a polychlorinated biphenyl (PCB), concentrations of organic analytes were also relatively low and below the SMS criteria. Another survey indicated that one station near Crescent Harbor had an SMS exceedance for 4-methylphenol. Chemicals exceeding the SMS at stations within Oak Harbor (west of Crescent Harbor) included benzoic acid, 4-methylphenol, and phenol (NMFS 2008).

Hood Canal at NBK-Bangor

NBK-Bangor is located on Hood Canal, a fjord-like body of water approximately 60 miles long (100 km), between 0.5 to 1.25 miles wide (1 to 2 km), and 150 to 650 feet deep (45 to 200 m) (Figure 3.4-4). The base itself is part of the Puget Sound Lowland, a broad trough filled with unconsolidated sediments overlying volcanic bedrock. Water enters Hood Canal from Admiralty Inlet north of the base and like many of the other basins in the sound, Hood Canal is partially isolated by a sill 150 feet below the surface (45 m) near its entrance that limits the transport of deep marine waters in and out of the canal. Narrow shorelines slope gently until reaching the steep walls of the main channel (Burns 1985, NMFS 2008).

Tides are the dominant force establishing current flow in the Hood Canal region, averaging 1-1.5 knots (50-75 cm per second). Due to density and temperature differences, incoming colder saline waters are near the bottom and warmer estuarine waters are near the surface. The salinity of the upper surface layers ranges from 23 to 30 ppt. Water temperatures range between 45ºF (7.2°C) and 62ºF (16.7°C) (average = 51ºF [10.5°C]). Salinity and temperature in the lower layers of Hood Canal remain fairly constant throughout the year. The canal bounds 4.5 miles of NBK-Bangor to the west (NMFS 2008, 2002).

Hood Canal's relative physical isolation from the main Puget Sound basin (because of the sill at the north end) restricts water circulation in the canal, especially deeper waters. Overall, this isolation makes the canal prone to seasonal episodes of low dissolved oxygen (DO). DO concentrations range from 3.5 to 12.75 mg/L, with DO decreasing with depth and with a change of season from cooler to warmer months. Many marine organisms exhibit stress or avoidance behaviors at DO levels between 3 and 5 mg/L (NMFS 2008).

Hood Canal is classified "Class AA" with "water quality that markedly and uniformly exceeds the requirements for all or substantially all uses" (WDOE 1997). Problems related to low DO and eutrophication generally increase in a north-to-south direction and in proximity to development (Newton et al. 2007). Water quality samples collected in 2001 in the vicinity of the base show concentrations of cadmium, copper, lead, and zinc well below Washington water quality criteria (DoN 2002).

Port Townsend Bay

Offshore gradients in Port Townsend Bay are slight in most tidal zones, with steeper offshore slopes dropping to 100 feet (30 m) to the south and west. The bottom of the bay varies between 50 and 85 feet deep (15 to 25 m) and is relatively flat (NMFS 2008). Port Townsend Canal connects the south bay with Oak Bay and has a maintained water depth of 15 feet (4.5 m) (Figure 3.4-5).

As with much of Puget Sound, wind and waves are the primary drivers of water circulation and transport in Port Townsend Bay. Tidal currents are variable in the bay, but typically do not exceed 0.5 knots (25 cm per second). Surface water temperatures range from 43 to 68ºF (6 to 20^{o}C) and salinity within the bay ranges from 5 to 42 ppt (average = 30 ppt) (DoN 2000c). Water column stratification varies seasonally in areas of freshwater input. Lower salinity in surface water is observed during winter periods of high run-off. Results of monitoring suggest that the bay generally meets Washington state marine water quality standards for DO and temperatures, although it is susceptible to low DO levels in some areas (WDOE 2008b, Norris and Hutley 1997).

Port Townsend Bay is not listed as impaired by the Washington State Department of Ecology under Section 303(d) of the federal Clean Water Act, but Chimacum Creek, the bay's largest tributary, is listed as impaired because of elevated temperature and fecal coliform levels (WDOE 2008b). Chimacum Creek

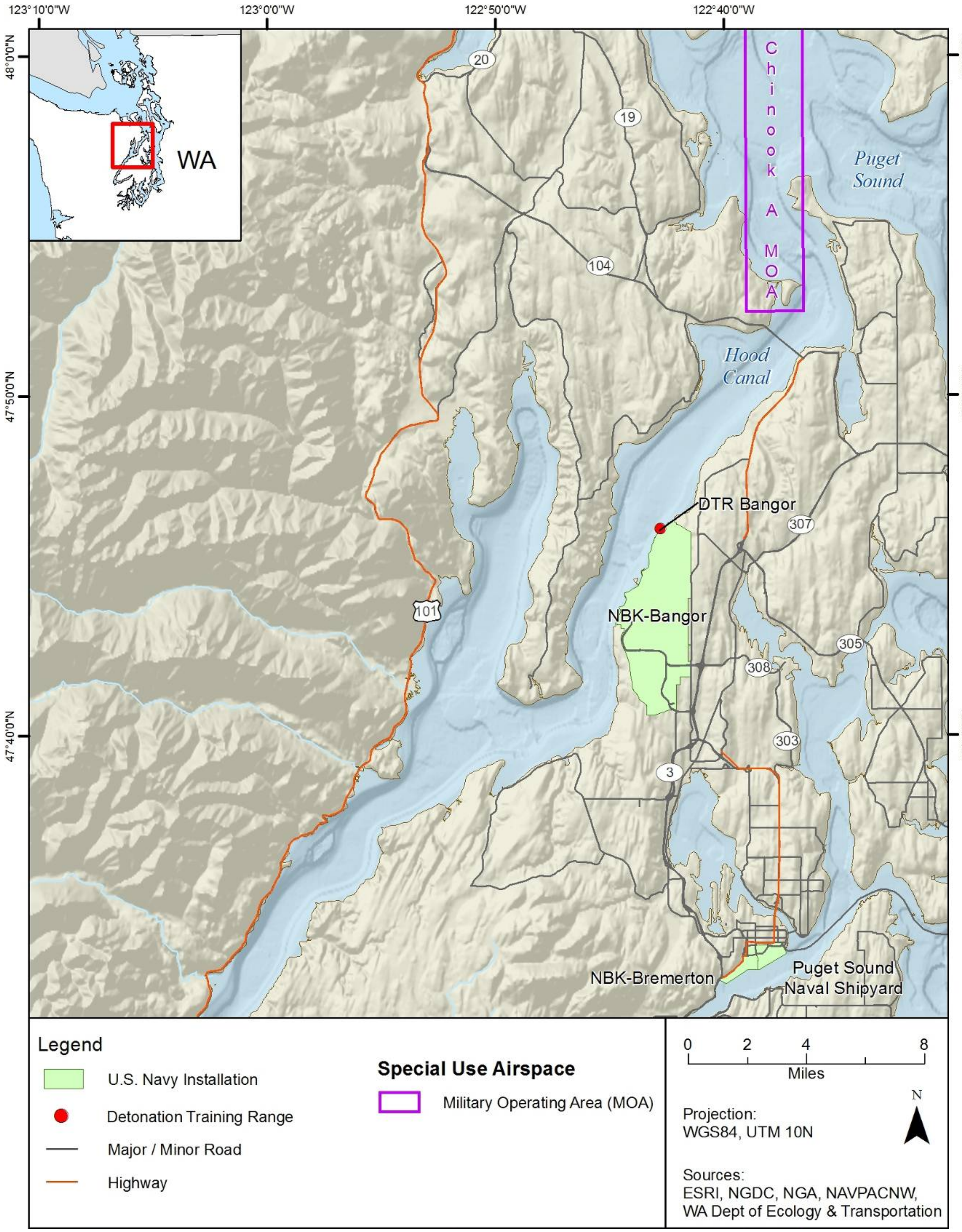

Figure 3.4-4: NBK-Bangor and Hood Canal

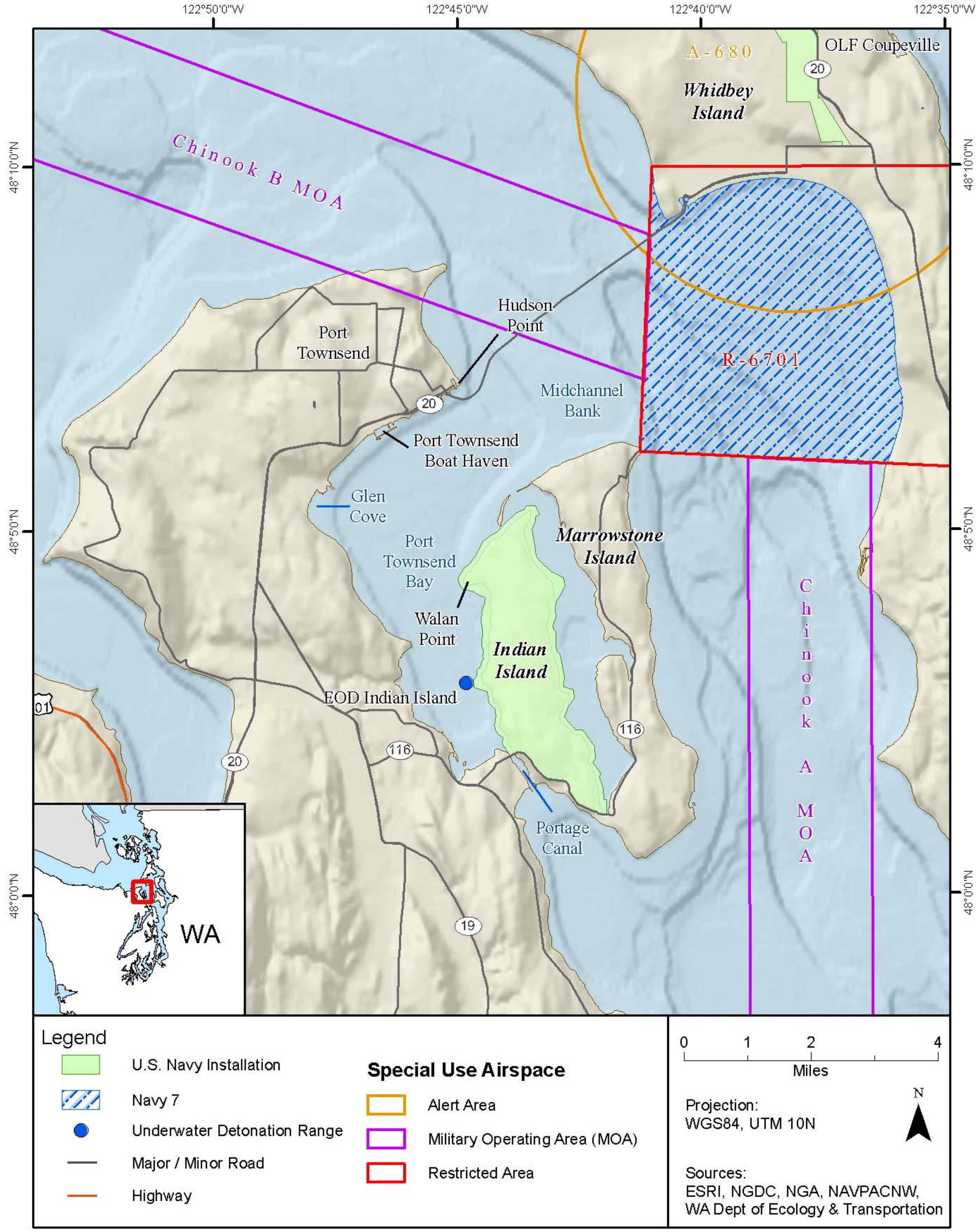

Figure 3.4-5: Indian Island and Surrounding Features

represents an important link between land use activities upstream and water quality in the bay (Norris and Hutley 1997). Threats to water quality in the bay include agriculture, logging, development, failing septic systems, and untreated storm water (NMFS 2008).

Nearshore Sediment Parameters

A major source for sediment along the coast in the Study Area is the Columbia River. The sediment is first deposited near the mouth of the river and then transported by tides and currents northward along the coast (Hickey and Banas 2003). These transported sediments make their way into regional bays and harbors along the coastline. Sediments in Puget Sound are composed primarily of compact, glacially-formed clay layers and relict glacial tills (Crandell et al. 1965). (Glacial till is unsorted, angular gravel, rock, and boulders deposited by glaciers and which is contained within powdery material.) Major sources of sediment in the sound are derived from shoreline erosion and river discharge. Sand and mud prevail in the eastern regions of the sound, while the shores of Vancouver Island and the complex formation of the Gulf Islands have prominent slopes composed of bedrock and boulders (Palsson et al. 2003).

Existing Nearshore Sediment Quality

Contaminated sediments are defined as soils, sand, organic matter, or minerals that accumulate on the bottom of a water body and that contain toxic or hazardous materials that may adversely affect human health or the environment (USEPA 1998). Common sediment contaminants include hydrocarbons, such as halogenated pesticides (e.g., DDT); polychlorinated biphenyls (PCBs); polycyclic aromatic hydrocarbons (PAHs) associated with petroleum products; and heavy metals, such as iron, zinc, copper, lead, and mercury (Hameedi et al. 2002). These materials tend to bind to sediments, particularly very small, organic particles (less than 0.63 micrograms [µg]). Conversely, organic-rich particles bind some contaminants so strongly that the threat to organisms are greatly reduced (NEP 2007). Because many of the organisms at the base of the food chain live and eat in sediments, they can accumulate these materials in their bodies. Once ingested by larger organisms, the contamination moves up through the food chain, and becomes progressively more concentrated ("bioaccumulation"), threatening the health of marine wildlife and people (PSWQMP 2000).

Sediment quality in Puget Sound is rated poor (NEP 2007). Ratings are based on a composite index of three components – sediment toxicity, sediment contaminant concentrations, and the sediment total organic carbon (TOC) concentration. Although Puget Sound rated good for contaminant concentrations and TOC, very low scores at two locations in the sediment toxicity component of the index generated the overall poor rating. As of 1999, the Washington State Department of Ecology (WDOE) had compiled sufficient data to characterize more than 15,000 acres (60 km^2) of Puget Sound's urban embayments. According to WDOE records, 38 percent of this area, or 5,750 acres (25 km^2), was identified as contaminated above the state's sediment quality standards, although contaminants in some areas are declining (PSWQMP 2000). Two other estuaries in the Study Area were included in the NEP analysis of estuary health – Tillamook Bay (good) and the Columbia River (fair) (NEP 2007).

Crescent Harbor

Crescent Harbor was used by the military for torpedo testing and seaplane landing and take-off practice during WWII and for practice drops of inert bombs, mines, and smoke lights from 1951 to 1961. Quantities for the latter are unknown and no clearance operation is planned (DoN 2007). As part of a remedial investigation study conducted at NASWI, sediment samples were collected along the north shoreline of Crescent Harbor. Results indicated the presence of arsenic (12 µg/L), chromium (92.6 µg/L), lead (146 µg/L), and zinc (260 µg/L) at levels at or above background concentrations, but below Washington's sediment management standard (SMS) criteria. Levels of PCBs and 4-methylphenol exceeded SMS criteria. In addition, 1,2-dichloroethane, methylene chloride, benzo(a)anthracene, DDD (dichloro-diphenyl-dichloroethane) DDE (dichloro-diphenyldichloro-ethylene), and DDT (dichloro-diphenyl-trichloroethane) were also detected, but at very low levels (NMFS 2008).

Hood Canal at Naval Base Kitsap-Bangor

No exceedances of Washington state sediment quality standards (SQS) or sediment clean-up screening levels (CSL) guidelines have been reported at monitoring areas north of NBK-Bangor (WDOE 2008b). On the other hand, another study of marine sediments at NBK-Bangor found several exceedances for copper, mercury, lead, PAHs, phenols, and phthalates. Activities near several of the wharf and pier areas, including terrestrial sites that discharge to Hood Canal, have contributed to locally elevated concentrations of several inorganic and organic compounds (NMFS 2008).

EOD Indian Island

Laboratory analyses of sediment samples taken between 1989 and 1995 detected arsenic and bis (2-ethyhexyl) phthalate above SQS limits. Other sediments collected from the bay have shown detectable levels of arsenic (6.52 parts per million [ppm]), copper (33.6 ppm), and zinc (67.4 ppm). Several reference sediment samples collected near the explosive ordnance disposal (EOD) test site in Port Townsend Bay suggested relatively uncontaminated sediments (NMFS 2008).

3.4.1.3 Freshwater Resources

The discussion of freshwater resources in the Study Area is categorized by surface water, groundwater, and drinking water. Approximately 80 percent of annual precipitation falls during October through May, although local totals vary widely, ranging from 19 inches (48 cm) at Port Townsend on the west side of Puget Sound to 50 inches (130 cm) at Bremerton (NMFS 2008).

Surface Water

Surface water includes natural features like lakes, ponds, rivers, streams, and freshwater wetlands, as well as man-made impoundments and ditches, especially those that conduct and retain surface runoff and wastewater for treatment. Surface water resources in the Study Area are dominated by streams and rivers. The quality of existing surface water resources is often related to proximity to development. In general, more than half of the Puget Sound river stations monitored routinely for fecal coliform bacteria violate state standards. However, bacterial contamination in those rivers varies considerably year to year (PSAT 2000).

Crescent Harbor

No significant rivers or streams occur on Whidbey Island. Natural surface water systems are present in all areas except Outlying Landing Field (OLF) Coupeville. Island streams tend to be small, shallow coastal tributaries with densely vegetated riparian zones. Freshwater and saltwater wetlands comprise more than 14 percent of the area of Seaplane Base. Restoration of Crescent Harbor Marsh has been assisted by reinstituting tidal flows, and Penfold Pond was created to further augment wetland habitat on the base. Available data for the water quality parameters, dissolved oxygen, and turbidity indicate generally good water quality in the area (DoN 1996).

Floral Point at Hood Canal

There are nine major river systems entering Hood Canal, three in the northern Hood Canal: 1) the Big and Little Quilcene rivers; 2) the Dosewallips River; and 3) the Duckabush River, all on the west side of the canal (DoN 2002). Other freshwater inputs include groundwater, stormwater sewer outfalls, and many other small streams. Salt- and freshwater mixing zones exist at the mouths of each of these streams (NMFS 2008).

NBK-Bangor has four lakes and three marshes that provide storm water control, outdoor recreation opportunities, and fish and wildlife habitat. Freshwater inflow to Hood Canal from the base is dominated by five small streams, three of which flow through Cattail Lake, Hunter's Marsh, and Devils Hole Lake. Overland flow comes from much of the western portion of the base and is routed to Hood Canal through a series of storm water outfalls (DoN 2001). A prior environmental document identified 15 small streams affected by the base (NMFS 2008). Stream flows ranged from a minimum of 0.01 cubic feet per second (cfs) to a maximum of 4 cfs from drainage areas ranging from 0.03 to 3.68 square miles. NBK-Bangor has a storm water management pollution prevention plan. Water testing indicates current permit compliance (DoN 2001).

Port Townsend Bay

Chimacun Creek is the primary input of freshwater into Townsend Bay and a mixing zone exists at the mouth of this tributary. There are no notable natural surface water bodies on Indian Island (NMFS 2008).

Man-made Surface Water Systems

Systems of ditches, storm drains, and detention ponds direct surface runoff at Crescent Harbor and Hood Canal at NBK-Bangor. Some are associated with natural and man-made impoundments; all eventually flow into freshwater or saltwater wetlands. For instance, the 17-acre pond (0.07 km^2) at Seaplane Base discharges effluent into Crescent Harbor (DoN 1996, 2000c, and 2001).

Groundwater Resources

Groundwater is water that collects or flows below the surface of the land. It originates as rain and snowmelt that percolates below the surface and fills the spaces between soil, sediments, and rock. Depending on the nature of the material, groundwater may be essentially stationary, move very slowly, or it may move fairly rapidly. The material through which groundwater moves may also affects its quality. An aquifer is a groundwater source that yields useable amounts of water. Groundwater may connect with the Earth's surface as springs and seeps, or it may exit into local freshwater streams or lakes, nearshore areas, or into the ocean. Concerns with these aquifers involve potential contamination coupled with their use for drinking water and the potential movement of contaminated groundwater into Puget Sound or the Pacific Ocean. Of the groundwater issues of concern in the Study Area – seawater intrusion and contamination – only contamination is relevant to the Proposed Action.

Drinking Water Resources

In the Study Area, drinking water is available for public water supplies from both surface and groundwater sources.

The City of Oak Harbor, west of Seaplane Base on Whidbey Island, operates the largest municipal water supply system in Island County. The water is supplied by two pipelines from the town of Anacortes at the north end of the island. The system also supplies water to NASWI. All other residents on Whidbey Island depend on groundwater for drinking water. A small groundwater well serves personnel working at OLF Coupeville. Water quality data is not available for this well (DoN 1996, Island County 1998). NBK-Bangor utilizes 40 million gallons per month. The system is managed by the Public Works Department which operates and maintains four Navy-owned wells, two water towers, and two underground storage tanks (DoN 2001).

Groundwater as Drinking Water

Drinking water aquifers have been identified at Seaplane Base and OLF Coupeville on Whidbey Island (Jones 1985) and at NBK-Bangor (DoN 2001). The Washington State Department of Ecology has designated the Whidbey Island groundwater supply as a "sole source aquifer" and has also designated Island County – Whidbey Island and Camano Island – as a high priority groundwater management area.

Section 1424(e) of the Safe Drinking Water Act authorizes USEPA to designate aquifers as the principal source of drinking water for a designated area and, if that aquifer becomes contaminated, it would create a significant hazard to public health. This designation means that all federal projects proposed in the designated area are subject to USEPA review to ensure that they do not create a significant hazard to public health. At OLF Coupeville, groundwater wells range from 40 to 120 feet (12 to 60 m) below the surface. Although water quality is considered good, the amount of available water is limited. Deeper aquifers generally suffer from saltwater intrusion, and there are indications of isolated nitrate contamination in some of the smaller aquifers (DoN 1996). NASWI does not withdraw significant amounts of groundwater. Three distinct aquifer systems have been identified at NBK-Bangor. They have been designated, in order of increasing depth, the perched aquifer, shallow aquifer, and sea level aquifer. An intermediate groundwater zone has also been identified within the Kitsap Formation. Aquifer water levels are monitored quarterly while wells along the shoreline are also being monitored for sea water intrusion (DoN 2001).

3.4.1.4 Current Requirements and Practices

Environmental compliance policies and procedures related to ocean and nearshore water quality are regulated by federal and state programs discussed in more detail in the next section. In addition, the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) prohibits certain discharges of oil, garbage, and other substances from vessels. The MARPOL convention is implemented by national legislation, including the Act to Prevent Pollution from Ships (33 USC 1901, et seq.) and the Federal Water Pollution Control Act ("Clean Water Act"; 33 USC 1321, et seq.). For the Navy, these and other requirements are implemented by the *Navy Environmental and Natural Resources Program Manual* (OPNAVINST 5090.1C, 2007) and related Navy guidance documents governing waste management, pollution prevention, and recycling. Measures that reduce potential impacts to water resources include creation and adherence to storm water management plans, erosion control, maintaining vegetative buffers adjacent to waterways, and enforcement of pollution permit requirements under the National Pollution Discharge Elimination System (NPDES; 33 USC 1342).

At sea, Navy vessels are required to operate in a manner that minimizes or eliminates any adverse impacts to the marine environment. Environmental compliance policies and procedures applicable to shipboard activities afloat are defined in the *Navy Environmental and Natural Resources Program Manual* (OPNAVINST 5090.1C, 2007), Chapter 4, "Pollution Prevention," and Chapter 22, "Environmental Compliance Afloat"; DoD Instruction 5000.2-R (§C5.2.3.5.10.8, "Pollution Prevention") (DoN 2003). In addition, provisions in Executive Order (EO) 12856, *Federal Compliance With Right-To-Know Laws and Pollution Prevention Requirements*, and EO 13101, *Greening the Government through Waste Prevention, Recycling, and Federal Acquisition*, reinforce the CWA's prohibition against discharge of harmful quantities of hazardous substances into U.S. waters out to 200 nm (371 km), and mandate stringent hazardous waste discharge, storage, dumping, and pollution prevention requirements. Table 3.4-1 below provides information on current Navy requirements and protective measures for shipboard management, storage, and discharge of hazardous materials and wastes, and on other measures intended to protect water quality.

Shipboard waste-handling procedures governing the discharge of non-hazardous waste streams have been established for commercial and Navy vessels. These categories of wastes include solids (garbage) and liquids such as "black water" (sewage), "grey water" (water from deck drains, showers, dishwashers, laundries, etc.), and oily wastes (oil-water mixtures). Table 3.4-1 summarizes the waste stream discharge restrictions for Navy vessels at sea. Onshore policies and procedures related to spills of oil and hazardous materials are detailed in OPNAVISNT 5090.1C, Chapter 12. These are discussed in more detail in Chapter 5.

Table 3.4-1: Waste Discharge Restrictions for Navy Vessels

Zone (nm from shore)	Type of Waste	
	Black Water (Sewage)	**Gray Water**
U.S. Waters (0-3 nm)	No discharge.	If vessel is equipped to collect gray water, pump out when in port. If no collection capability exists, direct discharge permitted.
U.S. Contiguous Zone (3-12 nm)	Direct discharge permitted.	Direct discharge permitted.
>12 nm from shore	Direct discharge permitted.	Direct discharge permitted.
Zone	**Oily Waste**	**Garbage (Non-plastic)**
U.S. Waters (0-3 nm)	Discharge allowed if waste has no visible sheen. If equipped with Oil Content Monitor (OCM), discharge < 15 ppm oil.	No discharge.
U.S. Contiguous Zone (3-12 nm)	Same as 0-3 nm.	Pulped garbage may be discharged.
>12 nm from shore	If equipped with OCM, discharge < 15 ppm oil. Vessels with Oil/Water Separator but no OCM must process all bilge water through the oil-water separator.	Direct discharge permitted.
Zone	**Garbage (Plastic) (Non-food-contaminated)**	**Garbage (Plastic) (food-contaminated)**
U.S. Waters (0-3 nm)	No discharge.	No discharge.
U.S. Contiguous Zone (3-12 nm)	No discharge.	No discharge.
12-50 nm from shore	No discharge.	No discharge.
> 50 nm from shore	Retain last 20 days before return to port. Discharge if necessary.	Retain last three days before return to port. Discharge if necessary.

Source: Northern Division 1996; Office of the Chief of Naval Operations 1994

3.4.2 Environmental Consequences

Freshwater and marine ecosystems in the NWTRC Study Area developed around and are sustained by the chemical, physical, and biological processes as well as the seasonal patterns in each environment. The health of these systems is monitored and protected by a variety of federal, state, and local laws, programs, and policies. The discussion begins with a review of the legal and regulatory framework in which the Proposed Action would occur, the standards against which potential impacts are judged and, thereafter, an analysis of potential impacts under various alternatives.

3.4.2.1 Approach to Analysis

Regulatory Requirements – Federal

The principal federal laws protecting water quality are the Federal Water Pollution Control Act, more commonly known as the Clean Water Act (CWA; 33 USC 1251, et seq.) and the Safe Drinking Water Act (42 USC 300f, et seq.). Both are enforced by the USEPA and various state government agencies. In addition, the National Oceanic and Atmospheric Administration (NOAA; U.S. Department of Commerce) oversees coastal and marine water resources under CWA, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Coastal Zone Management Act, and the Oil Pollution Act (marine oil spills). NOAA also has responsibilities in managing and protecting coastal and marine habitats (and species) through the National Marine Fisheries Service.

Clean Water Act

The goal of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters, including coastal and marine waters. Various CWA sections govern point sources and nonpoint sources of pollution. Point sources include industrial and publicly-owned facilities, such as those for wastewater treatment (CWA §402). Discharges from point sources require NPDES permits. In contrast, nonpoint source pollution is indirect or widespread and generally cannot be traced to a single source. It arises as precipitation and snowmelt move across the land, picking up natural and man-made materials such as sediments, salts, and oils carried in urban stormwater runoff, and fertilizers and pesticides from agricultural lands. CWA §319 established the federal nonpoint source management program that involves identifying water bodies impacted by nonpoint pollution ("impaired waters"; CWA §303[d]), instituting best management practices, and developing water quality standards for such streams ("total maximum daily loads" [TMDL]). Most of these activities are conducted at the state level.

CWA also created Uniform National Discharge Standards that regulate incidental liquid discharges from military vessels operating in inland waters and the ocean out to 12 nautical miles. This program is jointly administered by the Department of Defense, USEPA, and the U.S. Coast Guard. A total of 25 vessel discharges requiring control standards have been identified under Phase I of the program (UNDS 2008). Phase II involves developing performance standards and control procedures for those discharges. The program also established processes that USEPA and the states must follow to establish zones in which any release of a specified discharge is prohibited. At this writing, no such zones have been designated within the NWTRC Study Area (USEPA 2008c).

Safe Drinking Water Act

Under the Safe Drinking Water Act, USEPA is responsible for setting standards for drinking water supplies, both surface and groundwater sources. USEPA also oversees the state and local government and private water suppliers that implement those standards. Provisions in the act apply to military facilities and activities. Relevant to this study are provisions in the act to protect sources of drinking water, including sole source aquifer and wellhead protection areas.

Coastal Zone Management Act

The federal Coastal Zone Management Act (CZMA; 16 USC 1451, et seq.) is a voluntary state-federal partnership that encourages states to adopt programs that meet federal goals of protecting and restoring coastal zone resources, especially protecting coastal waters from nonpoint source pollution (16 USC 1455[b]). The program is administered by NOAA. The act requires participating coastal states to develop management programs that demonstrate how states will carry out their obligations and responsibilities in managing their coastal areas. Upon federal approval of a state's coastal zone management program, the state becomes eligible for coastal grants and gains review authority over certain federal activities in the coastal zone. CZMA specifically excludes federal lands from state designation. For this study, NBK-Bangor and NASWI are excluded. However, federal consistency requirements in the act (Section 307) require that federal activities be consistent with the management program to the "maximum extent practicable."

Regulatory Requirements – State and Local

Washington

Water Quality and Pollution Standards

The Washington State Department of Ecology (WDOE) regulates water pollution control activities in the state (Chapter 90.48, Revised Code of Washington [RCW]). The department also jointly regulates water quality in Puget Sound with the Puget Sound Action Team (Chapter 90.71, RCW). The Puget Sound Water Quality Management Plan calls for the preparation and implementation of watershed action plans to control and prevent nonpoint source pollution and to protect the beneficial uses of water. The plan also serves as the federally-approved Comprehensive Conservation and Management Plan for Puget Sound under CWA §320, the National Estuary Program. (See also, Puget Sound Water Quality Protection Act 1996 [Chapter 90.71, RCW].)

Sediment Management Standards

Washington has established sediment management standards that consist of two sets of numeric chemical criteria that apply to Puget Sound marine sediments.

- A "no effects" level is used as a sediment quality goal, and is often referred to as sediment quality standards (SQS; Washington Annotated Code [WAC] 172-204-320).
- A "minor adverse effects" level is used as an upper regulatory level for source control and cleanup decision-making. This level is codified as the "Sediment Impact Zone Maximum Level" (WAC 173-204-420) and the "Sediment Cleanup Screening Level/Minimum Cleanup Level" (WAC 173-204-520).

Coastal Zone Management

WDOE also administers the state's coastal zone management program under CZMA. Washington's program applies to the 15 coastal counties that front on saltwater. These counties include a significant portion of the land in the Study Area. Six laws comprise the state's program: 1) Shoreline Management Act of 1971 (Chapter 90.58, RCW), including local government shoreline master programs; 2) the state Environmental Policy Act (Chapter 43.21c, RCW); 3) state responsibilities under the federal Clean Air Act; 4) state responsibilities under CWA; 5) the Energy Facility Site Evaluation Council Law (Chapter 80.50, RCW); and 6) the Ocean Resource Management Act (Chapter 43.143, RCW). Much of the enforcement of these coastal management activities is delegated to local governments.

Aquatic Habitats of Concern

State law identifies saltwater habitat of concern, such as eelgrass beds and intertidal wetlands (Washington Annotated Code [WAC] 220-110-250) and restricts times during which work can be conducted in saltwater areas to accommodate fish migration and breeding (WAC 220-110-271). The state's "Wild Salmonid Policy" also seeks to preserve migrating salmonid populations (WDFW 1997).

Safe Drinking Water

Washington's State Department of Health is the regulating agency for safe drinking water.

Oregon

Water Quality and Pollution Control

Oregon's Department of Environmental Quality regulates water pollution control and drinking water supplies for both surface and groundwater sources. For groundwater quality protection, see Oregon Administrative Rules (OAR) Chapter 340, Division 40. For water quality standards and beneficial uses, see OAR 340-41.

Coastal Zone Management

The Department of Land Conservation and Development administers Oregon's coastal zone management plan under the state's Land Use Planning Act, including the state's Ocean Resources Management Plan ("Ocean Plan"; ORS 196.405, et seq.; see also OAR 660-035, et seq.). The department sets specific protection and management goals for estuaries, coastal shorelands, beaches, and ocean resources. Local governments are required to develop plans in coordination with these goals. Although the department does not have regulatory authority, it has a large coordination role through federal consistency requirements under CZMA and local government planning requirements.

California

Water Quality and Pollution Control

In California, water quality is governed by the State Water Resources Control Board and nine regional water quality control boards, including point and nonpoint source pollution provisions of the federal Clean Water Act, and groundwater and surface waters within the three-mile state jurisdictional limit (California Water Code–Division 7, §13000, et seq.).

The state board adopted the Ocean Waters of California Water Quality Control Plan – the "Ocean Plan" – in 2005. This plan established beneficial uses and water quality objectives for waters of the Pacific Ocean adjacent to the California coast outside of enclosed bays, estuaries, and coastal lagoons. The plan also identifies "Areas of Special Biological Significance" that are approved by the state board. Within the NWTRC Study Area, these areas include Trinidad Head Kelp Beds (#6), Kings Range National Conservation Area (#7), and Redwoods National Park (#8) (Figure 3.4-6). Trinidad Head Kelp Beds is 2 miles long (3 km) and has 297 acres of marine water (1.2 km^2). Kings Range National Conservation Area is 33 miles long (53 km) with 25,055 acres of marine water (100 km^2). Redwoods National Park area has 36 miles of coastline (58 km) and includes 62,643 acres of marine water (255 km^2) (SWRCB 2008).

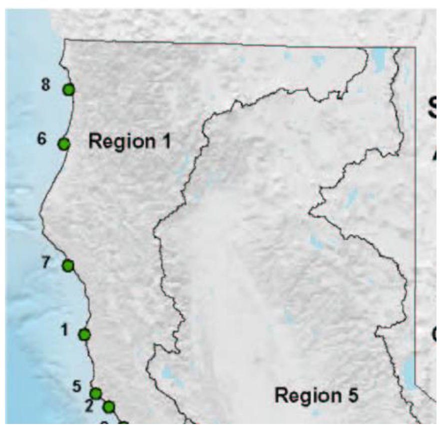

Figure 3.4-6: Areas of Special Biological Significance

Coastal Zone Management

The California Coastal Act (CCA) defines the coastal zone as the area of the state which extends three miles seaward and (generally) about 1,000 yards inland (915 m). The act also sets forth specific uses that may be permitted in the coastal zone, provides for additional review and approvals for proposed actions, and directs local governments within the coastal zone to prepare a "local coastal program" for certification. CCA activities are overseen by the California Coastal Commission (California Public Resources Code §30000, et seq.). Under the California Ocean Resources Management Program, the California Resources Agency is charged with comprehensive management and stewardship of the state's ocean resource, including review of oil and gas development on the continental shelf and coordination of resources management in the exclusive economic zone (California Public Resources Code §36000, et seq.).

California- DoD Coordination

For onshore military facilities, the Defense and State Memorandum of Agreement among the state board, the regional boards, and DoD defines the division of responsibilities for addressing water quality issues.

Study Area

The Study Area for the analysis of water resources is aquatic habitat in marine operating areas in the Pacific Ocean and the mine countermeasure training areas within Puget Sound, specifically at Crescent Harbor Underwater EOD Range, Floral Point Underwater EOD Range, and Indian Island Underwater EOD Range. Aircraft overflight and training activities are assumed to have no impacts on water resources. Therefore, the military operating areas (MOAs) over the Olympic Peninsula, R-6701, as well as Okanagan and Roosevelt MOAs over northeastern Washington are excluded from further analysis in this section.

Sources of Information

A systematic review of relevant literature was conducted to complete this analysis of water resources in the Study Area, including journals, technical reports published by government agencies, work conducted by private businesses and consulting firms, and Department of Defense reports, operational manuals, natural resource management plans, and current and prior environmental documents for facilities and activities in the NWTRC Study Area. The literature and other information sources cited are identified in Chapter 9, References.

Methods

Activities under the Proposed Action that may affect water resources are those materials expended during training that may affect water and sediment quality, such as petroleum products, heavy metals, and combustion byproducts. Factors considered in evaluating impacts on marine water and sediment quality include the extent or degree to which:

- deposition of expended training materials would directly affect bottom sediment quality or indirectly affect water quality;
- concentrations of potentially hazardous materials produced by the alternative exceed established standards or violate existing laws or regulations; or
- the alternative would affect existing or future beneficial uses of existing water resources.

Significant impacts are those that violate: 1) established water quality standards; or 2) established sediment quality standards. In terms of water quality, standards are based on the proposed use for the water, its so-called “designated use.” For example, water for drinking must be of a higher quality than water used for irrigating a golf course or water used to control dust at a construction site. Once the water’s designated use is established, criteria are established to protect the water at the desired level of quality. For the NWTRC Study Area, designated uses are those for marine water in Puget Sound. These include aquatic life, shellfish harvest, recreation (primary and secondary contact), and miscellaneous uses, such as wildlife, harvesting, navigation, boating, and aesthetics.

Within the Study Area, the USEPA has established saltwater quality guidelines (USEPA 2006). These standards would apply in Puget Sound and within the three nautical mile limit. Otherwise, state standards apply. The State of Washington has water quality standards for Puget Sound, as well as sediment standards. Because activities under the alternatives would occur beyond the three nautical mile limit for Oregon and California, no further review of water resource issues for those states is conducted.

3.4.2.2 No Action Alternative

This section analyzes the circumstances under which water quality in the Study Area may be degraded by physical materials expended during training or the by-products of explosions during training. Since none of the activities under the Proposed Action would affect fresh water or groundwater, no further analysis will be conducted for those resources. The types and amounts of materials expended in the Study Area are presented in Table 3.4-2.

In terms of potential impacts to water resources, the types of materials expended can be categorized in three ways: 1) heavy metals, 2) chemicals, and 3) explosives. A particular training material may contain components from one of these categories, such as ordnance with a lead core, or they may contain more than one, such as a missile with a variety of metals in its housing and electronics, solid fuel propellant, and an explosive warhead. The following discussion contains examples of these materials, the training materials they are found in, and the activities in which they are used.

Heavy metals. Some metals are necessary for biological organisms to function properly, such as iron, zinc, copper, and manganese in humans. Heavy metals commonly noted for concern include lead, cadmium, mercury, and chromium, but zinc, copper, and manganese may also be noted when exposure levels are too high. In the NWTRC Study Area, heavy metals are present in vessels, manned and unmanned aircraft, bombs, shells, missiles, bullets, sonobuoys, batteries, electronic components, and as anti-corrosion compounds coating exterior surfaces (e.g., missiles, vessels).

Chemicals. Hazardous chemicals include fuels and other propellants, and combustion byproducts of those fuels and propellants (for details see Section 3.3 Hazardous Materials). These materials are present or may become present from the use of aircraft, vessels, and self-propelled machines such as torpedoes, High Speed Maneuverable Surface Targets (HSMSTs), Expendable Mobile ASW Training Targets (EMATTs), and unmanned aerial vehicles. Batteries within these machines may also contain hazardous chemicals, as do smoke canisters and marine markers. Toxic components of fuel oils include aromatic hydrocarbons such as benzene, toluene, xylene, and polycyclic aromatic hydrocarbons (PAHs) such as naphthalene, acenaphthene, and fluoranthene. Examples of shipboard materials necessary for normal operations and maintenance include lubricants and hydraulic fluids, paint, solvents, corrosion inhibitors, adhesives, coolants, and cleaning compounds. Like commercial and recreational watercraft, boat engines discharge petroleum products in their wet exhaust.

Explosives. Explosives are contained in live bombs, missiles, torpedoes, and sonobuoys. Most new military explosives are mixtures of plastic or other polymer binders and RDX (Royal Demolition Explosive, cyclotrimethylene trinitramine) and HMX (High Melting Explosive, cyclotetramethylene tetranitramine) (Janes 2005, 2006). PETN (pentaerythritol tetranitrate) is used in blasting caps, detonation cord, and similar initiators of explosions. When functioning properly, 99.997 percent of the explosive is converted to inorganic compounds (Renner and Short 1980, USACE 2003).

Nonhazardous expended materials are defined as parts of a device that are made of nonreactive materials, including parts made of non-toxic metals (e.g., steel, iron, aluminum); polymers (e.g., nylon, rubber, vinyl, and various other plastics); as well as glass, fiber, and concrete. Sources of these materials include inert bombs, inert shells, and targets. While these items represent persistent seabed litter, their strong resistance to degradation and their chemical composition mean that they do not chemically contaminate the surrounding environment by leaching heavy metals or organic compounds. Most of these objects will settle to the bottom where they will lodge in deep sediments, eventually be covered by sediment, encrusted by chemical processes (e.g., rust), or covered by marine organisms (e.g., coral). Therefore, these materials are not subject to further analysis. These non-hazardous materials may cause other concerns that are discussed in other sections, such as benthic communities (Section 3.6), sea turtles (Section 3.8), or marine mammals (Section 3.9).

Table 3.4-2: Number of Activities or Expended Training Items – All Alternatives

Warfare Area and Location(s)	Platform	Training Item	Heavy Metals	Chemicals	Explosives	No Action Alternative	Alternative 1	% Change	Alternative 2	% Change
Air Combat Maneuvers (ACM) All MOAs/ATCAAs, W-237	EA-6B, F/A-18, F/16, EA-18G (future), and support aircraft	a/ b/								
Air-to-Air Missile Exercise (A-A MEX) [c/] W-237	EA/18G	Tactical air launched decoy (TALD, not recovered)	✓			0	11	–	22	–
		LUU-2B/B flare (not recovered)		✓		0	6	–	11	–
		AIM-7 Sparrow missile	✓	✓	✓	0	6	–	13	–
		AIM-9 Sidewinder missile	✓	✓	✓	0	5	–	9	–
		AIM-120 AMRAAM missile	✓	✓	✓	0	4	–	7	–
Surface-to-Air Gunnery Exercise [c/] **(S-A GUNEX)** W-237, PACNW OPAREA	DDG, FFG, AOE	Naval 5-inch 54 BLP gun		✓	✓	136	151	11.0	303	122.8
		20 mm cannon shells (CIWS)	✓			7,200	8,000	11.1	16,000	122.2
		7.62 mm shells				1,224	1,360	11.1	2,720	122.2
		TDU-34 towed target				72	80	11.1	160	122.2
Surface-to-Air Missile Exercise [c/] **(SAMEX)** W-237, PACNW OPAREA	P-3C, Learjet or C-130 (support), CVN	NATO Seasparrow missile	✓	✓	✓	0	0	0.0	8	–
		BQM-74E target	✓	✓		0	0	0.0	16	–
Surface-to-Surface Gunnery Exercise [c/] **(S-S GUNEX)** W-237, PACNW OPAREA	CVN, DDG (and Canadian DDH), FFH (and Canadian FFH), AOE	5-inch/54 cal inert				1,716	2,351	37.0	3,463	101.8
		57 mm shells				630	700	11.1	1,260	100.0
		76 mm shells				560	800	11.1	1,120	100.0
		25 mm cannon shells				15,750	17,500	11.1	31,500	100.0
		.50 cal rounds				58,500	65,000	11.1	117,000	100.0
		High speed maneuverable surface target (HSMST)		✓		0	5	–	9	–
		Trimaran target				0	11	–	20	–
		SPAR target				0	17	–	31	–
		Killer Tomato (FAST) target				60	67	11.7	120	100.0

Table 3.4-2: Number of Activities or Expended Training Items – All Alternatives (cont'd)

Warfare Area and Location(s)	Platform	Training Item	Heavy Metals	Chemicals	Explosives	No Action Alternative	Alternative 1	% Change	Alternative 2	% Change
Air-to-Surface Bombing Exercise (BOMB A-S) W-237, PACNW OPAREA	P-3 P-8 (future)	MK-82 live HE bomb (500 lb., 192 NEW*)		✓	✓	8	10	25.0	10	25.0
		MK-82 inert bomb (BDU-45)				88	110	25.0	110	25.0
		MK-58 marine marker		✓		8	10	25.8	10	25.0
Sink Exercise (SINKEX) W-237, PACNW OPAREA	E-2, FA-18, P-3, SH-60B P-8 (future)	MK-82 live bomb (500 lb., 192 NEW)		✓	✓	4	8	100.0	8	100.0
		MK-83 live bomb (1,000 lb., 416 NEW)		✓	✓	4	8	100.0	8	100.0
		MK-84 live bomb (2,000 lb., 945 NEW)		✓	✓	4	8	100.0	8	100.0
		AGM-88 HARM missile	✓	✓	✓	2	4	100.0	4	100.0
		AGM-114 Hellfire missile	✓	✓	✓	1	2	100.0	2	100.0
		AGM-65 Maverick missile	✓	✓	✓	3	6	100.0	6	100.0
	CG, DDG, FFG, SSN (support)	AGM-84 Harpoon missile	✓	✓	✓	3	6	100.0	6	100.0
		SLAM ER missile	✓	✓	✓	1	2	100.0	2	100.0
		5-inch/62 mm shells				500	1,000	100.0	1,000	100.0
		76 mm shells				200	400	100.0	400	100.0
		MK-48 ADCAP torpedo	✓	✓	✓	1	2	100.0	2	100.0
		Decommissioned vessel				1	2	100.0	2	100.0
Antisubmarine Warfare Tracking Exercise (ASW TRACKEX – MPA) W-237, PACNW OPAREA	P-3 P-8 (future)	MK-39 EMATT (expendable mobile ASW training target)	✓	✓	✓	25	26	4.0	26	4.0
		SSQ-36 BT passive sonobuoy	✓	✓	✓	288	295	2.4	302	4.9
		SSQ-53 DIFAR passive sonobuoy	✓	✓	✓	7,283	7,503	3.0	7,661	5.2
		SSQ-62 DICASS active sonobuoy	✓	✓	✓	844	865	2.5	886	5.1

Table 3.4-2: Number of Activities or Expended Training Items – All Alternatives (cont'd)

Warfare Area and Location(s)	Platform	Training Item	Heavy Metals	Chemicals	Explosives	No Action Alternative	Alternative 1	% Change	Alternative 2	% Change
ASW TRACKEX – MPA (cont'd)		SSQ-77 VLAD passive sonobuoy	✓	✓	✓	593	623	5.1	653	10.1
		MK-58 marine marker		✓		200	205	2.5	210	
ASW Tracking Exercise – EER W-237, PACNW OPAREA	P-3C, P-8 MMA	SSQ-110A source explosive sonobuoy	✓	✓	✓	124	136	9.7	149	20.2
		SSQ-77 passive sonobuoy	✓	✓	✓	201	221	10.0	241	19.9
Surface Ship ASW	DDG, FFG	b/								
Submarine ASW TRACKEX PACNW OPAREA	SSBN, SSGN	MK-39 EMATT (not recovered)	✓	✓		96	100	4.2	100	4.2
Electronic Combat (EC) Exercise W-237A, Darrington Area	EA-6B, EA-18G, P-3, EP-3, CVN, DDG, FFG, AOE, SSGN, SSBN	a/ b/								
Mine Countermeasure Training EOD Crescent Harbor, EOD Indian Island, and EOD Floral Point		< 2.5 lb charge		✓	✓	3	0	–	0	–
		2.5 lb charge		✓	✓	51	4	-92	4	-92
		5.0 lb charge		✓	✓	1	0	-100	0	-100
		20.0 lb charge		✓	✓	5	0	-100	0	-100
Land Demolitions DTR Bangor, DTR Seaplane Base	Pickup Trucks (support)	C-4 – 1.25 lb block		✓	✓	1,570	1,693	7.8	1,693	7.8
		Igniters		✓	✓	170	183	7.6	183	7.6
		MK-142 firing device		✓	✓	97	104	7.2	104	7.2
		Hand grenades		✓	✓	170	183	7.6	183	7.6
		MK-174 CTG cal .50 impulse		✓	✓	901	971	7.7	971	7.7
		DetaSheet 2.0 lb (M024)		✓	✓	255	276	8.2	276	8.2
		DetaSheet C-2 (0.083 in.)		✓	✓	850	917	7.9	917	7.9
		C-4 – 2.0 lb block		✓	✓	255	275	7.8	275	7.8
		Blasting cap, electric (M130)		✓	✓	1,870	2,017	7.9	2,017	7.9
		Detonation cord (M456)		✓	✓	34,000 ft	36,667 ft	7.8	36,667 ft	7.8
		Timed blasting fuse (M670)		✓	✓	17,340 ft	18,700 ft	7.8	18,700 ft	7.8

Table 3.4-2: Number of Activities or Expended Training Items – All Alternatives (cont'd)

Warfare Area and Location(s)	Platform	Training Item	Heavy Metals	Chemicals	Explosives	No Action Alternative	Alternative 1	% Change	Alternative 2	% Change
Land Demolitions (cont'd)		Timed blasting fuse Igniter		✓	✓	340	367	7.9	367	7.9
		Blasting cap, non electric		✓	✓	1,020	1,100	7.8	1,100	7.8
		Red smoke (G950)		✓		238	256	7.6	256	7.6
		Green smoke (G940)		✓		97	104	7.2	104	7.2
		Violet smoke (G955)		✓		204	220	7.8	220	7.8
Insertion and Extraction Seaplane Base, OLF Coupeville, Crescent Harbor	C-130, H-60	a/								
HARMEX (non-firing) Okanogan, Olympic, and Roosevelt MOAs	EA-6B, E/A-18 (future)	CATM-88C missile (not released); a/				2,724	3,000	10.1	3,000	10.1
NSW Training Indian Island, Seaplane Base Survival Area	SEAL delivery vehicle, RHIB	b/								
Intelligence, Surveillance, and Reconnaissance (ISR) W-237, PACNW OPAREA	P-3C	SSQ-53 DIFAR passive sonobuoy	✓	✓	✓	980	1,043	6.4	1,043	6.4
UAV Activities R-6701, W-237, PACNW OPAREA	Scan Eagle, Global Hawk (future BAMS)	a/ b/				12	112	0.0	112	0.0

* NEW = "net explosive weight"

a/ Aircraft activities. Under the No Action Alternative, a total of 7,568 sorties (flights) would be flown by fixed-wing aircraft (98 percent), helicopters (one percent), and unmanned aerial vehicles (one percent). Compared to the No Action Alternative, sorties would increase 21 percent (to 9,204) under Alternative 1, and 55 percent under Alternative 2 (to 11,786). The relative proportion among the aircraft types would remain largely the same. Existing Navy directives manage the storage, use, and proper disposal of materials that may be harmful to the environment.

b/ Naval vessel activities. Under the No Action Alternative, naval vessels would be underway and conducting exercises for 6,940 hours each year. Compared to the No Action Alternative, this would increase four percent (7,228 hours) under Alternative 1, and it would increase ten percent under Alternative 2 (7,628 hours). Vessels, aircraft, and other military equipment used in these activities carry and use hazardous materials for routine operation and maintenance. Existing Navy directives manage the storage, use, and proper disposal of materials that may be harmful to the environment. Please see the discussion of requirements and protective measures below, as well as Table 3.4-1 for a summary of water discharge restrictions for Navy vessels.

c/ Proposed range enhancements, including surface target services, would result in increased air-to-air missile exercises, surface-to-air gunnery, surface-to-air missile exercises, and surface-to-surface gunnery exercises in the NWTRC.

Training Materials Expended in the PACNW OPAREA – No Action Alternative

This section discusses the potential impacts to water resources from training materials expended in the PACNW OPAREA.

Bombs

Under the No Action Alternative, 108 bombs would be expended in the PACNW OPAREA (Table 3.4.3). With an ocean area of approximately 122,400 square nautical miles (nm^2) (420,163 km^2) and assuming even distribution of activities, this amounts to 0.001 items per nm^2 (0.0003 per km^2).

Table 3.4-3: Types and Number of Bombs – No Action Alternative

Type of Bomb	Number
MK-82 – Live	12
MK-82 – Inert	88
MK-83 – Live	4
MK-84 – Live	4
Total	**108**

Eighty percent of the bombs (88) are inert and would settle to the sea bottom and become encrusted by chemical processes and marine organisms and, therefore, present no hazard to ocean water resources. Use of the remaining 20 live bombs would have no measurable impact on ocean water resources.

Missiles

Table 3.4-4 lists the types and number of missiles proposed under the No Action Alternative.

Table 3.4-4 Types and Number of Missiles – No Action Alternative

Type of Missile	Number
AIM-7 Sparrow	0
AIM-9 Sidewinder	0
AIM-120 AMRAAM	0
NATO Seasparrow	0
AGM-88 HARM	2
AGM-114 Hellfire	1
AGM-65 Maverick	3
AGM-84 Harpoon	3
SLAM ER	1
Total	**10**

In general, the single largest hazardous constituent of missiles is solid propellant, such as solid double-base propellant, aluminum and ammonia propellant grain, and arcite propellant grain. Table 3.4-5 describes the types of propellants for selected types of missiles proposed under the No Action Alternative. The solid propellant is primarily composed of rubber (polybutadiene) mixed with ammonium perchlorate. Hazardous constituents are also used in igniters, explosive bolts, batteries (potassium hydroxide and lithium chloride), and warheads, such as PBX-N high explosive components, PBXN-106 explosive, and PBX (AF)-108 explosive. Testing has demonstrated that water penetrates about 0.06 inches (0.15 cm) into the propellant during the first 24 hours of immersion, and that fragments will very slowly release ammonium and perchlorate ions (DoN 2007). These ions will be rapidly diluted and disperse in the surrounding water such that local concentrations will be extremely low.

Table 3.4-5: Propellant in Selected Missiles

Type of Missile	Type of Propellant
AIM-7 Sparrow	Propellant is dual-thrust, solid-fuel rocket motor (Hercules MK-58); warhead is an 88-lbs. (40 kg) WDU-27/B blast-fragmentation device
AIM-9 Sidewinder	Propulsion system contains up to 44 lb. (20 kg) of solid double-base propellant; warhead contains approximately 10 lbs. (4.5 kg) of PBX-N HE
AIM-114 Hellfire	Propellant is solid-fuel rocket motor (Thiokol TX-657 (M120E1); warhead contains approximately 17 lbs. (8 kg) of HE
AIM-120 AMRAAM	Propellant is solid-fuel rocket motor (ATK WPU-6B booster and sustainer with RS HTPB solid propellant fuel); warhead contains 40 lbs. (18 kg) of HE

Another concern is when ordnance do not function correctly – they either do not detonate or do not detonate completely (referred to as a low-order detonation) and some of the explosive remains. Table 3.3-6 provides a list of these items.

Table 3.4-6: Ordnance Constituents of Concern

Training Application, Ordnance Element	Hazardous Constituent
Pyrotechnics Tracers Spotting Charges	Barium chromate Potassium perchlorate Chlorides Phosphorus Titanium compounds Depleted uranium
Oxidizers	Lead oxide
Delay Elements	Barium chromate Potassium perchlorate Lead chromate
Propellants	Ammonium perchlorate
Fuses	Potassium perchlorate
Detonators	Fulminate of mercury Potassium perchlorate
Primers	Lead azide

As with propellants, these materials can release small amounts of hazardous materials into the water as they degrade and decompose. However, 1) the hazardous constituents decompose slowly, so existing ocean and tidal currents would dissipate these materials to undetectable levels; 2) the number of missiles (10) proposed for the No Action Alternative is small and few are lost during training; and 3) the failure rate of ordnance is relatively low – 3.4 percent for high-explosive ordnance, and 0.1 percent for low-order detonations (Rand 2005, USACE 2007). A more detail discussion of depleted uranium is include in Section 3.3, Hazardous Materials.

Naval Gunfire

Under the No Action Alternative, a total of 2,906 gunshells would be expended over an ocean area of approximately 122,400 nm^2 (420,163 km^2) (Table 3.4-7). This amounts to 0.02 items per nm^2 (0.007 per km^2), assuming an even distribution of activities. Approximately 37 percent of the shells are inert and would settle to the sea bottom where they would become encrusted by chemical processes and marine organisms and not pose a hazard to ocean water resources. The level of deposition for the remaining 1,826 gunshells would have a negligible impact on ocean water resources.

Table 3.4-7: Types and Number of Naval Gunshells – No Action Alternative

Type of Gunshells	Number	Percent of Total
20mm – live (CIWS)	7,200	28
25mm – live	15,750	61
57mm – live	630	2
76mm – live	560	2
5 inch – live	1,716	7
Total	**25,856**	

See Section 3.3, Hazardous Materials, for discussion of depleted uranium in 20mm shells.

Targets and Countermeasures

Table 3.4-8 summarizes the types, number, and relative proportion of targets and countermeasures proposed under the No Action Alternative. These training materials would not have a measurable impact on ocean water resources because: 1) items not recovered (76 percent of the total) are largely composed of inert materials; and 2) 54 percent of all items are marine markers that are mostly consumed as heat and smoke during use.

Table 3.4-8: Types and Number of Targets and Countermeasures – No Action Alternative

Type of Target or Countermeasure		Number	Percent of Total
Aerial	LUU-2B/B*	0	0.0
	TALD*	0	0.0
	BQM-74E	0	0.0
	TDU-34	72	15.6
Surface	HSMST	0	0.0
	Trimaran	0	0.0
	SPAR	0	0.0
	Killer Tomato	60	13.0
	MK-58 Marine Marker*	208	45.0
Subsurface	EMATT*	121	26.2
Sinking Exercise	Decommissioned Vessel*	1	0.2
	Total	**462**	

* Not recovered

An additional 500-600 smoke canisters are used during land demolition training. However, these materials do not affect water resources, so are not analyzed further.

For vessel-sinking exercises (SINKEX), the vessels used as targets are selected from a list of U.S. Navy-approved vessels that have been cleaned in accordance with USEPA guidelines. By rule, SINKEX is conducted at least 50 nautical miles offshore and in water at least 6,000 feet deep (1,830 m) (40 CFR

229.2). USEPA considers the contaminant levels released during the sinking of a target to be within the standards of the Marine Protection, Research, and Sanctuaries Act (16 USC 1341, et seq.). As with other inert materials discussed in the text, the vessel would become encrusted by chemical processes and biological organisms and not pose a hazard to ocean water resources.

Torpedoes

Torpedoes typically contain hazardous materials such as propellants, petroleum products and lubricants, components of guidance systems and instrumentation, and explosives in warheads. Under the No Action Alternative, only one torpedo is proposed for use. Given the size of PACNW OPAREA, this aspect of the proposed training is not expected to have an adverse impact on ocean water resources. Section 3.3, Hazardous Materials, contains further discussion.

Small Caliber Rounds

Under the No Action Alternative, a total of 66,924 small caliber ammunition and CIWS shells would be expended over an ocean area of approximately 122,400 nm^2 (420,163 km^2) (Table 3.4-9). This amounts to 0.5 items per nm^2 (0.2 per km^2), assuming an even distribution of activities. This level of deposition would have a negligible impact on ocean water resources since most of these materials are inert, would settle to the bottom, and become encrusted by chemical processes and biological organisms.

Table 3.4-9: Types and Number of Small Caliber Rounds – No Action Alternative

Type of Ordnance	Number	Percent of Total
7.62 mm projectile	1,224	2
.50 caliber rounds	58,500	98
Total	**59,724**	

The presence of shell casings in the sediments would not cause a significant impact on water quality since brass would undergo slow corrosion, even in a salty environment, and would be quickly diluted by bay waters. Most of the ammunition expended during activities involving small arms fire is comprised of steel with small amounts of aluminum and copper. Steel practice bullets may release small amounts of iron, aluminum, and copper into the sediments and the overlying water column as the bullets corrode. All three elements are widespread in the natural environment, although elevated levels can cause toxic reactions in exposed plants and animals. Any elevation of metals in sediments would be restricted to a small zone around the bullet, and any release to the overlying water column would be very quickly diluted. Thus, continued use of steel bullets would not adversely affect water quality in the bay. The projectiles for 5.56mm and 7.62mm small arms ammunition have lead cores. Lead has been identified as a toxic contaminant under Section 307 of the Clean Water Act. The total estimated amount of lead that would be annually deposited on the BIR from the use of these projectiles is 840 pounds under Alternative 2 and 1,260 pounds under Alternative 3, which correspond to a volume of lead of less than 2 cubic feet annually. However, lead is nearly insoluble in water, particularly at the nearly neutral pH levels that characterize the waters of north Tangier Sound (MDNR 2005a). While it is reasonable to assume some dissolution of lead could occur, such releases into the water column would be very small and would be rapidly dispersed and diluted (DoN 2006a [ref is from hazmat section]).

Under the No Action Alternative, a total of 7,200 rounds of 20-mm cannon shells would be used by close-in weapons systems (CIWS) training. Rounds are composed of depleted uranium (DU) as well as tungsten. As noted above, the Navy began phasing out DU rounds in 1989, a process that should be completed in 2008. As with small caliber rounds, these materials would sink to ocean bottom and begin to corrode. The rate of corrosion would be slow as would the release of materials to adjacent sediments. Materials entering the overlying water column would be diluted by ocean and tidal currents.

Sonobuoys

Sonobuoys are metal cylinders launched from aircraft and ships that collect and generate information about the marine environment and potential threats and targets. Sonobuoys are about 36 inches long (one meter), five inches in diameter (13 cm), and weigh 14 to 39 pounds (6 to 18 kg). They consist of two sections, a surface unit that contains the seawater battery and a metal subsurface unit. The battery becomes energized following contact with seawater. The subsurface assembly descends to a selected depth, the sonobuoy case falls away, and sea anchors deploy to stabilize the underwater microphone (hydrophone). At this point, an active sonobuoy emits a sound pulse to generate an echo from a potential threat or target; a passive sonobuoy listens for sound from a potential threat or target. Other sonobuoys (e.g., SSQ-36 BT) gather information about conditions in the water, such as temperature and ambient noise, that improves accuracy of detection or that may assist in avoiding detection. Table 3.4-10 summarizes the types and number of sonobuoys proposed under the No Action Alternative.

In addition to the sonobuoy's power source, expendable materials include a parachute assembly (12- to 18-inch diameter nylon chute), nylon cord, plastic casing, antenna float, metal clips, and electrical wires. Sonobuoy components of concern for water resources are the seawater batteries, lithium batteries, battery electrodes, metal housing, lead solder, copper wire, and lead used for ballast (NFEC 1993).

Table 3.4-10: Types and Number of Sonobuoys – No Action Alternative

Type of Sonobuoy	Number	Percent of Total
SSQ-53 DIFAR (passive)	7,283	80
SSQ-62 DICASS (active)	844	9
SSQ-77 VLAD (passive)	593	7
SSQ-36 BT (passive)	288	3
SSQ-110A (active, explosive)	124	1
Total	**9,132**	

With a total of 9,132 sonobuoys expended over an ocean area of approximately 122,400 nm^2 (420,163 km^2), this amounts to 0.07 items per nm^2 (0.02 per km^2), assuming an even distribution of activities. In terms of the inert components of sonobuoys, this level of deposition would have a negligible impact on ocean water resources. Other constituents are discussed below.

Sonobuoy Batteries – Potential Impacts

Regardless of type, each sonobuoy contains a seawater battery housed in the upper, floating portion and which supplies power to the sonobuoy. These seawater batteries contain about 300 grams of lead, in addition to battery electrodes composed of lead chloride, cuprous thiocyanide, or silver chloride (Green et al. 1996). In cases where the upper portion of the sonobuoy is lost to the seabed, the lead batteries are also lost (CFMETR 2005). Silver chloride, lithium, or lithium iron disulfide thermal batteries are used to power subsurface units. The lithium-sulphur batteries used typically contain lithium sulphur dioxide and lithium bromide, but may also contain lithium carbon monofluoroxide, lithium manganese dioxide, sulphur dioxide, and acenitrile (a cyanide compound). During battery operation, the lithium reacts with the sulfur dioxide to form lithium dithionite. Lithium iron disulfide thermal batteries are used in DICASS sonobuoys. Thermal batteries are contained in a hermetically-sealed welded stainless steel case 0.03 to 0.1-inches thick that is resistant to the battery electrolytes.

The evaluation of the potential effects associated with seawater batteries includes comparing the expected concentrations of potentially toxic battery constituents with USEPA water quality criteria that have been established for the protection of aquatic life (USEPA 2006) or the best available literature values that established conservative toxicity thresholds. USEPA recommends application of an acute limit and a chronic limit (Table 3.4-11). Either limit cannot be exceeded more than once every three years on the average.

Table 3.4-11: Threshold Values for Safe Exposure to Selected Metals

Metal	Acute Criteria (µg/L, 24-hr exposure)	Chronic Criteria (µg/L, 4-hr mean exposure)
Lead	210	8.1
Silver	1.9	n/a
Copper	4.8	3.1
Lithium	6,000	n/a

n/a = no chronic value is available; µg/L = micrograms per liter; hr = hour
No USEPA criteria available; values shown are based on literature (Kszos et al. 2003)

Chemical reactions with sonobuoy batteries proceed almost to completion once the cell is activated, and only a small amount of reactants remain when the battery life ends. These residual materials will slowly dissolve and become diluted by ongoing ocean and tidal currents. Given the mobility characteristics for the most soluble battery constituent, lead chloride, there is low potential for substantial accumulation of contaminant in sediments. In addition, the outside metal case can become encrusted from seawater processes and marine organisms, thus slowing the rate of further corrosion. Also, many of the components of concern are coated with plastic to reduce corrosion, providing an effective barrier to water exchange. In instances where seawater causes the body of the sonobuoy to corrode, that corrosion will take at least 40 years (Klassen and Roberge 2005).

Lithium always occurs as a stable mineral or salt, such as lithium chloride or lithium bromide (Kszos et al. 2003). Lithium is naturally present in freshwater, soil, and sediment, and has an average concentration of 150 parts per million (ppm) in the water column, 35 ppm in sediments at Dabob Bay (Crecelius 2001), and 57 ppm in marine pelagic sediments in the Strait of Georgia (CFMETR 2005). A study conducted by Kszos et al. (2003) demonstrated that sodium ions in saltwater mitigate the toxicity of lithium to sensitive aquatic species. Fathead minnows (*Pimephales promelas*) and the water flea (*Ceriodaphnia dubia*) were unaffected by lithium concentrations as high as 6 mg/L in the presence of tolerated concentrations of sodium. Therefore, it is expected that in the marine environment, where sodium concentrations are at least an order of magnitude higher than tolerance limits for the tested freshwater species, lithium would be essentially nontoxic. Because of these factors, lithium batteries would not adversely affect marine water quality. One estimate concluded that 99 percent of the lithium in a battery would be released to the environment over 55 years (Klassen and Roberge 2005). The release will result in a dissolved lithium concentration of 83 mg/L in the immediate area of the breech in the sonobuoy housing. At a distance of 5.5 mm from the breech, the concentration of lithium will be about 15 mg/L, or 10 percent of typical seawater lithium values (150 ppm); thus it would be difficult to discern the additional concentration due to the lithium leakage from the background concentration (Klassen and Roberge 2005). Because of these factors, lithium batteries would not adversely affect marine water quality.

Several studies have evaluated the potential impacts of batteries expended in seawater (NFEC 1993, USCG 1994, Borener and Maugham 1998, and CFMETR 2005). Sediment samples were taken adjacent to and near fixed navigation sites where these batteries are used and analyzed for all metal constituents in the batteries. Results indicated that metals were either below or consistent with background levels or compared favorably with National Oceanic and Atmospheric Administration (NOAA) sediment screening levels (NOAA 2008), "reportable quantities" under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) §103(a), or USEPA toxicity procedures (USEPA 2008d).

A study by the Department of the Navy examined the impact of materials from activated seawater batteries in sonobuoys that freely dissolve in the water column (e.g., lead, silver, and copper ions), as well as nickel-plated steel housing, lead solder, copper wire, and lead shot used for sonobuoy ballast (NFEC 1993). The study concluded that constituents released from saltwater batteries as well as the decomposition of other sonobuoy components did not exceed state and federal standards and that the reaction products are short-lived in seawater.

The sonobuoy battery experiment employed lead chloride batteries in a 17-gallon seawater bath for eight hours (NFEC 1993). Under these conditions, the dilution assumptions are conservative relative to normal ocean bottom conditions. The concentration released from the battery was diluted to 0.2 mg/L or 200 micrograms per liter (µg/L) in two seconds, which is less than the acute criteria of 210 µg/L, a criteria applied as a 24-hour mean. Further, since lead chloride tends to dissolve more readily ($K_{sp} = 1.0 \times 10^{-4}$) than either silver chloride ($K_{sp} = 1.56 \times 10^{-10}$) or copper thiocyanate ($K_{sp} = 1.64 \times 10^{-11}$) (IUPAC/NIST 2008), this assures that the potential effects from batteries employing silver chloride or copper thiocyanate are substantially lower than those for the lead chloride battery. While the copper thiocyanate battery also has the potential to release cyanide, a material often toxic to the marine environment, thiocyanate is tightly bound and can form a salt or bind to bottom sediments. Therefore, the risk associated with thiocyanate is low.

A study of the impacts of lead and lithium (among other materials) was conducted at the Canadian Forces Maritime Experimental and Test Ranges near Nanoose Bay, British Columbia, Canada (CFMETR 2005). These materials are common to EMATTs, acoustic device countermeasures (ADCs), sonobuoys, and torpedoes. The study noted that lead is a naturally-occurring heavy metal in the environment. Typical concentrations of lead in seawater in the test range are between 0.01 and 0.06 ppm, and from 4 to 16 ppm in sediments. Factors that are generally understood to reduce risks associated with contaminated sediments include acid-volatile sulfide concentrations and organic carbon; both act to reduce the bioavailability of metals (USEPA 2001). Cores taken of marine sediments in the test range show a steady increase in lead concentration from the bottom of the core to a depth of approximately 8 inches (20 cm). This depth corresponds to the late 1970s and early 1980s and was attributed to atmospheric deposition from lead as a gasoline additive. The sediment cores showed a general reduction in concentration to the present time, coincident with the phasing out of lead in gasoline by the mid-1980s. The study also noted that studies at other ranges have shown minimal impacts of lead ballasts because they are usually buried deep in marine sediments where they are not biologically available. The study concluded that there would be no effects from the lead ballasts due to the low probability of mobilization.

Regarding lithium, cores taken of marine sediments in the test range showed fairly consistent lithium concentrations with depth, indicating little change in lithium deposition with time. Given ambient lithium concentrations taken outside the range, the report concluded that “it is difficult to demonstrate an environmental impact of lithium caused by CFMETR” (CFMETR 2005).

Explosive Sonobuoys – Potential Impacts of Detonation Byproducts

Only one type of explosive sonobuoy is proposed for use in the PACNW OPAREA, the SSQ-110A. This sonobuoy is composed of two sections, an active – explosive – section and a passive section. The upper section is similar to the upper electronics package of the SSQ-62 DICASS sonobuoy, while the lower section consists of two explosive payloads of Class A explosive weighing 4.2 pounds each (1.9 kg). This explosive is composed of cyclo-1,3,5-tetramethylene-2,4,6-tetranitramine (HLX), which is 90 percent RDX, plus small amounts (less than 0.3 grams) of plastic-bonded explosive (PBXN) and hexanitrostilbene, a detonator component.

Once in the water, the charges explode, creating a loud acoustic signal. The explosion creates an air bubble of gaseous byproducts that travels to the surface and escapes into the atmosphere. A small amount of the gas, however, dissolves into the water column. Explosive byproducts using the Cheetah 4 computational program are summarized on Table 3.4-12. The byproducts with the greatest toxicity are hydrogen fluoride compounds (H_xF_x), a reaction byproduct associated with the binding agent used to stabilize the HLX (DoN 2008).

Table 3.4-12: Detonation Byproducts from Explosive Sonobuoys

Detonation Byproducts	Initial Detonation State		Ambient	
	Grams per charge	Percent of total	Grams per charge	Percent of total
Hydrogen fluoride compounds (H_xF_x)	24.6	1.23%	12.5	0.63%
Nitrogen (N_2)	634		675	
Carbon dioxide (CO_2)	669		565	
Water (H_2O)	211		332	
Ammonia (NH_3)	61		13.4	
Formic acid (CH_2O_2)	156		1.7	
Ethylene (C_2H_6)	84.6		2.1	

Laboratory studies with freshwater species indicate a probable no effect concentration of 0.9 and 0.4 mg/L for hard and soft water, respectively. These values are apparently close to background levels measured in many natural water bodies. Characterization of natural exposure levels and effects in saltwater are needed to provide further basis for the assessment of risks in marine systems. However, only a small percentage (0.63 percent) of the available hydrogen fluoride explosion byproduct is expected to dissolve in the water prior to reaching the surface, and rapid dilution would occur upon mixture with ambient water. Given this dilution, the wide area across which the sonobuoys will be deployed (approximately 122,400 nm^2 [420,163 km^2]), and the number of explosive sonobuoys used under the No Action Alternative, adverse impacts from detonation byproducts would be negligible (DoN 2008).

Aviation Fuel

Under the No Action Alternative, a total of 7,586 sorties would be flown by aircraft in the NWTRC Study Area (Table 3.4-13).

Table 3.4-13: Aircraft Overflights per Year – No Action Alternative

Type of Aircraft	Number of Overflights	Percent of Total
Fixed-wing aircraft	7,478	98.5
Helicopter	96	1.3
Unmanned aerial vehicles	12	0.2
Total	**7,586**	

Issues associated with aviation fuel arise with the need to jettison fuel from a manned aircraft or with the loss of an unmanned aircraft. Both situations are infrequent. Aircraft will only jettison fuel in emergencies. Aircraft operating from an aircraft carrier prefer to divert to a land-based airfield during an emergency rather than attempt a carrier landing. Fuel that is jettisoned is discarded above 8,000 feet (2,500 m) over water west of NASWI just prior to landing. At that elevation, the fuel dissipates in the air before any liquid reaches the surface. Given the small numbers of such incidents and the wide area across which they might occur, aircraft activities are not expected to have a measurable adverse impact on water resources.

Summary of Training Materials Expended in the PACNW OPAREA – No Action Alternative

Table 3.4-14 below summarizes the types and number of items that will likely end up on the ocean floor in the PACNW OPAREA under the No Action Alternative. Figures exclude mine countermeasure training in the Puget Sound, which is discussed in the next section.

With a total of 95,700 items expended over an ocean area of approximately 122,400 nm^2 (420,163 km^2), this amounts to 0.8 items per nm^2 (0.2 per km^2), assuming an even distribution of activities. Of those expended items, over 60 percent would be small caliber rounds. Given that many of these materials are inert, this level of deposition would have negligible impacts to ocean water resources.

Table 3.4-14: Summary of Training Materials Expended – No Action Alternative

Type of Training Material	Number
Bombs	108
Missiles (excluding CATM-88c HARM)	10
Cannon Shells (20 mm)	7,200
Naval Gunshells (5-inch, 25mm, 57mm, 76mm)	18,656
Small Caliber Rounds (.50 caliber, 7.62mm)	59,724
Pyrotechnics	539
MK-58 Marine Marker	208
EMATTs	121
TALDs	0
Sonobuoys	9,132
Torpedoes	1
Vessel Sinkings	1
Total	**95,700**

Other Factors Influencing Marine Water and Sediment Quality

The ocean and nearshore environment are complex and dynamic systems composed of physical, chemical, and biological components that continually influence each other. This complexity can make it difficult to accurately identify the source of a particular material or to predict the ultimate fate of specific materials expended during training.

- Many contaminants are carried into marine systems by the wind and rivers. For instance, the water quality of rivers and streams in the Puget Sound area have problems with fecal bacteria, excess nutrients, insecticides, and other organic chemicals (USGS 2000).
- Once in place, natural physical, chemical, and biological processes can re-suspend, transport, and re-deposit materials to areas far removed from the original source (Hameedi et al. 2002).
- The properties of seawater, such as temperature, salinity, pH, level of dissolved oxygen, and hardness, affect the mobility and the toxicity of various contaminants. The presence of other substances in seawater, such as extremely small particles (< 0.63 µm), bicarbonates, sulphides, phosphates, and other metals, affect the mobility and the toxicity of various contaminants (Kszos et al. 2003).
- Different species have different sensitivities to various contaminants, some species can develop tolerances to some contaminants, and some species are able to metabolize or rid themselves of some contaminants (Kszos et al. 2003). Some materials, such as petroleum products, can be metabolized by marine micro-organisms (Leahy and Colwell 1990).

- The conditions in sediments, such as low- or no-oxygen and low oxidation-reduction ("redox") state, can lead to contaminants being immobilized. Conversely, perturbation of sediments by bottom-dwelling organisms can alter these conditions and re-mobilize the contaminant (Salomons and Forstner 1984).

Training Materials Expended in Puget Sound – No Action Alternative

In terms of training materials expended in Puget Sound, three locations are relevant – Crescent Harbor (EOD Crescent Harbor), Floral Point in Hood Canal at NBK-Bangor (EOD Floral Point), and west of Indian Island in Port Townsend Bay (EOD Indian Island). These are the Navy's designated locations for mine countermeasure training (MCT) and have been used consistently for this purpose for several years. The sites at EOD Crescent Harbor and EOD Indian Island are between 1,000 to 7,200 feet (330 to 2200 m) from the nearest shoreline and the detonations typically occur in 50 to 60 feet (15 to 20 m) of water over sandy or muddy bottoms. EOD Floral Point is about 600 feet (183 m) offshore and charges are placed on a training structure that is 3 to 8 feet (1 to 3 m) above the bottom (NMFS 2008).

MCT trains personnel in the destruction of mines, unexploded ordnance, obstacles, and structures. EOD personnel must re-qualify at least monthly in the preparation, placement, and detonation of underwater explosives. In general, 2.5-pound explosives (Table 3.6-2) are used to demonstrate the ability of personnel to set and detonate the explosive and to destroy the inert mine. The 20-pound explosive is used only for specialized training when a disabled mine is retrieved for research and testing (NMFS 2008).

Underwater demolition training involves detonation of charges at or near the surface and the bottom. The explosive charges are typically raised above the seafloor prior to detonation in order to minimize impact to the seafloor. Each exercise entails placement of the dummy mine in the training area, location of the mine by EOD personnel, placement of the charge on or near the mine, attachment of detonating equipment, detonation, debris retrieval, and in-water inspection of the detonation site. In some of the exercises, a disabled mine is raised and moved ashore for dismantling and inspection. However, the disabled mines are eventually recovered. Typically two blocks of C-4 are used per activity, with each activity consisting of one surface and one subsurface detonation. The total duration of the exercise is five hours (NMFS 2008).

The explosive used is C-4, composed of RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine) (approximately 95 percent), plus a plastic binder (polyisobutylene). Most of the charges are linear "shaped" charges contained in copper, aluminum, or plastic housing. Some of these charges are intended to disable "limpet" mines on the hulls of ships, while others are designed to disable moored or bottom mines (NMFS 2008).

Table 3.4-15 shows the number and the size of the explosive charges that would be expended annually at each site under the No Action Alternative. EOD Crescent Harbor represents 87 percent of the total.

All surface debris, consisting mainly of floats and attached equipment, is retrieved. Personnel are instructed to retrieve debris from the seafloor, which consists mainly of pieces of the mine and the housing for the explosive charge (i.e., pieces of aluminum, plastic, or copper). The majority of the explosive itself is consumed. In cases where the mine is only disabled, not destroyed, the mine is either loaded into the primary boat, if the mine is small enough, or suspended below the boat. The mine is then taken to a remote beach for dismantling and inspection. Again, this is a dummy mine (lacking explosive), so that an explosion is not possible at this point (NMFS 2008).

Table 3.4-15: Mine Countermeasure Training – No Action Alternative

Location	Charge Size	Number
EOD Crescent Harbor	< 2.5 lbs	3
	2.5 lbs	45
	5.0 lbs	1
	20.0 lbs	4
EOD Floral Point	2.5 lb	3
EOD Indian Island	2.5 lbs	3
	20.0 lbs	1
	Total	**60**

Underwater Detonations – Potential Impacts of Solid Debris

Standard procedure requires that divers retrieve this debris from the seafloor. Adverse impacts from mine countermeasure training at each site under the No Action Alternative would be negligible because of the relatively small number of underwater explosions, the inert nature of the materials, standard site investigation and clean up procedures, and the fact that all three sites have been used for such activities for several years.

Underwater Detonations – Potential Impacts of Explosion Byproducts

Table 3.4-16 details the byproducts of underwater detonation of C-4. High-order detonations result in almost complete conversion of explosives (99.997 percent; USACE 2007). The majority of these byproducts are commonly found in seawater, that is, water, carbon dioxide (CO_2), hydrogen (H_2), carbon monoxide (CO), nitrogen (N_2), and ammonia (NH_3) (Renner and Short 1980, DoN 2000). These byproducts represent 98 percent of all byproducts produced.

Table 3.4-16: Byproducts of Underwater Detonation of RDX

Byproducts	Percent of Total, by Weight
Nitrogen	37.0
Carbon dioxide	24.9
Water	16.4
Carbon monoxide	18.4
Ethane	1.6
Hydrogen	0.3
Propane	0.2
Ammonia	0.9
Methane	0.2
Hydrogen cyanide	< 0.01
Methyl alcohol	< 0.01
Formaldehyde	< 0.01
Other compounds	< 0.01

The remaining byproducts are either gases or liquids that will dissipate, evaporate, or dilute to undetectable or insignificant levels, or they react with constituents of salt water in the existing currents to form harmless substances. Underwater explosions re-suspend sediments into the water column, creating a turbidity plume. However, these effects would be negligible because, depending on specific site conditions of wind and tidal currents, the turbidity plume eventually dissipates as particles return to the bottom or are dispersed.

Detonation failure, low-order detonations. The preceding discussion indicates that the majority of detonation byproducts are not harmful and those that may be harmful dissipate under normal conditions. It is when explosives fail to detonate or incompletely detonate (low-order detonation) that the explosive are more problematic. A more detailed discussion of the potential impacts of detonation failure or a low-order detonation is provided under the No Action Alternative. The conclusion was that the overall impact of these constituents would be negligible. During mine countermeasure training, the prospects of adverse impacts from low-order or no detonation is even less because of the procedures that require EOD personnel to return to and inspect the detonation site, to clean up debris, and to retrieve unexploded materials for further examination.

3.4.2.3 Alternative 1

Training Materials Expended in the PACNW OPAREA – Alternative 1

This section discusses the types and number of training materials expended under Alternative 1.

Bombs

Under Alternative 1, a total of 144 bombs would be expended in the PACNW OPAREA, a 33 percent increase over the No Action Alternative (Table 3.4-17). With an ocean area of approximately 122,400 nm^2 (420,163 km^2) and assuming even distribution of activities, this amounts to 0.001 items per nm^2 (0.0003 per km^2).

Table 3.4-17: Types and Number of Bombs – No Action and Alternative 1

Type of Bomb	No Action	Alternative 1		
	Number	Number	Numerical Increase	Percent Increase
MK-82 – Live	12	18	6	50
BDU-45 – Inert	88	110	22	25
MK-83 – Live	4	8	4	100
MK-84 – Live	4	8	4	100
Total	**108**	**144**	**36**	**33**

The majority of the bombs are inert (76 percent) and would settle to the sea bottom and become encrusted by chemical processes and marine organisms and, therefore, pose no hazard to ocean water resources. Although use of live bombs increases, the relative number is low – 14 additional live bombs over 122,400 nm^2.

Missiles

Under Alternative 1, 35 missiles would be used, an increase of 25 over the No Action Alternative (Table 3.4-18). As noted under the No Action Alternative, few of these missiles are lost, the constituents of concern with missiles (i.e., solid propellant) become hazardous to water resources only if the missile fails to function properly, and such materials decompose very slowly in the marine environment. Ongoing ocean and tidal currents would dissipate these materials to undetectable levels.

Table 3.4-18: Types and Number of Missiles – No Action and Alternative 1

Type of Missile	No Action	Alternative 1	
	Number	Number	Numerical Increase
AIM-7 Sparrow	0	6	6
AIM-9 Sidewinder	0	5	5
AIM-120 AMRAAM	0	4	4
NATO Sea Sparrow	0	0	0
AGM-88 HARM	2	4	2
AGM-114 Hellfire	1	2	1
AGM-65 Maverick	3	6	3
AGM-84 Harpoon	3	6	3
SLAM ER	1	2	1
Total	**10**	**35**	**25**

Naval Gunfire

Under Alternative 1, 14 percent more shells (3,495) would be used compared to the No Action Alternative (Table 3.4-19). With an ocean area of approximately 122,400 nm^2 (420,163 km^2) and assuming even distribution of activities, this amounts to less than 0.2 gunshells per nm^2 (0.07 per km^2).

Table 3.4-19: Types and Number of Naval Gunshells – No Action and Alternative 1

Type of Gunshell	No Action	Alternative 1	
	Number	Number	Percent Increase
20mm – live (CIWS)	7,200	8,000	11
25mm – live	15,750	17,500	11
57mm – live	630	700	11
76mm – live	560	800	43
5 inch – live	1,716	2,351	37
Total	**25,856**	**29,351**	**14**

Inert gunshells represent 31 percent of the total under Alternative 1. These shells would settle to the sea bottom and become encrusted by chemical processes and marine organisms and, therefore, pose no hazard to ocean water resources. Under Alternative 1, the potential impact of these items on ocean water resources would be similar to the No Action Alternative – negligible. See Section 3.3, Hazardous Materials, for discussion of depleted uranium in 20mm shells.

Targets and Countermeasures

Under Alternative 1, there would be a 15 percent increase (80 items) in the number of targets and countermeasures over the No Action Alternative (Table 3.4-20). These training materials would not have a measurable impact on ocean water resources because: 1) items not recovered (71 percent of the total) are largely composed of inert materials; and 2) 45 percent of all items are marine markers that are mostly consumed as heat and smoke during use. The number of vessel sinkings would increase from one to two under Alternative 1 compared to the No Action Alternative. This level of deposition is not expected to adversely impact water resources. The discussion of vessel sinkings under the No Action Alternative contains more details.

Table 3.4-20: Types and Number of Targets and Countermeasures – No Action and Alternative 1

Type of Target or Countermeasure		No Action	Alternative 1		
				Change from No Action	
		Number	Number	Numerical Increase	Percent Increase
Aerial	LUU-2B/B*	0	6	6	–
	TALD*	0	11	11	–
	BQM-74E	0	0	0	–
	TDU-34	72	80	8	11
Surface	HSMST	0	5	5	–
	Trimaran	0	11	11	–
	SPAR	0	17	17	–
	Killer Tomato	60	67	7	12
	MK-58 Marine Marker*	208	215	7	3
Subsurface	EMATT*	121	126	5	4
Sinking Exercise	Decommissioned vessel*	1	2	1	100
	Total	**462**	**540**	**78**	**17**

* Not recovered

Torpedoes

Torpedoes typically contain hazardous materials such as propellants, components of guidance systems and instrumentation, and explosives in warheads. Under Alternative 1, two torpedoes are proposed. Given this number of torpedoes and the size of the PACNW OPAREA, this aspect of the proposed training is not expected to have an adverse impact on water resources.

Small Caliber Rounds

Under Alternative 1, 11 percent more small caliber rounds would be used compared to the No Action Alternative (from 59,724 to 66,360), of which 98 percent would be .50 caliber rounds (Table 3.4-21). With an ocean area of approximately 122,400 nm^2 (420,163 km^2) and assuming even distribution of activities, this amounts to about one-half round per nm^2 (0.2 per km^2). Given the inert nature of the majority of these items, this level of deposition would have a negligible impact on ocean water resources.

Table 3.4-21: Types and Number of Small Caliber Rounds – No Action and Alternative 1

Type of Ordnance	No Action	Alternative 1		
	Number	Number	Numerical Increase	Percent Increase
7.62 mm projectiles	1,224	1,360	136	11.1
.50 cal munitions	58,500	65,000	6,500	11.1
Total	**59,724**	**66,360**	**6,636**	**11.1**

Sonobuoys

Under Alternative 1, there would be a three percent increase in the number of sonobuoys compared to the No Action Alternative (Table 3.4-22). With an ocean area of approximately 122,400 nm^2 (420,163 km^2) and assuming even distribution of activities, this amounts to less than 0.08 items per nm^2 (0.02 per km^2).

In terms of the inert components of sonobuoys, this level of deposition would have a negligible impact on ocean water resources.

Table 3.4-22: Types and Number of Sonobuoys – No Action and Alternative 1

Type of Sonobuoy	No Action	Alternative 1		
	Number	Number	Numerical Increase	Percent Increase
SSQ-36 BT (passive)	288	295	7	2.4
SSQ-53 DIFAR (passive)	7,283	7,503	220	3.0
SSQ-62 DICASS (active)	844	865	21	2.5
SSQ-77 VLAD (passive)	593	623	30	5.1
SSQ-110A (explosive)	124	136	12	9.7
Total	**9,132**	**9,422**	**290**	**3.2**

The discussion of sonobuoys under the No Action Alternative contains more detail regarding the potential impact on water resources of sonobuoy batteries and explosive components. Given the conclusions in that section, the proposed increase in sonobuoy use in the PACNW OPAREA under Alternative 1 would not have a measurable impact on ocean water resources.

Aviation Fuel

Under Alternative 1, sorties would increase 21 percent (1,618) over the No Action Alternative (Table 3.4-23).

Table 3.4-23: Aircraft Sorties – No Action and Alternative 1

Type of Aircraft	No Action	Alternative 1		
	Number of Sorties	Number of Sorties	Numerical Increase	Percent Increase
Fixed-wing aircraft	7,478	8,983	1,505	20
Helicopter	96	109	13	14
Unmanned aerial vehicles	12	112	100	833
Total	**7,586**	**9,204**		**21**

Issues associated with aviation fuel arise with the need to jettison fuel from a manned aircraft or with the loss of an unmanned aircraft. Given how infrequent such events are, that they occur above 8,000 feet (2,500 m), and the wide area across which they might occur, increased overflights would not have a measurable impact on water resources.

Summary of Training Materials Expended in the PACNW OPAREA – No Action and Alternative 1

Table 3.4-24 compares the number of items that will likely end up on the ocean floor in the PACNW OPAREA under the No Action Alternative and Alternative 1. These figures exclude mine countermeasure training in the Puget Sound, which is discussed in the next section.

Table 3.4-24: Summary of Training Materials Expended – No Action and Alternative 1

Type of Expended Material	No Action	Alternative 1		
	Number	Number	Numerical Increase	Percent Increase
Bombs	108	144	36	33
Missiles (excluding CATM-88c HARM)	10	35	25	250
Cannon Shells (20mm)	7,200	8,000	800	11
Naval Gunshells (5-inch, 25mm, 57mm, 76mm)	18,656	21,351	2,695	14
Small Caliber Rounds (.50 caliber, 7.62mm)	59,724	66,360	6,636	11
Pyrotechnics	539	580	41	8
MK-58 Marine Marker	208	215	7	3
EMATTs	121	126	5	4
TALDs	0	11	11	–
Sonobuoys	9,132	9,422	290	3
Torpedoes	1	2	1	100
Vessel Sinkings	1	2	1	100
Total	**95,700**	**106,248**	**10,548**	**11**

Under Alternative 1, a total of 106,248 items would be expended, an 11 percent increase over the No Action Alternative. Assuming an even distribution of these materials, the concentration of expended items would be 0.9 per nm^2 (0.3 per km^2). More than 60 percent of these materials would be small caliber rounds. Many of these items are inert, would settle to the sea bottom and become encrusted by chemical processes and marine organisms, and pose no hazard to ocean water resources. The number of vessel sinkings would increase from one to two under Alternative 1 compared to the No Action Alternative. This level of deposition is not expected to adversely impact water resources.

Training Materials Expended in Puget Sound – Alternative 1

Under all alternatives, the only activities in nearshore habitats in Puget Sound would occur during mine countermeasure training at EOD Crescent Harbor, EOD Floral Point, and EOD Indian Island.

In April 2008, the Navy decided to relocate Explosive Ordnance Disposal Mobile Unit Eleven (EODMU Eleven) forces out of the NWTRC Study Area to Imperial Beach, CA. This move is planned to be completed in the fall of 2009. Two EOD Shore Detachments (Bangor and Northwest) will remain in the NWTRC. These Shore Detachments report to Commander, Navy Region Northwest and respond to regional Navy taskings and incidents. As a result of the EODMU Eleven relocation, mine warfare underwater detonation training will significantly decrease from a yearly maximum of 60 underwater detonation as analyzed in the No Action Alternative (the baseline) to no more than four annual underwater detonation as analyzed in Alternatives 1 and 2, a decline of over 90 percent. The maximum charge size for these four explosions will be 2.5 lb net explosive weight.

Adverse impacts from this level of activity would be negligible because of relatively low level of activity and standard site investigation and clean up procedures. Last, 98 percent of explosion byproducts are normal constituents of seawater. Turbidity resulting from detonation would dissipate rather quickly depending on the site conditions at the time, such as wind speed and tidal currents.

3.4.2.4 Alternative 2

Training Materials Expended in the PACNW OPAREA – Alternative 2

This section discusses the types and number of training materials expended in the PACNW OPAREA under Alternative 2, the Preferred Alternative.

Bombs

Under Alternative 2, a total of 144 bombs would be expended in the PACNW OPAREA, a 33.3 percent increase over the No Action Alternative and the same as Alternative 1 (Table 3.4-25). With an ocean area of approximately 122,400 nm^2 (420,163 km^2) and assuming even distribution of activities, this amounts to 0.001 items per nm^2 (0.0003 per km^2).

Table 3.4-25: Types and Number of Bombs – No Action and Alternative 2

Type of Bomb	No Action	Alternative 2	
	Number	Number	Percent Increase
MK-82 – Live	12	18	50
MK-82 – Inert	88	110	25
MK-83 – Live	4	8	100
MK-84 – Live	4	8	100
Total	**108**	**144**	**33**

The majority of bombs are inert (81 percent) and would settle to the sea bottom and become encrusted by chemical processes and marine organisms and, therefore, pose no hazard to ocean water resources. Although use of live bombs increases, the relative number is low (14 additional live bombs over 122,400 nm^2).

Missiles

Under Alternative 2, 57 missiles would be used, an increase of 47 over the No Action Alternative (Table 3.4-26). The main component of concern with missiles is solid propellant. However, as noted under the No Action Alternative, few of these missiles are lost, they become hazardous to water resources only if the missile fails to function properly, and such materials decompose very slowly in the marine environment. Ongoing ocean and tidal currents would dissipate these materials to undetectable levels under this alternative.

Naval Gunfire

Under Alternative 2, a doubling of the gun shells used would occur (from 25,856 to 53,343; Table 3.4-27). With an ocean area of approximately 122,400 nm2 (420,163 km2) and assuming even distribution of activities, this amounts to about 0.4 shells per nm2 (0.1 per km2). Given the largely inert nature of these materials and the wide dispersion across the PACNW OPAREA, this increase would not have a measurable impact on the environment.

Table 3.4-26: Types and Number of Missiles – No Action and Alternative 2

Type of Missile	No Action	Alternative 2		
	Number	Number	Difference from No Action	
			Numerical Increase	Percent Change
AIM-7 Sparrow	0	13	13	–
AIM-9 Sidewinder	0	9	9	–
AIM-120 AMRAAM	0	7	7	–
NATO Seasparrow	0	8	8	–
AGM-88 HARM	2	4	2	100
AGM-114 Hellfire	1	2	1	100
AGM-65 Maverick	3	6	3	100
AGM-84 Harpoon	3	6	3	100
SLAM ER	1	2	1	100
Total	**10**	**57**	**47**	**470**

Table 3.4-27: Types and Number of Naval Gunshells – No Action and Alternative 2

Type of Gunshell	No Action	Alternative 2	
	Number	Number	Percent Increase
20mm – live (CIWS)	7,200	16,000	122
25mm – live	15,750	31,500	100
57mm – live	630	1,260	100
76mm – live	560	1,120	100
5 inch – live	1,716	3,463	102
Total	**25,856**	**53,343**	**106**

Inert shells represent 37 percent of the total under Alternative 2. These shells would settle to the sea bottom and become encrusted by chemical processes and marine organisms and, therefore, pose no hazard to ocean water resources. Under Alternative 2, the potential impact of these items on ocean water resources would be negligible (similar to the No Action and Alternative 1).

Targets and Countermeasures

Under Alternative 2, there would be a 40 percent increase (279 items) in the number of targets and countermeasures used (Table 3.4-28). These training materials would not have a measurable impact on ocean water resources because: 1) items not recovered (57 percent of all targets and countermeasures) are largely composed of inert materials; and 2) 38 percent of all items are marine markers that are mostly consumed as heat and smoke during use. The discussion of vessel sinkings under the No Action Alternative contains more details.

Table 3.4-28: Types and Number of Targets and Countermeasures – No Action and Alternative 2

Type of Target or Countermeasure		No Action	Alternative 2		
				Change from No Action	
		Number	Number	Numerical Increase	Percent Increase
Aerial	LUU-2B/B*	0	11	11	–
	TALD*	0	22	22	–
	BQM-74E	0	16	16	–
	TDU-34	72	160	88	122
Surface	HSMST	0	9	9	–
	Trimaran	0	20	20	–
	SPAR	0	31	31	–
	Killer Tomato	60	120	60	100
	MK-58 Marine Marker*	208	220	12	6
Subsurface	EMATT*	121	126	5	4
Sinking Exercise	Decommissioned vessel*	1	2	1	100

* Not recovered

Torpedoes

Torpedoes typically contain hazardous materials such as propellants, components of guidance systems and instrumentation, and explosives in warheads. Under Alternative 2, two torpedoes are proposed. Given this number of torpedoes and the size of the PACNW OPAREA, this aspect of the proposed training is not expected to have an adverse impact on water resources.

Small Caliber Rounds

Under Alternative 2, a doubling of the small caliber rounds would occur (from 59,724 to 119,720; Table 3.4-29). With an ocean area of approximately 122,400 nm^2 (420,163 km^2) and assuming even distribution of activities, this amounts to one round per nm^2 (0.3 per km^2). Given the inert nature of these materials, their small size, and the wide dispersion across the PACNW OPAREA, this increase would have no measurable impact on the environment.

Table 3.4-29: Types and Number of Small Caliber Rounds – No Action and Alternative 2

Type of Ordnance	No Action	Alternative 2	
	Number	Number	Percent Increase
7.62 mm projectiles	1,224	2,720	122
.50 cal munitions	58,500	117,000	100
Subtotal	**59,724**	**119,720**	**101**

Sonobuoys

A total of 9,651 sonobuoys would be used, an increase of six percent (519) over the No Action Alternative (Table 3.4-30). With an ocean area of approximately 122,400 nm^2 (420,163 km^2) and assuming even distribution of activities, this amounts to less than 0.08 items per nm^2. In terms of the inert components of sonobuoys, this level of deposition would have a negligible impact on ocean water resources.

The discussion of sonobuoys under the No Action Alternative contains a detailed discussion of the potential impact on water resources of sonobuoy batteries and explosive components. Given the conclusions in that section, the proposed increase in sonobuoy use under Alternative 2 would not have a measurable impact on ocean water resources.

Table 3.4-30: Types and Number of Sonobuoys – No Action and Alternative 2

Type of Sonobuoy	No Action	Alternative 2	
	Number	Number	Percent Increase
SSQ-36 BT (passive)	288	302	4.9
SSQ-53 DIFAR (passive)	7,283	7,661	5.2
SSQ-62 DICASS (active)	844	886	5.0
SSQ-77 VLAD (passive)	593	653	10.1
SSQ-110A (explosive)	124	149	20.2
Total	**9,132**	**9,651**	**5.7**

Aviation Fuel

Under Alternative 2, overflights would increase 55 percent (4,200) over the No Action Alternative (Table 3.4-31). Issues associated with aviation fuel arise with the need to jettison fuel from a manned aircraft or with the loss of an unmanned aircraft. Given how infrequent such events are, that they occur above 8,000 feet (2,500 m), and the wide area across which they might occur, the increase would not have a measurable impact on water resources.

Table 3.4-31: Aircraft Sorties – No Action and Alternative 2

Type of Aircraft	No Action	Alternative 2		
	Number of Sorties	Number of Sorties	Numerical Increase	Percent Increase
Fixed-wing aircraft	7,478	11,565	4,087	55
Helicopter	96	109	13	14
Unmanned aerial vehicles	12	112	100	833
Total	**7,586**	**11,786**		**55**

Summary of Training Materials Expended in the PACNW OPAREA – No Action and Alternative 2

Table 3.4-32 compares the types and number of items that will be expended in the PACNW OPAREA under Alternative 2. These figures exclude mine countermeasure training in the Puget Sound, which is discussed in the next section.

Under Alternative 2, a total of 183,867 items would be expended, a 92 percent increase over the No Action Alternative. Assuming an even distribution of these items within the PACNW OPAREA, the concentration of expended items would be about 1.5 per nm^2 (0.4 per km^2). More than 60 percent of these materials would be small caliber rounds. Many of these items are inert, would settle to the sea bottom and become encrusted by chemical processes and marine organisms, and pose no hazard to ocean water resources. The number of vessel sinkings would also increase from one to two compared to the No Action Alternative. This level of deposition is not expected to adversely impact water resources.

Training Materials Expended in Puget Sound – Alternative 2

Under all alternatives, the only activities in nearshore habitats in Puget Sound would occur during mine countermeasure training at EOD Crescent Harbor, EOD Floral Point, and EOD Indian Island.

Table 3.4-32: Summary of Training Materials Expended – No Action and Alternative 2

Type of Expended Material	No Action	Alternative 2		
	Number	Number	Numerical Increase	Percent Increase
Bombs	108	144	36	33
Missiles (excluding CATM-88c HARM)	10	57	47	470
Cannon Shells (20mm)	7,200	16,000	8,800	122
Naval Gunshells (5-inch, 25mm, 57mm, 76mm)	18,656	37,343	18,687	100
Small Caliber Rounds (.50 caliber, 7.62mm)	59,724	119,720	59,996	100
Pyrotechnics	539	580	41	8
MK-58 Marine Marker	208	220	12	6
EMATTs	121	126	5	4
TALDs	0	22	22	–
Sonobuoys	9,132	9,651	519	6
Torpedoes	1	2	1	100
Vessel Sinkings	1	2	1	100
Total	**95,700**	**183,867**	**88,167**	**92**

In April 2008, the Navy decided to relocate Explosive Ordnance Disposal Mobile Unit Eleven (EODMU Eleven) forces out of the NWTRC Study Area to Imperial Beach, CA. This move is planned to be completed in the fall of 2009. Two EOD Shore Detachments (Bangor and Northwest) will remain in the NWTRC. These Shore Detachments report to Commander, Navy Region Northwest and respond to regional Navy taskings and incidents. As a result of the EODMU Eleven relocation, mine warfare underwater detonation training will significantly decrease from a yearly maximum of 60 underwater detonation as analyzed in the No Action Alternative (the baseline) to no more than four annual underwater detonation as analyzed in Alternatives 1 and 2, a decline of over 90 percent. The maximum charge size for these four explosions would be 2.5 pounds. Adverse impacts from this level of activity would be negligible because of relatively low level of activity and standard site investigation and clean up procedures. Lastly, 98 percent of explosion byproducts are normal constituents of seawater.

Adverse impacts from this level of activity would be negligible because of relatively low level of activity and standard site investigation and clean up procedures. In addition, 98 percent of explosion byproducts are normal constituents of seawater. Turbidity resulting from detonation would dissipate rather quickly depending on the site conditions at the time, such as wind speed and tidal currents.

3.4.3 Mitigation Measures

As discussed in Section 3.4.7, impacts to water resources resulting from the alternatives proposed in the EIS/OEIS would be below thresholds that could result in long-term degradation of water resources or affect water quality in the NWTRC. Current requirements and protective measures described in Chapter 5 would continue to be implemented, and no further mitigation measures would be needed to protect water resources in the NWTRC.

3.4.4 Summary of Effects by Alternative

None of the proposed action alternatives would have long-term or significant impacts on marine or fresh water resources in the Study Area. Short-term effects on water quality would be related to ordnance use and expended materials, and would not be anticipated to be measurable given the large area over which activities occur and the dynamic nature of the marine environment of the PACNW. Table 3.4-33 summarizes the effects of the alternatives.

Table 3.4-33: Summary of Effects – Water Resources

Alternative	NEPA (Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Releases of ordnance constituents from explosives and ordnance used during training exercises have no substantial impacts. • No long-term degradation of marine, surface, or ground water quality.	• Ordnance constituents and other materials (batteries, fuel, and propellant) from training devices have minimal effect; are below standards; or result in local, short-term impacts. • No long-term degradation of marine water quality.
Alternative 1	• Ordnance constituents (explosives, ordnance) from training devices and training exercises would have little effect or result in short-term impacts. • No long-term degradation of marine, surface, or ground water quality.	• Ordnance constituents and materials (batteries, fuel, and propellant) from training devices would have minimal effect; would be below standards; or would result in local, short-term impacts. • No long-term degradation of marine water quality.
Alternative 2 (Preferred Alternative)	• Impacts to Alternative 2 would be substantially the same as Alternative 1.	• Impacts to Alternative 2 would be substantially the same as Alternative 1.

3.5 Acoustic Environment

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3.5 ACOUSTIC ENVIRONMENT (AIRBORNE)

This section describes the existing airborne noise environment and the noise associated with the alternative training and testing scenarios. It also analyzes the potential impacts of this airborne noise on human receptors. Potential impacts stemming from military-generated sound sources on natural resources above and below the water are addressed in Sections 3.7 (Fish), 3.8 (Sea Turtles), 3.9 (Marine Mammals), 3.10 (Birds), and 3.11 (Terrestrial Biological Resources).

Airborne noises generated through implementation of the proposed action generally consist of either (1) noise that would be experienced over the course of an aircraft overflight or (2) impulse noise such as would be experienced during gunfire, bomb detonation, or small-scale land demolition practice events. The noise associated with the variety of Navy training events will be discussed in this section. Noise impacts on humans depend on a variety of factors, including the duration of the noise event, the decibel level of the noise event, and the context of the noise within the ambient noise environment. This section begins with an introduction to noise characteristics. The introduction is followed by a description of the existing airborne noise environment at sea and over land. The section concludes with an assessment of how each alternative is likely to impact the airborne noise environment. With the exception of submarines, all Navy platforms involved in the proposed training and testing events produce some level of airborne noise from engine or ordnance noise sources. Therefore, all training and testing events listed in Chapter 2 will be analyzed in this section. Surface vessel engine noise, aircraft engine noise, and ordnance-related noises are the stressors that will be analyzed in Section 3.5.3.

3.5.1 Introduction

Sound is a physical phenomenon and a form of energy that can be described, measured, and represented with mathematical expressions. Noise, on the other hand, is not a physical process, but rather an implicit social value, defined generally as unwanted sound. Recognition of sound is based on the receptor's objective and reproducible response to sound's primary physical attributes: intensity (perceived by the receptor as loudness), frequency (perceived as pitch), frequency distribution and variation over time, and duration (whether continuous, sporadic, or impulse). Perception of sound, however, is subjective and circumstantial. Sounds that are soothing to some are annoying to others, and sounds barely noticed and generally ignored in one circumstance may be considered highly objectionable in another circumstance.

Beyond subjective effects, however, sound at higher intensities or power levels can have physical consequences. The range of such impacts have been defined as falling into three categories as sound pressure levels increase: subjective effects (e.g., annoyance, nuisance, dissatisfaction), interferences with activities (e.g. communication, sleep, learning, behavioral changes), and physiological effects (e.g., anxiety, hearing impacts, loss of hearing).

3.5.2 Sound Characteristics

3.5.2.1 Sound Fundamentals

Sound is typically described by its magnitude (otherwise referred to as amplitude), intensity, and frequency and the changes in those values over time (e.g., sudden impulse vs. continuous vs. repetitive). The physical phenomenon of sound is generated by mechanical vibrations traveling through an elastic medium (*i.e.* air or water), resulting in a rapid change in pressure (high and low pressure fluctuations or waves) in the medium.

Sound waves are characterized by parameters such as amplitude, intensity, wavelength, frequency, and velocity. The amount of energy contained in a sound pressure wave is referred to as its amplitude, while the amount of energy passing through a unit area per unit of time is the sound wave's intensity. The units of sound intensity are watts per square meter (energy per unit of time per unit of area). Amplitude and intensity are directly and linearly related. Higher amplitude sounds are perceived to be louder than lower amplitude sounds. Sound pressures are usually represented in micro Pascals (μPa.). A Pascal is equal to one Newton of force distributed over one square meter. The maximum sound pressure level of a noise event is referred to as the "peak noise level."

The frequency of sound represents the rate at which the source produces sound waves (a complete cycle of high and low pressure waves) or the rate at which the sound-producing body completes one vibration cycle. Frequency is a precisely measurable quantity representative of a particular sound. Sounds are produced throughout a wide range of frequencies, including frequencies beyond the audible range of a given receptor. Most of the sounds we hear in the environment do not consist of a single frequency, but rather a broad band of frequencies differing in sound level. The intensities of each frequency add to generate the sound we hear.

The speed of sound is not affected by its intensity, amplitude, or frequency, but rather depends wholly on the characteristics of the medium through which it is passing. Sound generally travels faster as the density of the medium increases. Speeds of sound through air are primarily influenced by air temperature, and negligibly by the air's relative humidity and pressure, averaging about 1,115 feet/second (340 meters/second) at standard barometric pressure. Sound speeds in air increase as air temperature increases. Speed of sounds in liquid is similarly influenced primarily by the liquid's density and temperature. Thus, the speed of sound in 32°F (0°C) water is 4,600 feet/second (1,402 meters/second) and in 68°F (20°C) water is 4,862 feet/second (1,482 meters/second).

The speed of sounds in solids is a more complex matter, with longitudinal and transverse waves traveling at different speeds depending on the density of the material as well as its geometry and molecular structure.

The mathematical relationship between sound stimulus and sound perception by a human receptor is logarithmic. This logarithmic relationship between magnitude and perception is the basis for the decibel (dB) scale used to express sound intensity. The decibel scale measures relative sound intensities rather than absolute intensities; specifically, it measures the ratio of a given intensity (of sound) to the threshold sound intensity of human hearing (by definition 0 dB). For most human individuals, a sound wave pressure of 20 μPa represents the hearing threshold. As sound stimuli increases geometrically (i.e., multiplied by a fixed factor), the corresponding perception changes arithmetically (i.e., additive by constant amounts). Thus, a tenfold increase in sound stimulus over the threshold of hearing is assigned a value of 10 dB but is perceived as a doubling of loudness; a hundredfold increase to 20 dB is perceived as sound that is four times louder, and so forth.

Although sound is a physical phenomenon that can be represented by mathematical expressions and measured with precision, perception of sound pressure level is the result of physiological responses as well as subjective factors, each influenced by current circumstances and past exposures. The sound pressure level is the perception of a sound wave's pressure by a single receptor at a specified distance and direction from the sound source.

Sound pressure levels are measured by sound level meters, which typically contain filters that reduce the meter's sensitivity to frequencies of little or no relevance to the human receptor. The method commonly used to quantify environmental sounds consists of determining all of the frequencies according to a weighting system that reflects the nonlinear response characteristics of the human ear. A meter that filters very low and very high frequency sounds thus acts as a general approximation of the human ear's response to sounds of medium intensity. This is called "A" weighting, and the decibel level measured is called the A-weighted sound level (dBA). In practice, the level of a noise source is conveniently measured using a sound level meter that includes a filter corresponding to the dBA curve.

A common method of describing sound pressure levels is by comparing commonly experienced sounds. Typical sound sources and their corresponding environments are listed below in Figure 3.5-1. Sound levels indicated are for single events. Such events are discrete, and two or more events cannot simply be added together. Integrating varying noise levels and sources over a given period requires complex calculations or modeling.

The sound measure employed by federal agencies is known as the day-night average sound level (DNL). The DNL is defined as the A-weighted average sound level for a 24-hour day. It is a calculated noise metric derived from measurements but includes a 10-dB penalty for late-night (*i.e.*, 10:00 p.m. to 7:00 a.m.) sound levels. This penalty accounts for the increased sensitivity of humans to noise at night.

3.5.2.2 Sound Propagation

Understanding the impact of sound on a receptor requires a basic understanding of how sound propagates from its source. Sound propagation follows the inverse square law: the intensity of a sound wave decreases inversely with the square of the distance between the source and the receptor. Thus, doubling the distance between the receptor and a sound source results in a reduction in the intensity of the sound of one fourth of its initial value; tripling the distance results in one ninth of the original intensity, and so on.

Sound propagates through gases and liquids primarily as longitudinal waves, causing displacements of the molecules comprising the gas or liquid in directions generally parallel to the direction of the sound wave. While the concept of a longitudinal or transverse sound wave traveling from its source to a receptor is relatively simple, sound propagation in fact is quite complex due to the simultaneous presence of numerous sound waves of different frequencies and other phenomena such as reflections of sound waves and subsequent constructive or destructive interferences between reflected and incident waves.

Interferences between two waves with different frequencies result in the production of “beats.” Depending on whether the interferences between these waves are constructive (where their amplitudes are additive) or destructive (where their amplitudes cancel each other), the sound perceived by the receptor is alternately loud and soft, with the rate at which such amplitude changes occur generally reflecting the difference between the frequencies of the two interacting waves. Perception of interfering sound waves is complex, and in some frequency ranges the receptor perceives (“hears”) neither of the frequencies of the interacting waves, but rather a third frequency known as a “subjective tone” or “difference tone.”

3.5.2.3 Noise-Related Environmental Stressors

Table 3.5-1 illustrates the various training events that occur within the NWTRC, the noise stressors associated with each training event, and the general location where the events occur. As shown in the table, potential noise stressors can emanate from aircraft engine noise, surface vessel engine noise, and ordnance noise. Furthermore, as shown in the table, most training event types occur beyond 12 nautical miles from shore and beyond the hearing of any human receptors.

3.5.3 Affected Environment

Various activities and processes, both natural and anthropogenic, above and below the water’s surface, contribute to the sound profile of the ocean environment. This section focuses on sound above the water’s surface and its potential impacts to human receptors. In the offshore operating area, these receptors include boaters. The potential impacts stemming from military-generated sound sources on natural resources above and below the water are addressed in the relevant sections of this chapter.

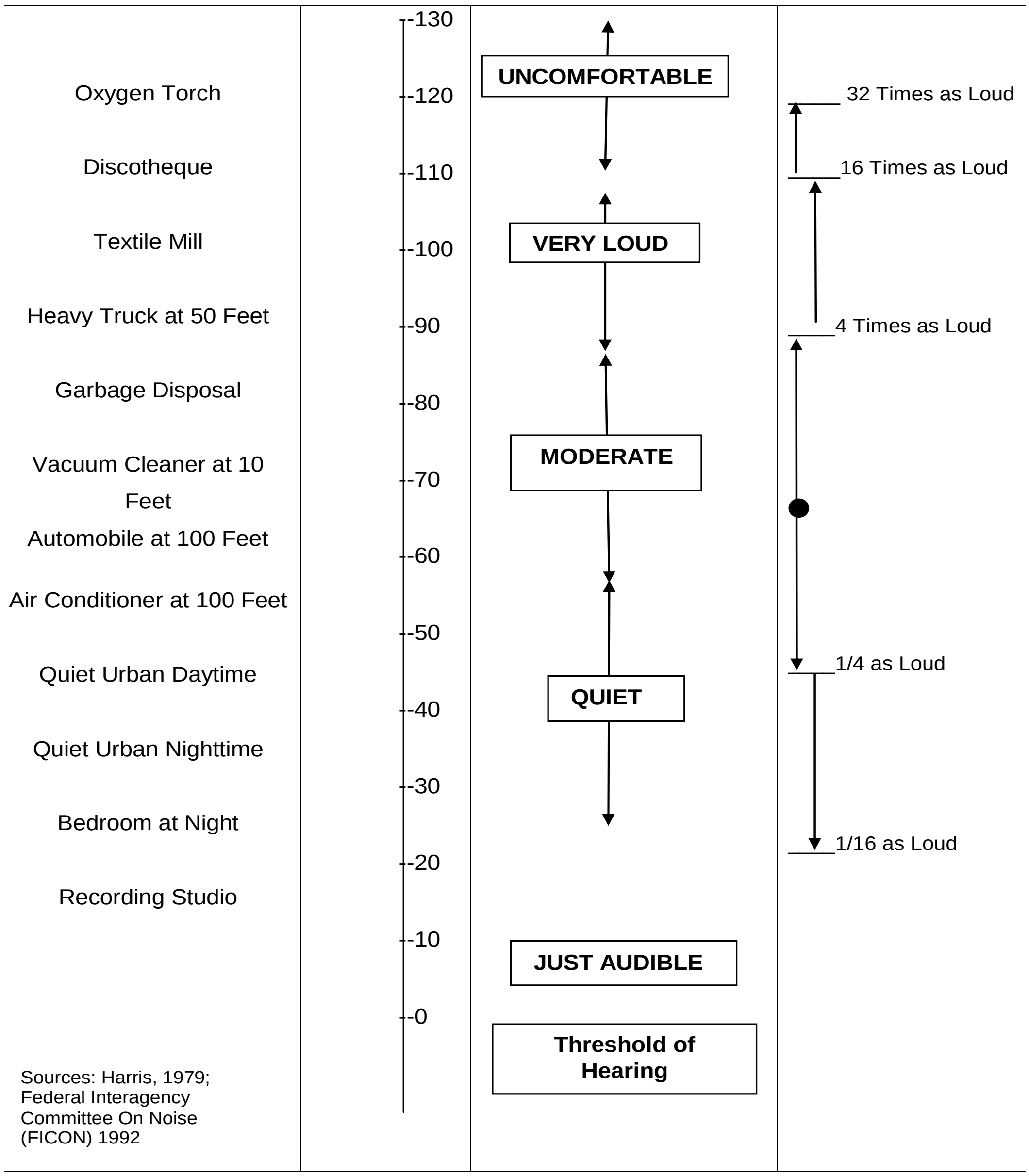

Figure 3.5-1: Sound Levels of Typical Airborne Noise Sources and Environments

3.5.3.1 Pacific Northwest OPAREA

Ambient Sound

In general, ambient sound levels in the ocean environment tend to be greatest in relatively shallow nearshore environments and appear to be directly related to wind speeds and indirectly related to sea-state (breaking waves) (Willie and Geyer 1984). The seafloor also plays a role in either reflecting or absorbing sound, with that role being more influential in shallow waters (Urick 1983). Ambient sound in the ocean environment includes intermittent sources such as lightning strikes, underwater volcanoes, earthquakes, and hydrothermal eruptions can also represent major contributions. The impacts of these intermittent events can be substantial. For example, lightning striking the surface of the water can have sound power levels of as much as 260 dB underwater at 39 inches (1 meter), and heavy rain can add as much as 35 dB over a broad frequency range (Office of Marine Programs 2006).

Table 3.5-1: Warfare Areas and Noise-Related Environmental Stressor in the NWTRC

		Stressors			Location		
Primary Warfare Area and Activity	**Training Area(s)**	**Surface Vessel Engine Noise**	**Aircraft Engine Noise**	**Explosive or Gunfire Noise**	**Over land or 0-3 nm from shore**	**3-12 nm from shore**	**More than 12 nm from shore**
Anti-Air Warfare (AAW)							
Air Combat Maneuver (ACM)	Okanogan, Olympic, & Roosevelt MOAs, ATCAAs, W-237		✓		✓	✓	✓
Missile Exercise (Air-to-Air) (MISSILEX [A-A])	W-237		✓	✓			✓
Gunnery Exercise (Surface-to-Air) (GUNEX [S-A])	W-237, OPAREA	✓	✓	✓		✓	✓
Missile Exercise (Surface-to-Air) (MISSILEX [S-A])	W-237, OPAREA	✓	✓	✓		✓	✓
Surface Warfare (SUW)							
Gunnery Exercise (Surface-to-Surface) (GUNEX [S-S])	W-237, OPAREA	✓		✓		✓	✓
Bombing Exercise (Air-to-Surface) (BOMBEX [A-S])	W-237, OPAREA		✓	✓			✓
Ship Sinking Exercise (SINKEX)	W-237, OPAREA	✓	✓	✓			✓
Anti-Submarine Warfare (ASW)							
Anti-Submarine Warfare Tracking Exercise – Maritime Patrol Aircraft (ASW TRACKEX-MPA)	W-237, OPAREA		✓		✓	✓	✓
Anti-Submarine Warfare Tracking Exercise -Extended Echo Ranging (EER)	W-237, OPAREA		✓			✓	✓
Anti-Submarine Warfare Tracking Exercise-Surface Ship (ASW TRACKEX-Surface)	OPAREA	✓				✓	✓
Anti-Submarine Warfare Tracking Exercise –Submarine (ASW TRACKEX-Sub)	W-237, OPAREA		✓			✓	✓
Electronic Combat (EC)							
Electronic Combat (EC) Exercises	W-237, Darrington Area		✓		✓	✓	✓

Table 3.5-1: Warfare Areas and Noise-Related Environmental Stressor in the NWTRC (cont'd)

		Stressors			Location		
Primary Warfare Area and Activity	**Training Area(s)**	**Surface Vessel Engine Noise**	**Aircraft Engine Noise**	**Explosive or Gunfire Noise**	**Over land or 0-3 nm from shore**	**3-12 nm from shore**	**More than 12 nm from shore**
Mine Warfare (MIW)							
Mine Countermeasures (MCM)	Crescent Harbor, Indian Island, Floral Point	✓	✓	✓	✓		
Land Demolitions	DTR Bangor DTR & DTR Seaplane Base			✓	✓		
Naval Special Warfare (NSW)							
Insertion/Extraction	Seaplane Base, Outlying Landing Field (OLF) Coupeville & Crescent Harbor	✓	✓		✓		
Naval Special Warfare (NSW) Training	Indian Island	✓			✓		
Strike Warfare (STW)							
HARM Missile Exercise (HARMEX)	Okanogan, Olympic, & Roosevelt MOAs, ATCAAs, W-237		✓		✓	✓	✓
Support Operations							
Intelligence, Surveillance, and Reconnaissance (ISR)	W-237, OPAREA		✓		✓	✓	✓
Unmanned Aerial Vehicle (UAV) RDT&E and Training	Admiralty Bay (R-6701), W-237 & OPAREA		✓		✓	✓	✓

[1] Numbers in the columns for all three alternatives represent aircraft sorties and ship events, depending on the type of training activity.

Intermittent airborne noise sources also include those from manmade sources. In addition to the sounds produced from commercial shipping engines, other manmade sources of airborne noise in the OPAREA include military, general aviation, and commercial aircraft; nearshore construction activities; military explosive use; recreational boating; mineral exploration and extraction; and scientific vessel engine noise.

Ambient noise in the land environment includes many of the same noise sources as the ocean environment, as well as automobile traffic, trains, and construction.

Sound from Military Sources

Airborne noise attributable to military activities in the OPAREA emanates from multiple sources including naval ship power plants, military aircraft, targets, bombs, missiles, and small arms fire. Sound from military sources in the OPAREA is virtually all transitory, and can be widely dispersed or concentrated in small areas for varying periods. Sound from military sources also varies in a west (far offshore) to east (near shore) direction across the OPAREA. Navy sound in the western part of the OPAREA is dominated by fixed-wing aircraft noise, with occasional impulsive noise associated with ship gunfire and with missile and bomb detonations. Navy training sounds nearshore are dominated by aircraft overflight noise.

Military Aircraft

Flying aircraft contribute sound to the environment. Fixed-wing aircraft engaged in anti-submarine warfare (ASW) and associated training activities are a common source of airborne sound in offshore areas. As with most manmade sounds, most aircraft sounds involve low frequencies. Aircraft sound entering the water at an angle of incidence of 13 degrees from the vertical or less will lose some of the sound energy as sound is transmitted under the water's surface. At greater angles of incidence, the water surface acts as an effective reflector of the sound wave, allowing the sound energy to remain largely unchanged in the above-water environment (Urick, 1972). Military activities involving aircraft generally are dispersed over large expanses of the open ocean, but can be highly concentrated in time and location near Naval Air Station Whidbey Island (NASWI) (arrivals and departures) and Outlying Landing Field (OLF) Coupeville. Air combat maneuvers and electronic combat training are also conducted by tactical jets in the northwest portions of the NWTRC OPAREA (W-237). Representative sound levels associated with military aircraft are depicted in Table 3.5-2.

Table 3.5-2: Representative Aircraft and Ordnance Sound Sources in the NWTRC

Noise Source	Sound Level (dBA)	Typical Noise Environment
Jet Aircraft Takeoff	115 @ 1,000 ft	OPAREA at Aircraft Carrier
SH-60 Helicopter Hovering	90 @ 50 ft	OPAREA, Crescent Harbor, OLF Coupeville, Seaplane Base
ASW Target Drop	90 @ 50 ft	OPAREA
HC Smoke Charge MK-58, 25	60 @ 50 ft	OPAREA
Torpedoes (at impact with water)	105 @ 50 ft	OPAREA
Mine Shapes (BDU-45,MK-62, 63, 65)	105 @ 50 ft	OPAREA
Chaff (packet rupture at high altitude) Aircraft ALE-37	90 @ 50 ft	OPAREA
Aircraft Defensive Flares	65 @ 50 ft	OPAREA
Practice Bombs, 25 lb inert, spotting charge	60 @ 50 ft	OPAREA
Inert Bombs, 500 lb (at impact)	105 @ 50 ft	OPAREA
Inert Bombs, 1,000 lb (at impact)	108 @ 50 ft	OPAREA
Live Bombs, 500 lb (at impact)	110 @ 50 ft	OPAREA
Live Bombs, 1,000 lb (at impact)	125 @ 50 ft	OPAREA
Naval Gun Ammunition 5"/54	110 @ 50 ft	OPAREA
Cannon Shells, 20mm (at source)	105 @ 50 ft	OPAREA
Cannon Shells, 25mm (at source)	110 @ 50 ft	OPAREA
7.62mm M60 Machine Gun	90 @ 50 ft	OPAREA
.50-caliber Machine Gun	98 @ 50 ft	OPAREA
Land demolition charges up to .5 lbs	84.9 @ 18,000 ft	Seaplane Base Detonation Training Range (DTR), DTR Bangor

Notes: 50 feet and 1,000 feet are standard reference distances. ASW - Anti-Submarine Warfare; BDU - Bomb Dummy Unit; cal - caliber; dBA - decibels, A-weighted; ft - feet; lb - pound; mm - millimeters;
Source: Investigative Science and Engineering (ISE), 1997; NASWI, 1993; Ewbank, 1977, 2005 Air Installation Compatibility Use Zone (AICUZ) Study Update

Sonic Boom Noise. Supersonic aircraft flights can occur from time to time in the NWTRC OPAREA. Such flights are usually limited to altitudes above 30,000 ft (9,144 m) and/or locations more than 30 nautical miles (55.6 km) from shore. Several factors influence sonic booms: weight, size, shape of aircraft or vehicle; altitude; flight paths; and atmospheric conditions. A larger and heavier aircraft must displace more air and create more lift to sustain flight compared with small, light aircraft. Therefore, larger aircraft create sonic booms that are stronger and louder than those of smaller, lighter aircraft. Consequently, the larger and heavier the aircraft, the stronger the sonic boom shock waves will be (DoN 2007).

Of all the factors influencing sonic booms, increasing altitude is the most effective method of reducing sonic boom intensity. The width of the boom "carpet" or area exposed to sonic boom beneath an aircraft is about one mile (1.6 km) for each 1,000 ft (305 m) of altitude. For example, an aircraft flying supersonic straight and level at 50,000 ft (15,240 km) can produce a sonic boom carpet about 50 miles (80 km) wide. The sonic boom, however, will not be uniform. Maximum intensity is directly beneath the aircraft, and decreases as the lateral distance from the flight path increases until shock waves refract away from the ground and the sonic boom attenuates. The lateral spreading of the sonic boom depends only on altitude, speed, and the atmosphere, and is independent of the vehicle's shape, size, and weight. The ratio of the aircraft length to maximum cross sectional area also influences the intensity of the sonic boom. The longer and more slender the aircraft, the weaker the shock waves will be. The wider and more blunt the vehicle, the stronger the shock wave can be (DoN 2007).

Sonic booms are generated as aircraft reach Mach 1.0 (speed of sound) and increase in intensity as the Mach number increases. Aircraft currently training in the NWTRC cannot fly at supersonic speeds in normal training configuration (with external jamming pods and fuel tanks).

Ordnance Use

Impulsive sound results from ordnance use in the OPAREA. Some representative ordnance sound levels are depicted in Table 3.5-2.

Missile and Target Launch

Sound associated with missile and target launches occurs in the OPAREA infrequently, and then only during scheduled events. Due to safety concerns over launch activities, a buffer zone of several square miles is always instituted and enforced. Sound due to missile and target launches is typically at a maximum at the point of initiation of the booster rocket, and rapidly fades as: (1) the missile or target reaches optimal thrust conditions; and (2) the missile or target reaches a downrange distance where the booster burns out and a sustainer engine continues. For example, data for the BQM-34 show that its booster Jet Assisted Take-Off (JATO) bottles generate 113 dBA at the source at launch. Sound levels decrease to 99 dBA at 2,400 ft (731.5 m) (DoN 1998). The BQM-34 may be used in the OPAREA (though much less frequently than the smaller BQM-74).

In the OPAREA, the BQM-74 is likely to be the typical target drone. It can be launched from surface vessels, as shown in Figure 3.5-2, as well as aircraft. The BQM-74s will be used during surface to air MISSILEX training proposed to occur under Alternative 2. They are proposed to occur very infrequently (four events per year). The events take place at high altitude (between 10,000 ft and 20,000 ft) and at least 12 nautical miles from shore.

Figure 3.5-2: Target Drone Launch

Non-Explosive Impact Noise

Non-explosive impact sound in the OPAREA is generally from high-velocity “dummy” projectiles and inert training bombs. Sounds of this type are produced by the kinetic energy transfer of the object with the target surface, and are highly localized to the area of disturbance. Sound associated with the impact event is typically of low frequency (less than 250 Hz) and of a short enough duration (*i.e.*, impulse sound) that it produces negligible amounts of acoustic energy. These events occur on remote ranges (OPAREA in connection with A-S BOMBEX and SINKEX events) that are restricted from the public, so they often go unobserved. SINKEXs occur infrequently (up to two times per year under any alternative), and they occur at least 50 nautical miles from shore. The impacts may be scored by remote observers – participants in the exercise who are at a safe distance from the source.

Explosives

Explosives detonated at the water surface and underwater introduce loud, impulsive, broadband sounds into the marine environment. The potential impacts of explosive detonations on wildlife are considered in Sections 3.6, 3.7, 3.8, 3.9 and 3.10. The airborne noise associated with underwater explosions is minimal. A characteristic phenomenon of the difference in acoustic impedance between air and water is that the air/water interface will act as a very good reflector, the so-called Lloyd mirror. Therefore, very little energy will pass this reflector, meaning that sound generated in the water will not pass over to the air and vice versa.

Three source parameters influence the effect of an explosive: the weight of the explosive warhead, the type of explosive material, and the detonation depth. The net explosive weight (NEW) accounts for the first two parameters. The NEW of an explosive is the weight of the explosive material in a given round, referenced to the explosive power of TNT or C4. Table 3.5-3 sets forth the explosive weight of various explosive ordnance items used in the NWTRC. The ordnance used is shown with the particular training event using the ordnance. All events (with the exception of Explosive Ordnance Disposal [EOD] underwater mine neutralization and land demolitions) occur in the OPAREA at least 3 nautical miles from shore. As mentioned earlier, SINKEX events occur at least 50 nautical miles from shore. The SINKEX, which occurred in July 2005, occurred 130 nautical miles from shore (DoN 2005b). Of all OPAREA training events that use explosives, SINKEXs uses the most explosives, but they occur infrequently.

The detonation depth of an explosive is important due to a propagation effect known as surface-image interference. For sources located near the sea surface, a distinct interference pattern arises from the coherent sum of the two paths that differ only by a single reflection from the pressure-release surface. As the source depth and/or the source frequency decreases, these two paths increasingly, destructively interfere with each other, reaching total cancellation at the surface (barring surface reflection scattering loss). Since most explosive sources used in military activities in the OPAREA are munitions that detonate essentially on impact, the effective source depths are quite shallow, and therefore the surface-image interference effect can be pronounced. One exception is the IEER sonobuoy which detonates underwater and thus produces no airborne noise (DoN 2001).

Table 3.5-3: Training Events Utilizing Explosives in the NWTRC

Training Event	Ordnance Involved (Net Explosive Weight per Item)
Air-to-Air MISSILEX	AIM 7 Sparrow (85 lb), AIM 9 Sidewinder (20.8 lb), AIM-120 AMRAAM (48 lb)
Surface-to-Air MISSILEX	NATO Sea Sparrow missile (90lb)
Air-to-Surface BOMBEX	MK-82 (500 lb), MK-83 (415.8 lb), and MK-84 (944.7 lb).
SINKEX	MK-82 (192.2 lb), MK-83 (415.8 lb), MK-84 (944.7 lb), HARM (48 lb), Hellfire AGM-114 (14.82 lb), Maverick (80 lb), Harpoon (488 lb), SLAM ER (360 lb), standard missile (223 lb), 5-inch naval gunfire (8.8 lb), 76mm gun rounds (1.3 lb), MK-48 ADCAP torpedo (650 lb)
ASW TRACKEX-MPA	IEER sonobuoys (two 4-lb charges per sonobuoy)
MCM-Mine Neutralization	Underwater Mine Neutralization Charges (0.5 lb, 2.5 lb)
Land Demolitions	Various charges ranging in size up to 5 lb

The sound of a Hellfire missile detonation (used in the SINKEX events) is described in the Overseas Environmental Assessment of Testing the Hellfire Missile System's Integration with the H-60 Helicopter (NAVAIR 2005). The greatest sound intensity generated from the firing of a Hellfire missile is approximately 149 dB re 1 μPa at 15 ft (4.6 m) in altitude (NAVAIR 2005). This is the altitude above the water where the Hellfire missile is expected to detonate upon impact with the floating target.

3.5.3.2 Nearshore and Onshore Airborne Noise, and Sensitive Receptors

Ambient Sound

Ambient sounds in the nearshore or land portions of the complex are generated by natural sources, such as wind and surf; however, the primary sources of noise include transportation activities and waterfront operations.

Noise levels from flight activities exceeding ambient background sound levels typically occur beneath main approach and departure corridors, beneath local air traffic patterns around an airfield, and in areas immediately adjacent to parking ramps and aircraft staging areas. As aircraft in flight gain altitude, their noise contribution drops to lower levels, often becoming indistinguishable from the background noise.

Noise potentially becomes an issue when its intensity exceeds the ambient or background sound pressures. Ambient background noise in metropolitan, urbanized areas typically varies from 60 to 70 dB and can be as high as 80 dB or greater; quiet suburban neighborhoods experience ambient noise levels of approximately 45 to 50 dB (USEPA 1978). Noise levels at Naval Air Station Whidbey Island (NASWI) and OLF Coupeville are described in the 2005 Air Installation Compatibility Use Zone (AICUZ) Report update and are not considered a part of the training range complex. Thus they are not further analyzed here (Figure 3.5-3 from DoN 2005a).

A portion of the sound attributable to training and testing events in those portions of the NWTRC closest to shore (within 3 nautical miles), on shore, or over land results from helicopter flights associated with mine countermeasures training, or insertion extraction. Helicopter noise associated with mine countermeasures training at Crescent Harbor and insertion extraction training at Crescent Harbor, Seaplane Base, and OLF Coupeville takes place within the existing higher noise contours established by the EA-6B and newer EA-18G. Helicopter noise in these areas would be either indistinguishable from the background jet noise or masked by the louder jet noise. MCM training at Crescent Harbor, takes place at a lesser extent offshore from Indian Island (6 percent) and at Floral Point (6 percent). Airborne noise associated with MCM activities is limited because the detonations take place underwater.

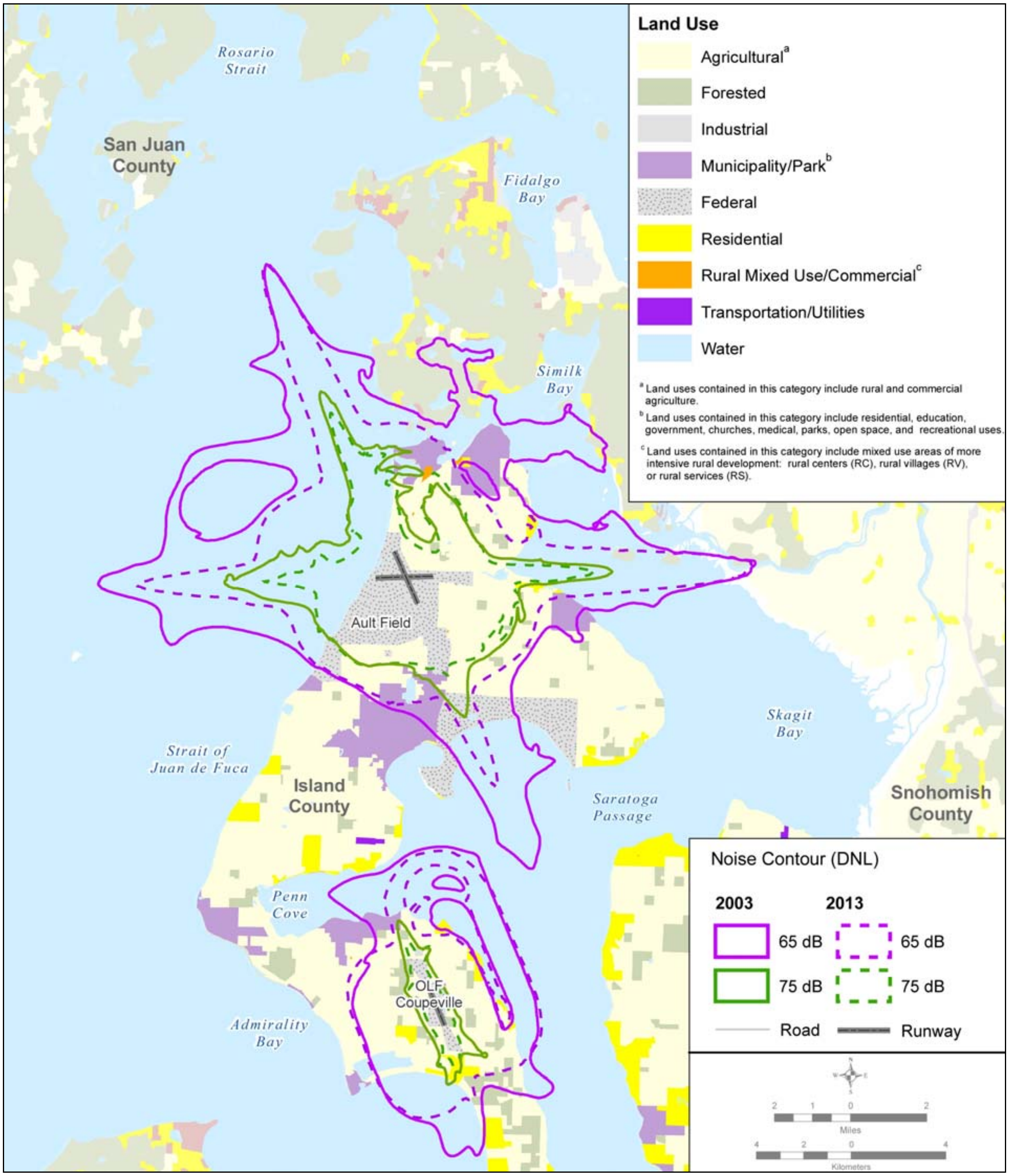

Figure 3.5-3: Comparison between Existing 2003 DNL Contours and Projected 2013 Noise Contours over Land Use

Sound in the nearshore or over land portions of the range complex can also result from higher-altitude, fixed-wing aircraft noise associated with electronic combat and air combat maneuvers throughout the inland MOAs (Olympic, Okanagan, and Roosevelt). For example, although the airspace floor is as low as 300 ft above the ground, ACM and HARMEX training typically occurs at altitudes over 10,000 ft (3,048 m) above ground level. As mentioned above, high-altitude flight noise is often indistinguishable from the background noise.

An environmental assessment was prepared for the establishment of the Okanagan MOA (USAF 1976). As stated in the environmental assessment, noise impacts were expected to be minimal in that the areas lie over sparsely populated mountainous forest terrain. The frequency of use is spread over a large enough area that recurring passage over the same place is only by chance. Recreation centers were not likely to be affected. Average noise levels could not be computed, since aircraft fly random flight paths within the areas. All aircraft operate at subsonic speed. Other MOAs overlie similarly sparsely populated areas, and aircraft passage over the same place is only by chance. The conclusions of this 1976 environmental assessment are relevant to our discussion of aircraft noise; further analysis of the potential effects of aircraft overflights on terrestrial species is provided in Section 3.11.

Occasional noise currently results from UAV flights from Admiralty Bay (currently an average of one flight per month) and from NSW and EOD small boat trips around Crescent Harbor or to Indian Island, though these sounds are likely to blend with ambient noise levels (aircraft noise around Ault Field and commercial and recreational fishing vessel noise).

Navy training sounds in the nearshore or on land portions of the complex can stem from the occasional land demolition at the DTR Seaplane Base or DTR Bangor. Land demolition training occurs primarily at Seaplane Base (94 percent), and has been occurring at Seaplane Base for approximately 15 years. An environmental assessment was produced for the DTR Seaplane in 1993 (NASWI 1993). Noise monitoring was conducted at this time. Table 3.5-4 outlines the noise study results.

Table 3.5-4: Sound Levels Near DTR Seaplane Base

Distance from ½ Pound Detonation	Decibel Level
2,200 ft	118.2 dB
2,700 ft	115 dB
3,200 ft	112.3 dB
5,800 ft	102.9 dB
6,000 ft	102.3 dB
7,000 ft	99.9 dB
16,000 ft	86.2 dB
18,000 ft	84.9 dB

Source: NASWI 1993

Noise complaint guidelines have been developed by Naval Surface Warfare Center (NSWC) Dahlgren, Virginia. These levels resulted from the best compromise between cost, efficiency of range operations, and good community relations (NASWI 1993). Table 3.5-5 sets forth these guidelines.

All noise receptor points in the 1993 noise modeling were within the range boundary. It was therefore unlikely that off-range noise receptors would experience noise levels in excess of 115 dB, and therefore the risk of noise complaints was considered minimal.

Table 3.5-5: Impulse Noise Guidelines

Predicted Noise Level (dBP)	Risk of Complaints	Action
<115	Low risk of noise complaints.	Proceed with required explosive activities.
115-130	Moderate risk of noise complaints.	Postpone non-critical explosive activities.
130-140	High risk of noise complaints; possibility for damage.	Proceed only with critically important explosive activities.
>140	Threshold for permanent physiological damage to unprotected human ears. High risk of physiological and structural damage claims.	Postpone all explosive activities.

Source: NASWI 1993

Sensitive receptors are those noise-sensitive areas, including developed and undeveloped areas for land uses such as residences, businesses, schools, churches, libraries, hospitals, and parks. Military personnel are not considered to be sensitive receptors of airborne noise for purposes of environmental impact analysis. While persons on recreational or fishing vessels in the Puget Sound, Straight of Juan de Fuca, Crescent Harbor, Admiralty Bay, and Hood Canal might be exposed to sound generated by military activities, the likelihood of such exposure is quite low, due to extensive standard operating procedures (SOPs) employed by the Navy to ensure civilian persons do not interfere and are not inadvertently affected by military activities. The nearest shore-based sensitive receptors would be located in residences and community facilities outside of the Seaplane Base and near Crescent Harbor.

The Navy tries to reduce the impacts of noise on civilian populations. If the NASWI Community Planning Liaison receives noise complaints, then he or she will initiate the noise complaint response procedure. This office contacts the complainant to follow up on the status of the complaint, if requested. If flight procedures were violated, appropriate commanders are notified for review and determination of appropriate action. The Community Planning Liaison also works with the local planning boards (Oak Harbor and Island County) to ensure cooperation between base operations and local land use decisions.

A noise study was conducted in 2000 at NASWI measuring the noise levels associated with the detonation of various charge sizes up to 5 pounds. This site is used infrequently (6 percent) in comparison to Seaplane Base (94 percent). The results are shown in Table 3.5-6.

Table 3.5-6: Unweighted Peak Noise Measurements (dBP) 2,000 feet from DTR NASWI

Net Explosive Weight (NEW) of Explosives (lbs)				
0.25 lb	0.50 lb	0.75 lb	1.0 lb	5.0 lb
109 - 114	115.5 – 119.5	116.5	115 – 117.5	120 - 125

Source: ROC, Melaas, March 13, 2000

No noise complaints have been filed in relation to the land demolitions conducted at NASWI.

3.5.3.3 Current Requirements and Practices

Navy activities in the OPAREAs comply with numerous established acoustic control procedures to ensure that neither participants nor non-participants engage in activities that would endanger life or property. SOPs for minimizing airborne noise impacts in the NWTRC fall into two categories; aircraft SOPs and EOD SOPs. For example, to mitigate the noise impacts from land demolitions, the Navy agreed in 1993 to limit detonations to daytime working hours and to favorable weather conditions (NASWI 1993).

3.5.4 Environmental Consequences

3.5.4.1 Approach to Analysis

The anticipated airborne-noise related environmental consequences for each alternative are discussed in this subsection. An introduction to the regulatory framework, assessment methodology, and stressor identification leads into that discussion.

Study Area

The Study Area is the airborne noise environment of the NWTRC.

Data Sources

A systematic review of relevant literature and data has been conducted to complete this analysis. Of the available scientific literature (both published and unpublished), the following types of documents were utilized in the assessment: Department of Defense operations reports, journals, books, periodicals, bulletins, and other technical reports published by government agencies, private businesses, or consulting firms.

Methods

The method used in this EIS/OEIS to assess the airborne noise environment impacts associated with existing and proposed Navy training and testing within the NWTRC includes the following steps:

- Analyze existing federal noise management regulations applicable to the proposed action;
- Consider existing Navy policies affecting noise production levels (e.g., range SOPs);
- Analyze the natural ambient or background noise levels in the range complex;
- Analyze the various types of noise sources associated with training and testing within the NWTRC (e.g., continuous versus impulsive noises);
- Review existing noise studies performed in connection with homebasing decisions, individual exercises, or tests; and
- Determine the overall noise environment impacts associated with existing Navy training and testing within the range complex given the regulatory/procedural framework.

The analysis presented in this section is limited to impacts of airborne sound on humans. Impacts of military-generated sound on natural resources are addressed in Sections 3.7, 3.8, 3.9, and 3.10.

Aircraft Standard Operating Procedures

Each aircrew will be familiar with the noise profiles of their aircraft and shall be committed to minimizing noise impacts without compromising operational and safety requirements (NASWI 2006). Flights of naval aircraft shall be conducted so that a minimum of annoyance is experienced by persons on the ground. It is not enough for the pilot to be satisfied that no person is actually endangered. Definite and particular effort shall be taken to fly in such a manner that individuals do not believe they or their property are endangered. Noise sensitive areas, to include resorts, beaches, national parks, national monuments, and national recreational areas shall be avoided when at altitudes of less than 3,000 ft (914.4 m) above ground level, except when in compliance with an approved traffic or approach pattern, established air route, or special use airspace. Noise sensitive areas shall be avoided in the development of low-level training routes and additional special use airspace unless the 3,000-foot criteria can be observed (DoN 2004).

Explosive Ordnance Disposal Standard Operating Procedures

The following EOD SOPs are in place to reduce noise impacts to human receptors:

- At the DTR Seaplane Base, the maximum net explosive weight per shot is 0.5 (1/2) lbs. (non-fragmenting). Multiple explosive charges attached to a main line/branch line are still considered the same shot.
- To greatly reduce the potential for noise complaints and to eliminate the potential for damage, detonations at the DTR Seaplane Base should only be conducted during specific meteorological conditions that take into account the temperature gradient, wind direction and speed, and the amount of explosive to be detonated.
- Restrict EOD detonations to daytime working hours, only.

In addition to these procedures, there are numerous safety-related procedures for all EOD ranges that also reduce noise impacts.

3.5.4.2 No Action Alternative

Under the No Action Alternative, noise levels at all locations through the range complex would remain at current levels. Navy training and testing in the OPAREA, especially live firing of weapons and aircraft activities, are sources of intrusive noise in the immediate vicinity, but the only receptors of that noise are typically military personnel. Military personnel who might be exposed to noise from these activities are required to take precautions, such as the wearing of protective equipment to reduce or eliminate potential harmful effects of such exposure (military personnel are not considered sensitive receptors for purposes of impacts analysis). Precautions are taken to prevent such exposure of non-military personnel in ocean areas (such as fishermen in the OPAREA). Over half of all Navy training event types occurring in the NWTRC occur at least 12 nautical miles from shore and are likely to be beyond the hearing of human receptors.

High-altitude overflights associated with electronic combat, air combat maneuvers, and HARMEX events are likely to blend in with ambient noise levels. These flights in over land MOAs also occur over sparsely populated areas, and repeated noise exposure is not likely due to random flight paths. Helicopter flights under the No Action Alternative would continue to occur within already elevated noise zones around Crescent Harbor and OLF Coupeville and thus pose indistinguishable noise. Unmanned Aerial Systems (UASs) conduct flight activities in the Admiralty Bay area. These aircraft are typically smaller and, by design, much quieter than civilian or other military aircraft. Due to their inherent quiet nature and randomness of flight paths, these UAS activities are not likely to create noticeable noise impacts. Land demolitions at Seaplane Base and NBK-Bangor have been occurring for approximately 15 years, with SOPs in place to mitigate impacts to sensitive receptors beyond the range boundary. Noise complaints will continue to be fielded for response by the community planning liaison.

Because sound-generating events are intermittent, occur in remote areas or off-limits areas, and do not expose a substantial number of human receptors to high noise levels, no sensitive receptors are likely to be exposed to sound from military activities under the No Action Alternative.

3.5.4.3 Alternative 1

Under Alternative 1, the number of most Navy training and testing activities would increase, as discussed in Chapter 2. Activities that include or could include aircraft make up a large portion of Alternative 1 activities. Although a small proportion of flights would be at altitudes as low as 300 ft, the preponderance of air activities takes place at high altitudes over land or far out to sea over the Pacific Ocean, out of range of human receptors. Approximately 109 annual aircraft activities in Alternative 1 involve helicopters at low-altitude flight, typically between NASWI, Crescent Harbor/Seaplane Base, and OLF Coupeville.

Alternative 1 also includes approximately 112 UAS aircraft activities, usually in the vicinity of Admiralty Bay.

As explained in detail in the environmental assessment for the replacement of the EA-6B with the EA-18G at NASWI (DoN 2005a), this platform substitution would have a positive impact on the noise environment over the foreseeable future. Slight decreases in noise levels throughout the NWTRC airspace can be expected given the projected decreases in noise levels around NASWI and OLF Coupeville. Figure 3.5-3 provides an example of this reduction in noise at NASWI and OLF Coupeville (DoN 2005a).

Under Alternative 1, the majority of activities involving or potentially involving explosives would increase, as discussed in Chapter 2. The exception to this is underwater EOD activities, which would be limited to four detonations per year with a maximum charge size of 2.5 pounds.

As noted previously, precautions are taken to eliminate exposure of non-military personnel to unwanted sound from military activities. As with the No-Action Alternative, sound-generating events under Alternative 1 are intermittent and occur in remote areas or off-limits areas. Because over half of the Navy training event types occur at least 12 nautical miles from shore, increases in training events in the NWTRC OPAREA under Alternative 1 are likely to be beyond the hearing of human receptors.

Likewise, in general, increases in explosive ordnance usage in the OPAREA during the events under Alternative 1 are not likely to be within the hearing range of human receptors, due to their distance from shore. One exception to this general statement is the increased land demolitions proposed under Alternative 1, and potential surface EOD activities. Under Alternative 1, there would be eight additional land demolitions at Seaplane Base each year, and up to four surface EOD detonations spread between Crescent Harbor, Floral Point, and Indian Island. Although the explosive noise associated with these land detonations would be within the hearing range of human receptors on and near the base, the noise impacts related to the detonations would be considered minor because they would occur sporadically throughout the year (less than once per month). In addition, noise from aircraft activities emanating from NASWI is the dominant noise in these vicinities and, at sound levels over 100 dB for a single event (Wyle Laboratories, Inc. 2004), would tend to mask the land demolition-related noise.

Adverse noise impacts occur under two conditions: 1) peak noise levels substantially greater than 127 dBP that could cause structural damage to nearby residences (e.g., broken windows); and 2) peak noise levels loud enough to cause annoyance to nearby residents and substantial enough to result in frequent noise complaints. As mentioned in the previous subsection, past noise studies have indicated that peak noise levels are below the threshold for structural damage, and no noise complaints have been received related to land demolitions. Under Alternative 1, the increase of 8 additional land demolitions per year is not expected to change this compatible scenario.

Under Alternative 1, there would be no change in the number of Surface-to-Air MISSILEX occurrences, and therefore there would be no additional noise during that event type. Under Alternative 1, there would be one additional SINKEX. SINKEXs produce the most explosive-related noise of all training events. However, SINKEXs take place at least 50 nautical miles from shore, and the required safety zone around a SINKEX would eliminate the presence of human receptors (such as boaters) within hearing distance of the exercise. Therefore, no sensitive receptors would be impacted during a SINKEX. Under Alternative 1, although most training events would experience a slight increase in occurrence over baseline levels, they are still within the range of historical operational levels and increases in associated noise would likely not be perceptible.

Because sound-generating events are intermittent, occur in remote areas or off-limits areas, and do not expose a substantial number of human receptors to high noise levels, no sensitive receptors are likely to be exposed to sound from military activities under the No Action Alternative.

3.5.4.4 Alternative 2

Under Alternative 2, the majority of Navy training and testing activities would increase, as discussed in Chapter 2. Activities that include or could include aircraft make up a large portion of Alternative 2 activities. Although a small proportion of flights would be at altitudes as low as 300 ft, the preponderance of these air activities take place at high altitudes over land or far out to sea over the Pacific Ocean, out of range of human receptors. Approximately 109 annual aircraft activities in Alternative 2 involve helicopters at low-altitude flight, typically between NASWI, Crescent Harbor/Seaplane Base, and OLF Coupeville. Alternative 2 also includes approximately 112 UAS aircraft activities, usually in the vicinity of Admiralty Bay.

Under Alternative 2, activities involving or potentially involving explosives would change, as discussed in Chapter 2. The types of effects on humans from sound generated by military activities under Alternative 2 would be similar to those under Alternative 1. As with the No-Action Alternative and Alternative 1, sound generating events under Alternative 2 are intermittent and occur in remote areas or off-limits areas. Under Alternative 2, over half of all Navy training event types would experience no further increase in occurrence over Alternative 1. The events under Alternative 2 that would experience the greatest increase in number over baseline amounts are electronic combat, MISSILEX (Air-to-Air and Surface-to-Air), GUNEX (Surface-to-Air and Surface-to-Surface), and ASW TRACKEX MPA.

All increases in these events occur in the OPAREA at a distance of over 12 nautical miles from shore. The increases in event occurrences, therefore, are not likely to be perceived by human receptors ashore. Precautions are taken pursuant to SOPs to prevent such exposure of non-military personnel in ocean areas (such as fishermen in the OPAREA). Non-military personnel in the OPAREA therefore would not likely be exposed to aircraft engine noise or explosive-related noise from these events.

Navy training near shore or over land within the NWTRC under Alternative 2 is not expected to increase over the levels proposed under Alternative 1.

Because sound-generating events are intermittent, occur in remote areas or off-limits areas, and do not expose a substantial number of human receptors to high noise levels, no sensitive receptors are likely to be exposed to sound from military activities under the No Action Alternative.

3.5.5 Mitigation Measures

Navy activities in the NWTRC OPAREAs comply with numerous established acoustic control procedures to ensure that neither participants nor non-participants engage in activities that would endanger life or property. SOPs for minimizing airborne noise impacts in the NWTRC fall into two categories; aircraft SOPs and EOD SOPs.

Aircraft SOPs are largely oriented toward safety, which also provide significant noise abatement benefits. For example many SOPs involve flight routing and minimum altitudes. Each of these procedures increases the range of the noise source from human receptors, thus reducing noise impacts. As stated in DoN (2006), all training and operational flights are to be conducted to have a minimum impact on surrounding communities. Each aircrew shall be familiar with the noise profiles of their aircraft and shall be committed to minimizing noise impacts without compromising operational and safety requirements (DoN 2006).

EOD measures include the following for reducing noise impacts during land detonation training:

- Detonation training will be conducted only during normal working hours (8:00 AM to 5:00 PM).
- Detonation training will be conducted only during days when the weather is favorable. Studies have shown that variation of temperature and wind velocity with altitude can cause a noise event to be inaudible at one time (favorable) and audible at another time (unfavorable). Favorable and unfavorable conditions are described in Table 5-2.

Table 3.5-7. Favorable and Unfavorable Detonation Conditions

Favorable Conditions	Unfavorable Conditions
• Clear skies with billowy cloud formations, especially during warm periods of the day • A rising barometer immediately following a storm	• Days of steady winds of 5-10 mph with gusts of greater velocities (above 20 mph) in any direction • Clear days on which layering of smoke or fog are observed • Cold, hazy or foggy mornings • Days following a day when large extremes of temperature (greater than 20 degrees C) between day and night are noted • Generally high barometer readings with low temperatures

Military personnel who might be exposed to sound in the air from military activities, such as military aircraft, land detonations or at sea detonations heard on the surface of the ocean, are required to take precautions, such as the wearing of protective equipment, to reduce or eliminate potential harmful effects of such exposure. With regard to potential exposure of non-military personnel in the ocean, Puget Sound areas, and inland OPAREAs, precautions are taken pursuant to SOPs to prevent such exposure. These include advance notice of scheduled training activities to the public and the commercial fishing community via the worldwide web, Notices to Mariners (NOTMARs), and Notices to Airmen (NOTAMs). In addition, range safety SOPs ensure that civilians are excluded from, and if necessary removed from areas of military activities, or that military activities do not occur when civilians are present. These procedures have proven to be effective at minimizing potential military / civilian interactions in the course of training or other military activities.

3.5.6 Summary of Effects

Airborne noise levels generated by the proposed action under the No-Action Alternative and Alternatives 1 and 2 would be less than significant for the following reasons:

- Noise from training activities in the PACNW OPAREA would be dispersed and intermittent, which would not contribute substantially to long-term noise levels, and few or no sensitive receptors (non-participants) would be exposed to these noise events.
- Noise from aircraft training activities over land in MOAs would typically take place at high altitude and over relatively lower populated areas. Few sensitive receptors (non-participants) would be exposed to these noise events.
- Noise associated with EOD on or near shore would take place in areas currently used for EOD training. Underwater explosives are not likely to impact the airborne noise environment.
- Noise would be generated in training areas that have been in similar use for more than 50 years, so no new public areas would be exposed to noise from training and testing activities.

- The incremental increases in the number of range events would not substantially increase long-term average noise levels; hourly average equivalent noise levels are, and would remain, relatively low.

Table 3.5-7 summarizes the airborne noise effects for the No Action, Alternative 1, and Alternative 2.

Table 3.5-8: Summary of Effects – Airborne Noise

Alternative and Stressor	Summary of Airborne Noise Effects	
	NEPA (On Land and Territorial Waters Out to 12 nm)	**Executive Order 12114 (Non-Territorial Waters, >12 nm)**
No Action		
Surface ship noise	Minor localized engine noise. Few to no sensitive receptors present.	Minor at-sea noise. Few to no sensitive receptors present.
Aircraft noise	Short-term noise impacts during transits to and from range areas.	Short-term noise impacts, including sonic booms. Few to no sensitive receptors present.
Weapon and target noise	Very short-term noise impacts. Few to no sensitive receptors present.	Very short-term noise impacts. Few to no sensitive receptors present.
EOD	Short-term minor noise impacts from on or near shore EOD activities which would occur infrequently. Underwater EOD would have no airborne noise effects.	There are no EOD activities in non-territorial waters.
Alternative 1		
Surface ship noise	Minor localized engine noise. Few to no sensitive receptors present.	Minor at-sea noise. Few to no sensitive receptors present.
Aircraft noise	Short-term noise impacts during transits to and from range areas.	Short-term noise impacts, including sonic booms. Few to no sensitive receptors present.
Weapon and target noise	Very short-term noise impacts. Few to no sensitive receptors present.	Very short-term noise impacts. Few to no sensitive receptors present.
EOD	Short-term minor noise impacts from on or near shore EOD activities which would occur infrequently. Underwater EOD would have no airborne noise effects.	There are no EOD activities in non-territorial waters.
Alternative 2 (Preferred Alternative)		
Surface ship noise	Minor localized engine noise. Few to no sensitive receptors present.	Minor at-sea noise. Few to no sensitive receptors present.
Aircraft noise	Short-term noise impacts during transits to and from range areas.	Short-term noise impacts, including sonic booms. Few to no sensitive receptors present.
Weapon and target noise	Very short-term noise impacts. Few to no sensitive receptors present.	Very short-term noise impacts. Few to no sensitive receptors present.
EOD	Short-term minor noise impacts from on or near shore EOD activities which would occur infrequently. Underwater EOD would have no airborne noise effects.	There are no EOD activities in non-territorial waters.

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3.6 Marine Plants and Invertebrates

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3.6 MARINE PLANTS AND INVERTEBRATES

3.6.1 Affected Environment

Some of the important ecosystem functions provided by marine plants include the following:

- Plankton form the basis of the ocean food chain.
- Seagrasses provide animal habitat for resting, feeding, and escape.
- Wetland plants provide erosion control and water quality improvements.

Invertebrates, which range from microscopic crustaceans to clams and crabs, also provide valuable links in the food chain and perform ecosystem functions such as nutrient processing. For humans, marine plants and invertebrates contribute to economic, cultural, and recreational activities in the Pacific Northwest.

This discussion is divided into the following habitats:

- Open ocean habitat includes free-floating (pelagic) and bottom dwelling (benthic) areas; and
- Nearshore habitat, also referred to as the littoral zone, includes islets and headlands, rocky intertidal areas, bottom-dwelling algaes (e.g., kelp forests), seagrass beds, soft substrate, estuarine and coastal salt marsh wetlands, fjords, and beaches.

3.6.1.1 Open Ocean Pelagic Habitats

Microscopic Communities

Phytoplankton make up most of the marine plant life in the Northwest Training Range Complex (NWTRC) Study Area. Phytoplankton – microscopic plants – are the most important primary producers in the ocean (Thurman 1997). Primary producers are organisms that make organic compounds from carbon dioxide in the air or water, principally through photosynthesis. They form the base of the food chain, such that almost all other life on Earth depends on them. The phytoplankton community primarily is in the upper 330 feet (100 m) of the water column. It is composed mainly of single-celled diatoms (cell wall composed of silicon) and dinoflagellates (have whip-like structures called flagella that give them mobility) (Walsh et al. 1977; Estrada and Blasco 1979; Hardy 1993). The distribution of phytoplankton depends on factors such as light intensity, salinity, water temperature, currents, topography, nutrients, reproductive cycles, and predators (Smith 1977; Strub et al. 1990; Batchelder et al. 2002). The coast of the Pacific Northwest supports a high density of phytoplankton (Sutor et al. 2005). During the spring and summer, the upwelling of nutrient-rich waters into the surface layers combines with high solar radiation and long days to produce huge numbers of these tiny plants (Strub et al. 1990; Batchelder et al. 2002; Perry et al. 1989).

Zooplankton is a term for microscopic (< 2 µm) to small animals (2 to 20 cm) that live in the open ocean. Examples include ciliates; a wide variety of crustaceans such as copepods and krill (euphausiids); and the eggs, larvae, and juvenile stages of organisms ranging in complexity from jellyfish to juvenile fish (Kideys 2002). Copepods are the dominant group of zooplankton in terms of biomass (Landry and Lorenzen 1989). Zooplankton occur at all depths and often undertake daily vertical migrations of up to several hundred feet. During the summer, a large standing stock of zooplankton resides 5 to 16 nm miles off the Olympic Coast (9 to 30 km) (OCNMS 1993).

Most zooplankton feed on phytoplankton. The zooplankton, in turn, serves as an important food source for other organisms, including fish, and whales. Copepods and krill are the two most important food sources for adult pelagic fish and baleen whales. Krill usually live at depths beyond the range of surface-feeding animals, but during swarming, large numbers may migrate to the surface within reach of flocks of birds (Sheard 1953; Boden et al. 1955).

Pelagic Invertebrates

Open-ocean or pelagic invertebrates consist of "jellies" – jellyfish (cnidarians), comb jellyfish (ctenophorans), and salps (chordates), plus a wide variety of other animals, including shrimp (decapods), gastropods, and polychaete marine worms. Most of these animals filter the sea water for plankton. Salps are more abundant in phytoplankton-rich surface waters, but have been found at depths to 3,300 feet (1,000 m). Many of these soft-bodied invertebrates are important sources of food for sea turtles.

3.6.1.2 Open Ocean Deepwater Benthic Habitats

For the purposes of this study, the deep-sea environment extends from the shelf break at a depth of 500 to 650 feet (150 to 200 m) to the abyss, which occurs at depths of more than 13,000 feet (4,000 m). Deepwater benthic communities of interest in the Study Area include corals reefs, sponge reefs, chemosynthetic ecosystems, communities common to deep rock substrate provided by submarine canyons and seamounts, and communities of the abyssal plain.

Coral Communities

In the NWTRC Study Area, habitat-forming deep-sea coral communities are commonly found between 875 and 4,200 feet deep (265 to 1,260 m), but may be found as deep as 11,400 feet (3,450 m) (Etnoyer and Morgan 2003). In these locations, there is usually no light and temperatures can be as low as 4°C. Examples include stony corals, hydrocorals, soft corals, black corals, and lace corals. Stony corals and hydrocorals build large, three-dimensional coral reefs that are comparable in size and complexity to shallow-water coral reefs. These deep-sea communities are typically found on the continental slope, the area from the edge of the continental shelf to the continental rise, and on undersea mountains ("seamounts"). The biological diversity of deep-sea coral communities is high, and includes sponges, polychaetes (bristleworms), crustaceans (crabs and lobsters), mollusks (clams and snails), cephalopods (octopus), echinoderms (starfish, sea urchins, brittle stars, and feather stars), bryozoans (sea moss), and fish (Freiwald et al. 2004; Hain and Corcoran 2004; Roberts and Hirshfield 2004).

Deep-sea coral communities are found along the entire continental slope of the Study Area, including training range W-237A, and in a few locations in Puget Sound. Black corals are the most common on the continental slope, while the rare *Lophelia* sp. is found off the Washington coast. A recent study indicated that deep corals are widespread on seamounts and continental shelves throughout the Northeast Pacific, down to a depth of 15,500 feet (4,700 m) (Etnoyer and Morgan 2003; Bowlby et al. 2005; Hyland et al. 2005; Brancato et al. 2006).

Deep-sea coral communities are slow-growing (4 to 25 mm per year compared to as much as 150 mm per year for shallow tropical corals) and fragile, and are vulnerable to human-induced physical impacts. Trawls and heavy fishing gear used by commercial fishing have caused severe damage to deep-sea coral communities in many areas of the world. These communities are also susceptible to physical impacts caused by oil- and gas-production, aggregate extraction, other mineral exploitation, cable laying, seabed shipping, disposal of waste in deep waters, coral harvest, and increased atmospheric carbon dioxide. It may take decades or centuries for damaged cold-water coral reefs to recover (Freiwald et al. 2004; Roberts and Hirshfield 2004; Brancato 2005; Brancato and Bowlby 2005; Hyland et al. 2005).

Sponge Reefs

Three sponge reef complexes occur in the northern Puget Sound region, including at North McCall Bank, South McCall Bank, and Fraser Ridge. These glass sponges are variously known as glass, chalice, vase, and cloud sponges. Species include *Heterochone calyx* and *Aphrocallistes vastus*. Their reefs typically are located 300 to 700 feet deep (90 to 210 m), are up to 65 feet high (20 m), and can extend for several miles. The communities at Fraser Ridge are densely clustered and brightly colored, unlike other reef areas where the sponges usually are white. The reef complex at North McCall Bank is abundant with large sponges, while the reef complex at South McCall Bank has an absence of healthy sponges (Conway et al. 2005). Like deep-sea corals, sponge reef communities are slow-growing, fragile, and susceptible to the same types of human-induced physical impacts.

Chemosynthetic Ecosystems

In most marine ecosystems, the primary producers at the base of the food chain include phytoplankton, macroalgae, and seagrasses that produce energy through photosynthesis. However, in environments on the ocean floor that are rich in methane and sulfides, chemosynthetic bacteria use sulfur-oxidizing, methane-oxidizing, and sulfide-reducing processes to create energy and organic matter that can be used by other organisms in the environment. Common animals include tubeworms, giant white clams, mussels, gastropods, and sponges (Kojima 2002). Chemosynthetic communities are a significant source of biological productivity on the deep-sea floor, and most such communities occur in association with fields of hydrothermal vents (Hessler and Lonsdale 1991; Smith et al. 2003) or in areas of gas hydrates in the sediments (Fisher et al. 2000; Reed et al. 2002). Chemosynthetic communities occur in the NWTRC Study Area, including within the Olympic Coast National Marine Sanctuary (Bowlby et al. 2005; Hourigan et al. 2007).

Deep Rocky Substrate Communities

The bottom substrate of the deep sea is mostly covered with silts, clays, and fine sediments. However, in waters deeper than 100 feet (30 m), about three percent of the bottom consists of hard substrates, including rocky outcroppings, rubble, talus, vertical walls, rocky reefs, and seamounts (DoN 2006, p.2-52). These substrates support diverse assemblages of invertebrates and fish (Grassle 1991; Airamé et al. 2003). The type of bottom substrate governs the abundance and diversity of deep-sea organisms. Most deep, hard-bottom organisms are suspension feeders, and in the Pacific Northwest these commonly include corals, anemones, and sea lilies (Lissner 1988).

Abyssal Plain

The Cascadia abyssal plain is a nearly flat area that begins approximately 375 nm (695 km) off the West Coast and extends to the Juan de Fuca Ridge (Figure 3.6-1). It is approximately 50,000 nm^2 in size (171,500 square kilometers [km^2]) and is regarded as the true ocean floor. Because it is several thousand feet below the surface, it is cold and lightless, but possesses extremely diverse marine inhabitants. While the abyssal plain is one of the largest and least explored ecosystems on Earth, it is established as a major reservoir of biodiversity and evolutionary novelty (Beaulieu 2001a and 2001b; O'Dor 2003).

The abyssal plain is flat and relatively featureless because its originally uneven surface of oceanic crust has been blanketed by fine-grained sediments, such as clay and silt channeled down from the continental margins along submarine canyons, dust blown out to sea from land, and the remains of small marine plants and animals, known as pelagic sediment, that constantly rains down from the overlying water column. This sinking detritus provides the primary source of nutrients for deep sea pelagic and bottom-dwelling communities.

Deep benthic animals grow more slowly, live longer, and have smaller broods than animals living in shallow waters (Airamé et al. 2003). Species of the abyss include mollusks, sea stars, brittlestars, sea pens, and sea cucumbers. In many areas of the deep sea, brittlestars are so abundant that their feeding behavior and high activity levels alter the ecology of benthic, soft-bottom communities.

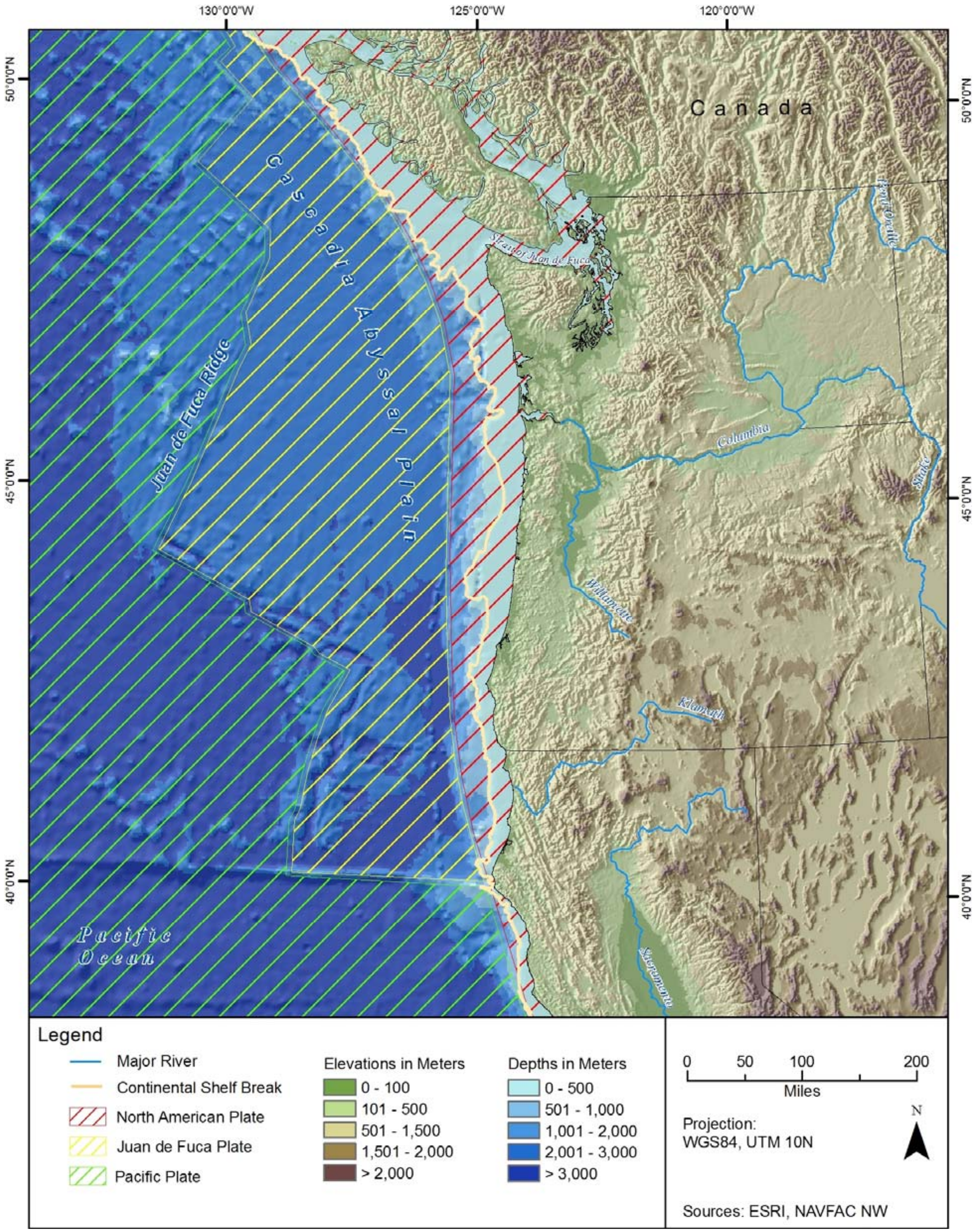

Figure 3.6-1: Cascadia Abyssal Plain and Oceanic Plates in the NWTRC

3.6.1.3 Nearshore Habitats

Eight major nearshore habitats occur in the greater Puget Sound area: 1) islets and headlands; 2) rocky intertidal areas; 3) bottom-dwelling algaes such as kelp forests; 4) seagrass beds; 5) soft substrate; 6) estuarine and coastal salt marsh wetlands; 7) fjords, and 8) beaches (Levings and Thom 1994). Kelp beds and eelgrass meadows cover the largest area, almost 300 nm^2 (1,030 km^2). Other major habitats include sub-aerial and intertidal wetlands (50 nm^2 [170 km^2]) and mudflats and sandflats (70 nm^2 [240 km^2]).

The extent of some of these habitats has markedly declined over the last century.

- Losses of intertidal habitat since European settlement have been nearly 60 percent for the greater Puget Sound area and nearly 20 percent for the Strait of Georgia (Hutchinson 1988).
- Four river deltas (the Duwamish, Lummi, Puyallup, and Samish) have lost more than 90 percent of their intertidal marshes (Simenstad et al. 1982; Schmitt et al. 1994).
- More than 75 percent of the wetlands in the greater Puget Sound area have been eliminated, especially in estuaries near urban areas. Substantial declines of mudflats and sandflats have occurred in deltas and estuaries (Levings and Thom 1994).

Benthic Invertebrates of Nearshore Habitats

Throughout the following sections, there are several references to "benthic invertebrates," a large, generalized group of bottom-dwelling creatures as diverse as microscopic copepods, crabs, and clams. The Pacific Northwest is particularly rich in species diversity because it lies along the northern boundary for many species that inhabit subtropical and temperate zones, and the southern boundary for many arctic species (Miller et al. 1980). Seasonal surveys in the Strait of Juan de Fuca have identified nearly 200 species of invertebrates. The most diverse groups include decapod crustaceans (crabs, lobsters, and shrimp), amphipods (small shrimp-like creatures), bivalves, barnacles, and gastropods (snails and slugs). Less common groups include other shrimp-like creatures like isopods, mysids, and euphausids (krill), and segmented bristleworms (polychaetes) (Fautin et al. 2002).

Geographically, species richness of benthic invertebrates in the Puget Sound increases from west to east, with species diversity lower in the fall and highest in the spring, and abundance highest in fall and winter. Distribution is governed primarily by sediment type, substrate type, and water depth, and secondarily by geographical location (Chess and Hobson 1997, Laetz 1998, Llansó 1998).

Species of Concern

There are three marine invertebrate species of concern in the NWTRC Study Area – the Olympia oyster (*Ostreola conchaphila*), a state species of concern; the Newcomb's littorine snail (*Algamorda subrotundata*), a federal species of concern and a state candidate species; and the Northern abalone (*Haliotis kamtschatkana*), also a federal species of concern and a state candidate species (WDFW 2008). The current known distribution of Newcomb's littorine snail is on the shores of Grays Harbor and Willapa Bay, WA; Coos Bay, OR; and Humboldt Bay, CA (Larson et al. 1995). Northern abalone is found clinging to rocks among kelp beds in coastal waters from Alaska to California (IUCN 2008). Current habitat is largely restricted to southern Puget Sound, Willapa Bay, and Grays Harbor. The Olympia oyster is being managed under the Olympia Oyster Stock Rebuilding Plan (Cook et al. 1998). The habitats for all of these species are far removed from the activities under the Proposed Action, so the topic is not retained for analysis.

Benthic Algae

Microalgae and macroalgae are abundant and diverse on the outer Olympic coast (OCNMS 1993) (Figure 3.6-2). For example, more than 120 species of algae have been identified just in the rocky intertidal areas of the outer coast of Olympic National Park (Dethier 1988).

Microalgae primarily include benthic diatoms that coat rocks or live within the sediment. They are a principal food source for many grazing animals such as gastropods (snails and sea slugs) and chitons (McConnaughey 1970). Marine lichens, which are combinations of algae and fungus living symbiotically, are found as thin veneers on rocks in the highest intertidal areas on exposed rocky areas.

Macroalgae are seaweeds that grow attached to a firm substrate from the intertidal region to as deep as 130 feet (40 m) (OCNMS 1993). The seaweeds are composed of three main phyla, including red algae (Rhodophyta), green algae (Chlorophyta), and brown algae (Phaeophyta).

- The red algae are the most diverse of the macroalgae in the Pacific Northwest based on number of genera (about 115) and species (at least 265) (Waaland 1977). In intertidal and shallow subtidal areas, red algae often occupy the understory of the larger kelps.
- Green algae inhabit the more protected marine and estuarine areas in Washington, primarily in tidepools and rocky intertidal areas. They are less common in the exposed areas of the outer coast. Green algae are the second most common vegetation in the intertidal areas of the Strait of Juan de Fuca (Bailey et al. 1998).
- Brown algae include the largest marine plants and are probably the most important macroalgae in terms of primary productivity and direct economic value (Gardner 1981). Brown algae range from the large kelps and sargassum (described below) to crusts on rocks and filaments living on other algae.

Kelp

The most conspicuous benthic macroflora in the Pacific Northwest is brown algae commonly known as kelp. The kelp beds in the Pacific Northwest are among the most extensive and elaborate in the world, and the region supports the highest diversity of kelps in the world. Kelp attach to rocky substrates at subtidal depths and form distinctive “kelp forests.” They grow in areas between three and 200 feet deep (two to 60 m) and may be more than 150 feet long (45 m), extending from the seafloor to surface. Kelp can grow up to four inches per day (ten cm) and are among the most productive of marine plants (Dayton 1985).

Distribution and abundance of kelp are determined by temperature, light, sedimentation, substrate, relief, wave exposure, nutrients, salinity, and biological factors such as grazing and competition with other species (Dayton 1985). The highest densities and most persistent kelp beds occur on solid rock substrate with moderately low relief and moderate sand coverage (Foster and Schiel 1985, Graham 1997). They also can be found on rocky reefs that occasionally experience severe wave action and tidal currents. However, because kelp is sensitive to high levels of sunlight, they are uncommon in waters less than six feet deep (2 m), even along protected shorelines (Rodríguez 2003).

Figure 3.6-2 shows the distribution of major kelp beds in the Puget Sound. Two species of brown algae dominate, bull kelp (*Nereocystis leutkeana*) and giant kelp (*Macrocystis intergrifolia*). Kelp beds extend into the Strait of Juan de Fuca to Crescent Rock, and some of the largest beds in the state are in the strait. About 45 percent of the shoreline of the strait consists of kelp habitat, compared to only 11 percent of the shoreline of the other four Puget Sound basins (Shaffer 1998). Kelp is uncommon in Dabob Bay and northern Hood Canal, although kelp beds are present near the Hood Canal Bridge.

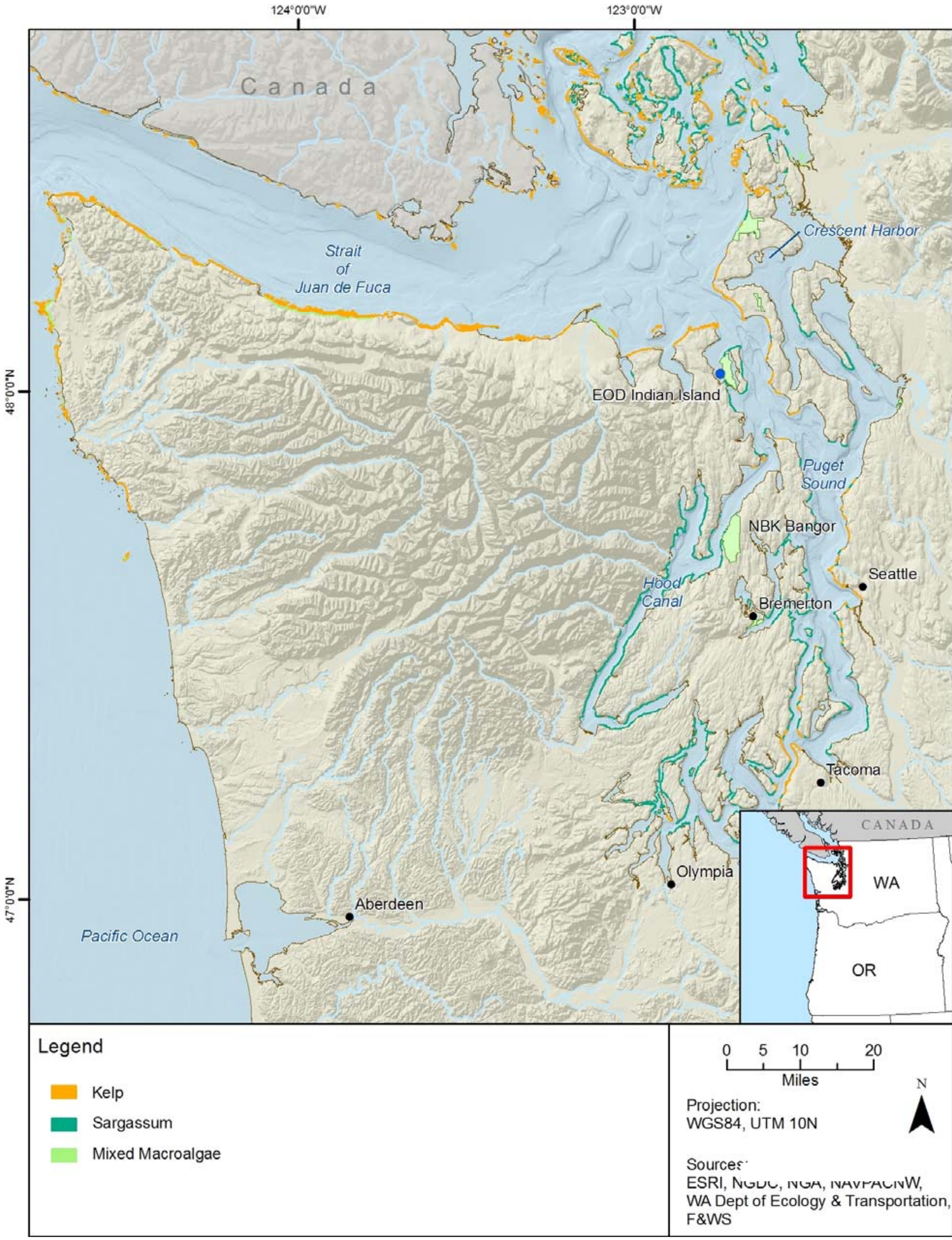

Figure 3.6-2: Mixed Macroalgae, Sargassum, and Kelp – Pacific Coast and Puget Sound

Within kelp forests, the kelp stems and blades, in concert with other species, form a multi-tiered habitat from seafloor to surface that includes crustose turf, understory, and canopy layers that are used by many other plant and animal communities. Kelp forests provide refuge, forage, and nursery areas to support commercial and sport fish, invertebrates, marine mammals, and marine birds (Proctor et al. 1980; Steelquist 1987; DoN 2002).

Kelp also provides secondary habitat benefits via drift kelp (detached kelp). Kelp forests provide large quantities of drift kelp to adjacent habitats and provide an important resource to areas of soft and rocky benthos, deep channel basins, sandy beaches, rocky shores, and coastal lagoons. For example, floating kelp masses provide food and shelter for fish, and drift kelp that has been carried into nearshore areas provides important nutrients to beach and rocky intertidal communities. A small portion of drift kelp contributes to production in the deep sea by sinking through the water column and providing nutrients to organisms on the continental shelf and slope and to deeper ocean zones (Airamé et al. 2003).

Kelp and seagrass beds provide important habitat for many species including some, such as the sea otter (*Enhydra lutris*), that are species of concern (Foster and Schiel 1985). However, at this time, no areas with these habitats have been designated as critical for any threatened or endangered species. In addition, all activities under the Proposed Action would occur at least three nm offshore beyond the zone for such habitat. In Puget Sound, proposed activities are some distance from these habitats and would not affect them.

Sargassum

Sargassum (*Sargassum muticum*) is a non-indigenous brown algae from Asia that has been established in the Pacific Northwest for decades (Figure 3.6-2). Sargassum colonizes cobble and rocky substrates in lower and shallow subtidal habitats and occurs along approximately 18 percent of the Washington shoreline. Sargassum is common along the shorelines of the Hood Canal, San Juan Archipelago, and Strait of Georgia. It is least common along the outer coast. Little is known about its interaction with local species (WDNR 2008).

Seagrass Beds

Seagrasses are submerged aquatic vegetation that form extensive underwater meadows or beds in shallow water (Thayer et al. 1984). In the Pacific Northwest, eelgrass (*Zostera marina*) and surfgrass (*Phyllospadix* spp.) are the dominant native seagrasses (den Hartog 1970). Eelgrass grows in shallow, subtidal or intertidal unconsolidated sediments; surfgrass grows on wave-beaten rocky shores. Eelgrass is the primary vegetation in the intertidal areas of the Strait of Juan de Fuca and Puget Sound, covering more than 40 percent of the intertidal area (Bailey et al. 1998). The distribution of major eelgrass beds in the Strait of Juan de Fuca and Puget Sound is shown in Figure 3.6-3.

Seagrass beds are among the most productive ocean habitats and are vital in sustaining coastlines, fisheries, benthic invertebrates, marine mammals, reptiles, and waterfowl (Fonseca et al. 1998). They also play an important role in nutrient regeneration and recycling, and carbon sequestration. Other important functions include: 1) sustaining ecosystem productivity by trapping detritus and supporting bottom-feeders; 2) reducing coastline erosion by slowing currents and waves, stabilizing the substrate, and promoting sedimentation; and 3) improving water quality by filtering sediments and sediment borne pollutants, excess nutrients, and dissolved and particulate pollutants from terrestrial run-off (Brouns and Heijs 1986; Phillips and Meñez 1988).

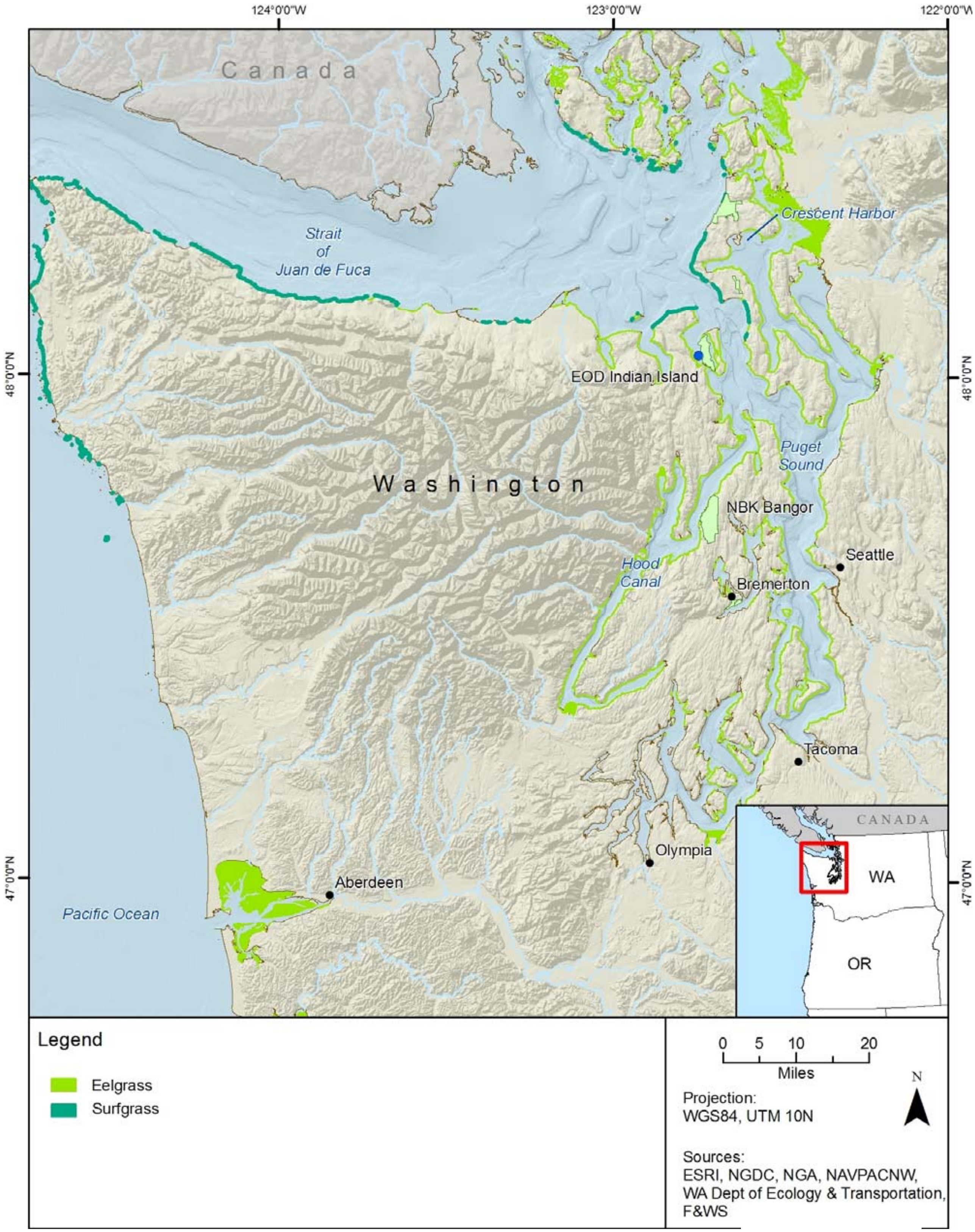

Figure 3.6-3: Surfgrass and Eelgrass Beds – Pacific Coast and Puget Sound

Soft Substrate

Rich invertebrate communities occur in the soft sediments of the Puget Sound, including clams, oysters, starfish, and bristleworms (DoN 2002). Soft substrate, whether as sandy bottoms in deeper waters or shoreline mud flats exposed at low tide, are important in supporting species, such as clams and oysters that are important food sources for people and wildlife. Five species of shrimp are associated with soft bottom habitats, although some species move up into the water column at night to feed (DoN 2002). Many important commercial and recreational fisheries depend on the soft substrate habitats of the Puget Sound. Areas with sandy sediments tend to have the most species, but the lowest biomass, and areas with mixed sediments usually have the highest biomass (Lie 1974, Llansó 1998).

Clams and Oysters

Aquaculture depends on the soft substrate habitats of Puget Sound. Pacific oysters (*Crassostrea gigas*), geoducks (pronounced "gooey duck") – *Panope abrupta*, a large saltwater clam, and other clams are cultivated in aquaculture activities in Puget Sound. Pacific oysters are widely cultivated in Dabob Bay which is one of only three bays on the west coast where successful spawning of Pacific oysters occurs. Geoducks are the basis of an important commercial fishery in the Puget Sound where they are found in lower intertidal to subtidal soft-bottom areas (DoN 2002).

Dungeness Crab

Dungeness crab plays an important role in the food chain as predator and prey in estuarine and marine environments, and is one of the most commercially important species in the Northwest. Adult Dungeness crabs (*Cancer magister*) can be found in waters as deep as 300 feet (90 m) and on substrates consisting of mud, rock, and gravel bottoms; however, they prefer soft substrates. Juvenile crabs are often found in the soft substrates of intertidal eelgrass beds (DoN 2002). Two important juvenile crab production estuaries are Willapa Bay and Grays Harbor in Washington State. Dungeness crab larvae and juveniles are important food for a variety of fish, including rockfish, salmon, and sharks. Dungeness crab feed primarily on fish, molluscs, and other crustaceans (PSMFC, no date).

Estuarine and Coastal Salt Marsh Wetlands

Wetlands form the transition zone between terrestrial and marine systems and perform vital functions of preventing shoreline erosion, reducing flood damage, and improving water quality. Wetlands are characterized by substrate that is inundated or saturated long enough to develop unique, hydric soils and a characteristic plant community of water-loving plants (hydrophytes) (Cowardin et al. 1979). They represent some of the most productive and diverse habitat on the planet and provide essential habitat for 80 percent of the world's fish and shellfish. Benefits include providing feeding, nesting, shelter, high-tide refuge, spawning grounds, and nursery habitats for numerous commercially and recreationally important fish, birds, mammals, and invertebrates (Airamé et al. 2003).

Along the Washington Coast, marine and estuarine wetlands cover about 240 nm^2 (825 km^2) or about 22 percent of the total wetland acreage in the state (Lane and Taylor 1997). Major expanses of estuarine wetlands exist around Grays Harbor and Willapa Bay along the coast, at the mouth of the Columbia River, and around Skagit and Padilla Bays in the Puget Sound.

Fjords

Fjords are river valleys that were deepened by glaciers during the last ice age; they often are deeper than 2,300 feet (700 m). There are dozens of fjords in Puget Sound and along the Pacific Coast. Fjords make the Puget Sound region the most complex nearshore ecosystem of the Pacific Northwest (Seliskar and Gallagher 1983). As another type of rocky substrate, fjords provide extensive habitat to bottom-dwelling creatures and communities. Leys et al. (2004) found nine species of glass sponges that inhabit the fjords of British Columbia. These sponge communities exist on fjord walls and other bare rock surfaces.

Hood Canal

Hood Canal is a glacial fjord that joins the main body of Puget Sound at Admiralty Inlet. The bathymetry in Hood Canal is typical of fjord estuaries with a U-shape cross-section with steeply sloping walls that become less steep at depth. The canal is 65 miles long (108 km), 1.5 miles wide (2.4 km) on average, and ranges 150 to 600 feet deep (45 to 180 m). Much of the bottom is filled with unconsolidated glacial sediments overlying volcanic bedrock. Two transverse sills exist north and south of Naval Base Kitsap (NBK) Bangor about 100 feet below the surface (30 m). Water enters the canal from Admiralty Inlet north of NBK-Bangor, creating southward flows during tidal flooding and a northward flow during an ebbing tide. The tide is the dominant force establishing current flow in the Hood Canal region although currents are also affected by winds, bathymetry, freshwater inflow, and density gradients (DoN 2001).

Except in the immediate vicinity of NBK-Bangor, nearshore and deeper habitats are largely intact. Given the canal's hard-rock walls, marine communities that require attachment are common. Although the sides of Hood Canal drop steeply, tidal habitats are fairly extensive, including eelgrass. Sargassum is common along the shorelines of the Hood Canal while kelp beds are less common in the northern portions. Given this diversity of habitats, many of the invertebrate and plant communities groups noted previously are found in Hood Canal. Hood Canal supports both commercial and recreational fisheries, and serves as an important passageway and rearing area for migrating salmon and salmonid species. Other important groups include bottom fish species (e.g., sole and Pacific cod) and shellfish (e.g., oysters, clams, and Dungeness crab) (DoN 2001). Populations of Olympia oysters (*Ostreola conchaphila*), a federally-listed species, are gradually recovering in Hood Canal (Peter-Contesse and Peabody 2005).

Beaches

Beach environments are intertidal zones of unconsolidated material that extend landward from the low water line (Kozloff 1993). Wind and waves continually influence the deposition and erosion of sediments. Beaches are often categorized into five zones:

- The upper intertidal beach is submerged for a short time and exposed to the widest range of temperatures. Animals inhabiting this zone rely on unpredictable and patchy food sources. This zone is used as a breeding habitat by a variety of birds and pinnipeds.
- The mid-littoral beach is alternately submerged and exposed for moderate periods of time. Dominant species are usually highly mobile, such as isopods, sand crabs, and polychaetes.
- The swash zone is submerged for approximately 12 hours per day.
- The low intertidal zone is exposed for brief periods during the lowest tides and is dominated by species that burrow into the sediments for protection.
- The surf zone is constantly submerged and subjected to the motion of breaking waves. The animals in the surf zone are subjected to nearly constant, intense physical agitation (Proctor et al. 1980; Airamé et al. 2003).
- In the Pacific Northwest, protected beaches exist in low-energy environments and unprotected beaches are exposed to constant, high-energy wave action. In the NWTRC Study Area, a two-part beach profile is typical, with a steep foreshore of course sand or gravel and a lower-gradient subtidal area of sand or mud.

Organisms in the Water Column

The abundance and distribution of zooplankton in the water column in various habitats in Puget Sound is not well understood, although it is likely that zooplankton assemblages vary both seasonally and annually. In general, the most numerically abundant zooplankton throughout the greater Puget Sound region are microscopic crustaceans, such as calanoid and cyclopoid copepods. Larvae of tunicates, jellyfish, and bristleworms in varying numbers also are abundant during the year (Chester et al. 1980; Dumbauld 1985; Ohman 1990; Giles and Cordell 1998). Abundance also varies by depth (Ohman 1990) and by type of sediment (Lie 1974, Llansó, et al. 1998).

3.6.1.4 Federally Protected Areas

Marine Protected Areas

"Marine protected areas" (MPAs) is a general term for natural and cultural marine resources that are protected by federal, state, tribal, or local governments. One example is Admiralty Head Marine Preserve on Whidbey Island, WA. There are many different kinds of MPAs, including national parks, wildlife refuges, monuments and marine sanctuaries, critical habitat for species of concern, state parks, and estuarine reserves. MPAs complement other management measures such as fishery regulations and pollution controls. Each of these areas is afforded varying degrees of protection under law. Washington, Oregon, and California also have several protected natural areas along their coasts.

Marine management areas (MMAs) are similar to MPAs, but encompass a wider range of management intents, including geological, cultural, or recreational resources, plus security zones, shellfish closures, sewage discharge areas, and pipeline and cable corridors. The primary difference between MPAs and MMAs is the duration of the site. MMAs must provide yearly protection for at least three months out of each year, and must provide a minimum of two years protection. MPAs must be designated with the intention of becoming permanent. There are 28 MPAs within the boundaries of the NWTRC Study Area (MPAC 2008).

Ocean training activities such as surface warfare and vessel-sinking under the Proposed Action would occur at least three nm offshore. In addition, nearshore activities such as mine countermeasure training are limited to areas in which those activities have been conducted in the past, such as Crescent Harbor. Therefore, the materials expended during training and the explosions and impacts anticipated will not affect these areas.

National Marine Sanctuaries

The national marine sanctuary system is administered by NOAA and protects special natural and cultural resources. As shown in Figure 3.6-4, the Olympic Coast National Marine Sanctuary (OCNMS) is in the Study Area. Significant features include undeveloped coastline, diverse nearshore marine habitats, and abundant marine life, including whales, seals, sea otters, and migratory waterfowl. The sanctuary's management plan guides the activities and sets the goals of the sanctuary, including reducing threats to its resources and ensuring water quality appropriate for those resources (MPAC 2008). The OCNMS EIS was completed in November 1993, and recognized the prior use of the sanctuary for a variety of Navy training activities (OCNMS 1993). Current regulations prohibit DoD from conducting bombing activities within the sanctuary (15 CFR 922.152[d][2]).

3.6.1.5 Current Requirements and Practices

Environmental compliance policies and procedures of importance to saltwater ecosystems concern water quality and habitat protection. Water quality in the ocean and nearshore areas is regulated by federal and state programs. In addition, the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) prohibits certain discharges of oil, garbage, and other substances from vessels. The MARPOL convention is implemented by national legislation, including the Act to Prevent Pollution from Ships (33 USC 1901, et seq.) and the Federal Water Pollution Control Act ("Clean Water Act"; 33 USC 1321, et seq.). These and other requirements are implemented by the *Navy Environmental and Natural Resources Program Manual* (OPNAVINST 5090.1C, 2007) and related Navy guidance documents

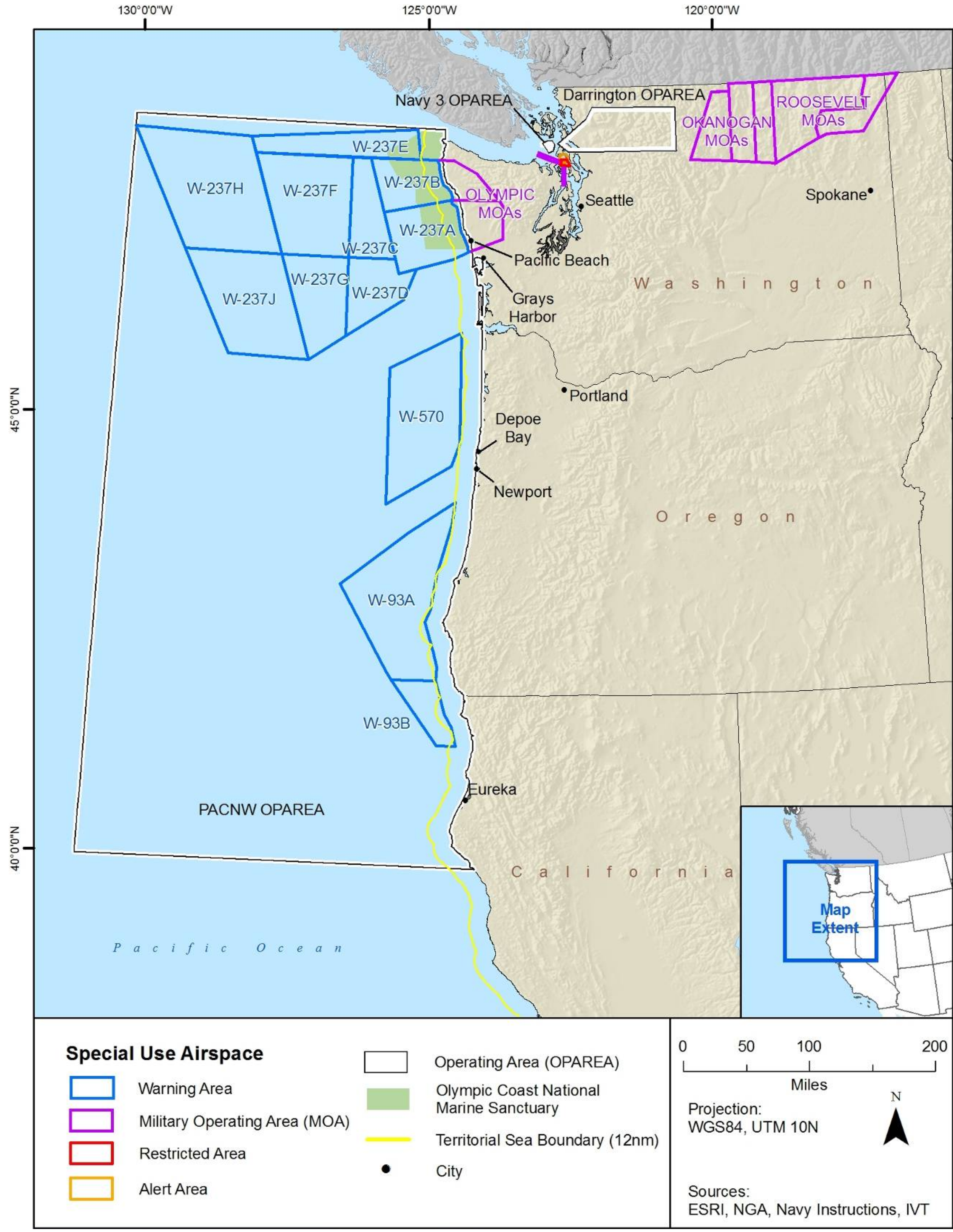

Figure 3.6-4: Location of Olympic Coast National Marine Sanctuary within the NWTRC

related pollution prevention, waste management, and recycling. In addition to water quality measures (see Section 3.3, Water Resources), measures that reduce potential impacts to saltwater ecosystems include designated buffer zones for activities using explosive and non-explosive ordnance and positioning of lookouts to survey for kelp beds or algal mats.

At sea, Navy vessels are required to operate in a manner that minimizes or eliminates any adverse impacts to the marine environment. Environmental compliance policies and procedures applicable to shipboard activities afloat are defined in the Navy environmental manual (DoN 2007), Chapter 4, "Pollution Prevention," and Chapter 22, "Environmental Compliance Afloat"; DoD Instruction 5000.2-R (§C5.2.3.5.10.8, "Pollution Prevention"). In addition, provisions in Executive Order (EO) 12856, *Federal Compliance With Right-To-Know Laws and Pollution Prevention Requirements*, and EO 13101, *Greening the Government through Waste Prevention, Recycling, and Federal Acquisition*, reinforce the CWA's prohibition against discharge of harmful quantities of hazardous substances into U.S. waters out to 200 nm (371 km), and mandate stringent hazardous waste discharge, storage, dumping, and pollution prevention requirements. Table 3.4-1 in the Water Resources section provides information on current Navy requirements and protective measures for management, storage, and discharge of shipboard materials and wastes.

3.6.2 Environmental Consequences

3.6.2.1 Approach to Analysis

Regulatory Framework – Federal

Impacts to wetlands, estuarine mud flats, and marine vegetated shallows are regulated under Section 404 of the Clean Water Act (33 USC 1251, et seq.) and Executive Order 11990, *Protection of Wetlands*. Dredge and fill activities are permitted by the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency (USEPA) (USACE 2008). Other provisions of the Clean Water Act are intended to address water quality, such as excess nutrient, that can affect the health of estuarine habitat like seagrass beds. The executive order directs federal agencies to minimize wetland loss and degradation resulting from federal projects and land management activities.

The federal Coastal Zone Management Act (CZMA; 16 USC 1451, et seq.) is a voluntary federal-state partnership that encourages states to adopt programs that meet federal goals of protecting and restoring coastal zone resources, especially protecting coastal waters from nonpoint source pollution (16 USC 1455[b]). The program is administered by NOAA. The act requires participating coastal states to develop management programs that demonstrate how states will carry out their obligations and responsibilities in managing their coastal areas. Upon federal approval of a state's coastal zone management program, the state benefits by becoming eligible for federal coastal zone grants and by gaining review authority over certain federal activities in the coastal zone and the consistency of those activities with the coastal zone management plan. CZMA specifically excludes federal lands from state designation. For this study, NBK-Bangor and Naval Air Station Whidbey Island are excluded. However, federal consistency requirements in the act (Section 307) require that federal activities be consistent with the management program to the "maximum extent practicable."

Regulatory Framework – State and Local Governments

Washington state law identifies saltwater habitat of concern, such as eelgrass beds and intertidal wetlands and restricts times during which work can be conducted to accommodate fish migration and breeding. Oregon's Department of Land Conservation and Development administers the state's coastal zone management plan, its Ocean Resources Management Plan, and it sets specific protection and management goals for estuaries, coastal shorelands, beaches, and ocean resources. In California, the State Water Resources Control Board oversees the state's "Ocean Plan" that, among other elements, identifies several

"Areas of Special Biological Significance" along the coast. Please see the Water Resources section for more detailed discussion of these state programs.

Study Area

The study area for consideration of impacts on marine plants and invertebrates includes the open ocean west of Washington, Oregon, and northern California (PACNW OPAREA) and Puget Sound, specifically underwater training areas at Crescent Harbor, Port Townsend Bay (Indian Island), and at Floral Point in Hood Canal. Aircraft overflight and training activities are assumed to have no impacts to marine communities, because impacts of sound on plants and invertebrates are unknown and difficult to quantify.

Sources of Information

To complete the analysis of marine plants and invertebrates in the Study Area, a systematic review of relevant literature was conducted, including journals, technical reports published by government agencies, work conducted by private businesses and consulting firms, and Department of Defense reports, operational manuals, natural resource management plans, and current and prior environmental documents for facilities and activities in the NWTRC Study Area. The literature and other information sources cited are identified in Chapter 9, References.

Methods

Potential stressors to marine communities in the Study Area that would result from the Proposed Action are limited to: 1) direct impacts to bottom-dwelling communities from materials expended during training, or the accumulation of those materials; and 2) explosions on the sea surface, below the sea surface, and on or near the bottom. Impacts to pelagic and benthic marine communities could include destruction of bottom habitat, partial or complete burial of bottom habitat, or detrimental effects to federal and state species of concern or their habitats. Some of the metals and other materials used during training are hazardous, such as lead ballast and battery components. The impact of these materials on marine water quality is discussed in Section 3.4, Water Resources.

Materials Expended during Training

Impacts on marine communities that may arise from materials expended during training were evaluated based on the estimated amount of debris under each alternative, the geographic dispersion of the proposed activities, and the resulting density of the debris.

Explosions

Alternatives were evaluated for long-term effects on marine communities that would result from explosions, based on their force, location, and proximity to the bottom. Short-term effects, including increases in local turbidity and the creation of shallow depressions in bottom sediments, were not considered because they dissipate relatively quickly under the influence of ocean and tidal currents, wind-generated currents, and the natural sediment transport processes that operate continuously in the ocean and in Puget Sound.

3.6.2.2 No Action Alternative

Activities under the No Action Alternative that may affect marine communities include materials expended during training and explosions and impacts. This analysis reviews the circumstances under which those expended materials and explosions may harm or substantially degrade the pelagic marine communities or benthic communities in the Study Area.

Expended Materials

Items expended during training include sonobuoys; parachutes and nylon cord; some towed, stationary, and remote-controlled targets; inert munitions; and exploded and unexploded munitions, including missiles, bombs, and shells. Materials include a variety of plastics, metals, and batteries. These materials arise from: 1) missiles and torpedoes launched during MISSLEX, GUNEX, and SINKEX; 2) shells fired during GUNEX, BOMBEX, and SINKEX; and 3) temporary, seasonal placement of a Portable Underwater Tracking Range used during TRACKEX exercises. BOMBEX mostly involves the use of inert training munitions, but explosives are used at times.

Unless otherwise noted in the discussion or the table, targets are not recovered. Most of these materials are inert and dense, and will settle deep in bottom sediments, become covered by sediments, or become encrusted by physical or biological processes. However, some of the metals and other materials such as lead, lithium, and batteries, are hazardous. The impact of these materials on marine resources is discussed in Section 3.3., Hazardous Materials, and Section 3.4, Water Resources.

For vessel-sinking exercises (SINKEX), the vessels used as targets are selected from a list of U.S. Navy-approved vessels that have been cleaned in accordance with USEPA guidelines. By rule, SINKEX is conducted at least 50 nm offshore (90 km) and in water at least 6,000 feet deep (1,830 m) (40 CFR 229.2).

Detonated munitions used in mine countermeasure training produce negligible amounts of solid materials because the bulk of the explosives are consumed in the explosion. The impact of these detonation by-products is discussed in Section 3.4, Water Resources. The following discussion is presented according to the materials expended during training in the PACNW OPAREA and in Puget Sound, specifically at Crescent Harbor, at Floral Point in Hood Canal, and at Indian Island.

The Portable Underwater Tracking Range (PUTR) consists of seven electronics packages each approximately 3 feet long (1 m) by 2 feet in diameter (0.6 m). Each package is powered by a D cell alkaline battery. This array is used for coordinated undersea warfare training. It is capable of tracking submarines, surface ships, weapons, targets, and unmanned underwater vehicles, and distributing the data to sea- and land-based sites. The seven packages would be installed on the seafloor at least 3 nm (5.5 km) from land in water 300 to 12,000 feet deep (90 to 3,650 m). The area covered would be up to 25 nm^2 (86 km^2). The packages are anchored to the seafloor by concrete or sand bags, each weighing approximately 300 pounds (136 kg). The system would be deployed for three months each year – approximately June through August – and TRACKEX activities would be conducted for 10 days per month. The PUTR equipment would be recovered when training is complete or at the end of the battery life. In either case, the anchors would remain on the seafloor.

Open Ocean Habitats

The effect of materials expended during training in the PACNW OPAREA is assessed by the number of expended items per unit area. Under the No Action Alternative, an estimated 94,953 items would be expended in this area (Table 3.6-1). Based on a PACNW OPAREA size of 122,400 nm^2 (420,163 km^2) and assuming an even distribution of activities, 0.8 items per nm^2 per year (0.2 per km^2) would be deposited in the ocean. More than 60 percent of these items would be small caliber rounds.

Table 3.6-1 excludes mine countermeasure training in the Puget Sound. Please see the discussion below, including Table 3.6-2. Additional materials expended during training include 500-600 smoke canisters, 208 to 220 marine markers, and 6 to 11 illuminating flares annually. These materials were dismissed from further analysis because canisters are only used on land at specially-designated areas; and the majority of the constituents in marine markers are consumed by heat and smoke, both of which dissipate in the air and water. Any remaining materials from marine markers would lodge sink into bottom sediments or become encrusted by chemical processes or by marine animals. Phosphorus contained in the markers and flares reacts with seawater to produce phosphoric acid, a variable, but normal, component of seawater.

Table 3.6-1: Training Materials Expended in the PACNW OPAREA – No Action Alternative

Type of Training Material	Number
Bombs	108
Missiles (excluding CATM-88c HARM)	10
Cannon Shells (20 mm)	7,200
Naval Gunshells (5-inch, 25mm, 57mm, 76mm)	18,656
Small Caliber Rounds (.50 caliber, 7.62mm)	59,724
EMATTs	121
TALDs	0
Sonobuoys	9,132
Torpedoes	1
Vessel Sinkings	1
Total	**94,953**

Pelagic Communities

Pelagic species, such as shrimp, are abundant, have high rates of reproduction, and are widely distributed, both across the ocean surface and vertically in the water column. Because of these factors and the low density of materials expended during training, negligible impacts are anticipated.

Deepwater Benthic Habitats

Specific conditions give rise to important deepwater benthic habitats such as the presence of hard substrate, hot springs, and methane seeps. About 3 percent of the open ocean bottom in the Study Area consists of hard substrates (DoN 2006, p2-52), and an undefined but smaller percentage of the area provides other conditions necessary for reef development.

Most expended materials are inert, dense, and readily sink into existing sediments, become covered with sediment over time, or become encrusted by chemical processes or by marine organisms that further isolates them from the environment. Once deposited, the materials would not pose a hazard to benthic communities. Because high quality habitat occupies only a small portion of the benthic environment, there is a small potential for the communities to be affected by initial impact of expended materials. However, injury or death could occur to bottom-dwelling organisms if struck.

The deposition of training materials on the ocean bottom under the No Action Alternative is judged to have negligible impacts because: 1) expended materials are distributed widely enough that less than one item would be deposited on the bottom per nm^2; and 2) the majority of those items are small caliber rounds that would have little impact. However, if important habitats were struck, especially in a concentrated manner such as would occur with SINKEX, the localized impacts could be severe. These communities usually have slow rates of recovery. On the other hand, over the long-term, such a vessel or other object could also provide new, hard substrate for benthic communities to utilize.

Nearshore Habitats

Materials expended during training in nearshore habitats primarily concern mine countermeasure training (MCT) in designated areas at Crescent Harbor (EOD Crescent Harbor), Floral Point at NBK-Bangor (EOD Floral Point), and west of Indian Island in Port Townsend Bay (EOD Indian Island). ("EOD" stands for explosive ordnance disposal.) These areas have been used for MCT consistently for many years. MCT trains personnel in the destruction of mines, unexploded ordnance, obstacles, and structures. EOD personnel must re-qualify at least monthly in the preparation, placement, and detonation of underwater explosives.

The sites at EOD Crescent Harbor and EOD Indian Island are from 1,000 to 7,200 feet from the nearest shoreline (330 to 2,200 m) and the detonations typically occur in 50 to 60 feet of water (15 to 20 m) over sandy or muddy bottoms. The MCT site at EOD Floral Point is about 600 feet offshore (183 m) and charges are placed on a training structure that is 3 to 8 feet above the bottom (1 to 3 m) (NMFS 2008).

At Crescent Harbor where the bulk of training occurs, two blocks of the plastic explosive C-4 are typically used per activity, one at the surface and one at or near the bottom. These charges are attached to an inert mine. For instance, during floating mine demolition training at EOD Crescent Harbor, the charge is attached to a clean, 55-gallon metal drum with one or two sand bags inside for ballast. Most of the charges are contained in a copper, aluminum, or plastic housing. Although most of the solids are consumed in the explosion, pieces of the mine and the explosive housing may remain. Personnel are instructed to retrieve this debris from the seafloor (NMFS 2008).

Table 3.6-2 shows the number and the size of the explosive charges that would be expended annually at each site under each alternative. In general, 2.5-pound explosives are used to demonstrate the ability of personnel to set and detonate the explosive. The 20-pound explosive is used only for specialized training when a disabled mine is retrieved for research and testing (NMFS 2008).

Table 3.6-2: Materials Expended During Mine Countermeasure Training – All Alternatives

Location	Charge Size	No Action	Alternative 1	Alternative 2
EOD Crescent Harbor	< 2.5 lbs	3	0	0
	2.5 lbs	45	2	2
	5.0 lbs	1	0	0
	20.0 lbs	4	0	0
EOD Floral Point	2.5 lb	3	1	1
EOD Indian Island	2.5 lbs	3	1	1
	20.0 lbs	1	0	0
	Total	**60**	**4**	**4**

Potential nearshore habitats of concern include eelgrass and kelp beds, but these habitats do not occur within the MCT areas and none would be affected. Therefore, the analysis of impacts to such habitats is not considered further.

Explosions and Impacts

Under the No Action Alternative, activities involving explosions and impacts occur at or just below the surface in the PACNW OPAREA, and at the surface and near the bottom at EOD Crescent Harbor, EOD Floral Point, and EOD Indian Island in Puget Sound.

- Sea surface explosions and impacts include missiles and torpedoes launched and bombs dropped during BOMBEX and SINKEX; and shells fired during GUNEX, BOMBEX, and SINKEX.
- Subsurface explosions involve the use of explosive sonobuoys used during TRACKEX, and detonated munitions used as part of mine countermeasure training.
- Explosions near the marine bottom involve the detonation of munitions as part of mine countermeasure training.

Open Ocean Habitats

The effect of explosions and impacts in the Study Area is based on the number and force of explosions and inert munitions in proximity to pelagic and deepwater benthic habitats. Under the No Action Alternative an estimated 94,953 explosions and impacts would occur in the open ocean portion of the NWTRC Study Area (Table 3.6-1). More than 60 percent of these would be small caliber rounds. This excludes mine countermeasure training in the Puget Sound. All of the explosions and impacts listed in Table 3.6-1 would occur at or near the surface. When averaged across the entire open ocean portion of the Study Area (122,420 nm^2 [420,163 km^2]), 0.8 explosions and impacts would occur per nm^2 (0.2 per km^2) per year.

Pelagic Communities

Pelagic species, whether plankton or large invertebrates, are most common in the surface and near-surface layers of the open ocean. Therefore, any surface or near-surface explosions or impacts have the potential to kill or harm individual animals and plants in the immediate vicinity. However, the shock waves from such explosions attenuate quickly. In situations where an explosion or impact occurred in an area with a high concentration of individuals, the extent of death or harm would be greater than in a more barren area. However, pelagic species are abundant, have high rates of reproduction, are widely distributed, both across the ocean surface and vertically in the water column, and their distribution tends to be patchy rather than uniform. Because of these factors and the very low density of explosions and impacts that would be associated with the No Action Alternative, negligible impacts are anticipated.

Deepwater Benthic Habitats

All of the explosions and impacts listed in Table 3.6-1 would occur at or near the surface of waters that average 650 feet deep (200 m) over the continental shelf and several thousand feet deep over the abyssal plain. In such settings, the shock waves from explosions and impacts at or near the surface would attenuate before reaching bottom-dwelling coral and sponge reefs. Thus, adverse impacts are not considered likely under the No Action Alternative.

Nearshore Habitats

As indicated in Table 3.6-2, there would be 60 underwater detonations under the No Action Alternative. These explosions would be of various sizes and would occur at EOD Crescent Harbor (86%), EOD Floral Point (7%), and EOD Indian Island (7%). Potential nearshore habitats of concern include eelgrass and kelp beds, but these habitats do not occur within the MCT areas, none would be affected, and nor would any of the communities they support. Explosions at or near the surface or the bottom could harm benthic invertebrates and other invertebrates living in the water column. The degree of harm, including death, would depend on the organism’s proximity to the explosion. Given the generally disturbed nature of these

MCT sites, the small number of MCT exercises each year, and the small area in which the exercises are concentrated, impacts would be negligible.

3.6.2.3 Alternative 1

Materials Expended During Training

Open Ocean Habitats

Under Alternative 1, an estimated 105,453 items would be expended in the open ocean portion of the NWTRC Study Area, an 11 percent increase over the No Action Alternative (Table 3.6-3). Based on an open ocean area of 122,400 nm^2 (420,163 km^2) and assuming an even distribution of activities, 0.9 items per nm^2 (0.3 per km^2) per year would be deposited in the ocean. More than 60 percent of these items would be small caliber rounds. The number of vessel sinkings would increase from one to two.

Table 3.6-3: Training Materials Expended in the PACNW OPAREA – No Action and Alternative 1

	No Action	Alternative 1		
Type of Training Material	Number	Number	Numerical Increase	Percent Increase
Bombs	108	144	36	33
Missiles (excluding CATM-88c HARM)	10	35	25	250
Cannon Shells (20 mm)	7,200	8,000	800	11
Naval Gunshells (5-inch, 25mm, 57mm, 76mm)	18,656	21,351	2,695	14
Small Caliber Rounds (.50 caliber, 7.62mm)	59,724	66,360	6,636	11
EMATTs	121	126	5	4
TALDs	0	11	11	–
Sonobuoys	9,132	9,422	290	3
Torpedoes	1	2	1	100
Vessel Sinkings	1	2	1	100
Total	**94,953**	**105,453**	**10,500**	**11**

Pelagic Communities

Pelagic species are abundant, have high rates of reproduction, and are widely distributed, both across the ocean surface and vertically in the water column. Because of these factors and the low density of materials expended during training, negligible impacts are anticipated from Alternative 1 (same as the No Action Alternative).

Deepwater Benthic Habitats

High-value deepwater benthic habitats of coral and sponge reefs represent a small percentage of the total bottom environment in the Study Area. However, the chances of adversely affecting these habitats with materials expended during training would be minimal under Alternative 1. The deposition of training materials on the ocean bottom under Alternative 1 is judged to have negligible impacts because: 1) expended materials are distributed widely enough that less than one item would be deposited on the bottom per nm^2; and 2) the majority of those items are small caliber rounds that would have little impact. However, if such habitats are struck by a very large, heavy object such as a vessel sent to the bottom during SINKEX, the localized impacts could be severe given the slow rates of recovery of deepwater communities. On the other hand, over the long-term, such a vessel or object could also provide new, hard substrate for benthic communities to utilize.

Nearshore Habitats

In April, 2008, the Navy decided to relocate Explosive Ordnance Disposal Mobile Unit Eleven (EODMU Eleven) forces out of the NWTRC Study Area to Imperial Beach, CA. This move is planned to be completed in the fall of 2009. Two EOD Shore Detachments (Bangor and Northwest) will remain in the NWTRC. These Shore Detachments report to Commander, Navy Region Northwest and respond to regional Navy taskings and incidents. As a result of the EODMU Eleven relocation, mine warfare underwater detonation training will decrease from a yearly maximum of 60 underwater detonation as analyzed in the No Action Alternative (the baseline) to no more than four annual underwater detonation as analyzed in Alternatives 1 and 2, a decline of over 90 percent. The maximum charge size would be 2.5 pounds.

Potential nearshore habitats of concern include eelgrass and kelp beds, but these habitats do not occur within the MCT areas and none would be affected. Little solid material remains during these activities because the bulk of the explosives are consumed in the explosion. Personnel are instructed to retrieve the pieces of inert mine and the housing that settle on the bottom. Based on these factors, impacts under Alternative 1 would be negligible.

Explosions and Impacts

Open Ocean Habitats

As shown in Table 3.6-3, an estimated 105,453 explosions and impacts would occur in the PACNW OPAREA under Alternative 1, an increase of 11 percent over the No Action Alternative. Over 60 percent of these items would be small caliber rounds. When averaged across the open ocean portion of the Study Area (122,400 nm^2 [420,163 km^2]), there would be about 0.9 explosions and impacts per nm^2 (0.3 per km^2) per year.

Pelagic Communities

Based on the abundance and wide-spread distribution of pelagic species, the effects of explosions and impacts under Alternative 1 would be negligible (same as the No Action Alternative).

Deepwater Benthic Habitats

Because all explosions and impacts in the open ocean would occur at or near the surface, the impacts to deepwater benthic habitats under Alternative 1 would be negligible (same as the No Action Alternative).

Nearshore Habitats

As noted above, the number of underwater detonations under Alternative 1 would decrease from 60 per year to 4, and the maximum charge size would be 2.5 pounds. Because eelgrass and kelp beds do not occur within the MCT areas, Alternative 1 would not result in any adverse effects on these plants and the communities they support. Explosions at or near the surface or the bottom could harm invertebrates. The degree of harm, including death, would depend on the organism's proximity to the explosion. Given the generally disturbed nature of the MCT sites, the small number of MCT exercises, and the small area in which the exercises are concentrated, impacts would be negligible.

3.6.2.4 Alternative 2

Materials Expended During Training

Open Ocean Habitats

Under Alternative 2, an estimated 183,067 items would be expended in the PACNW OPAREA, an increase of 93 percent over the No Action Alternative (Table 3.6-4). Based on an open ocean area of 122,400 nm^2 (420,163 km^2) and assuming an even distribution of activities, 1.5 items per nm^2 (0.4 per km^2) per year would be deposited in the ocean. More than 65 percent would be small caliber rounds. The number of vessel sinkings would increase from one to two.

Table 3.6-4: Training Materials Expended in the PACNW OPAREA – No Action and Alternative 2

	No Action	Alternative 2		
Type of Training Material	Number	Number	Numerical Increase	Percent Increase
Bombs	108	144	36	33
Missiles (excluding CATM-88c HARM)	10	57	47	470
Cannon Shells (20 mm)	7,200	16,000	8,800	122
Naval Gunshells (5-inch, 25mm, 57mm, 76mm)	18,656	37,343	18,687	100
Small Caliber Rounds (.50 caliber, 7.62mm)	59,724	119,720	59,996	100
EMATTs	121	126	5	4
TALDs	0	22	22	—
Sonobuoys	9,132	9,651	519	6
Torpedoes	1	2	1	100
Vessel Sinkings	1	2	1	100
Total	**94,953**	**105,453**	**88,114**	**93**

Pelagic Communities

Pelagic species are abundant, have high rates of reproduction, and are widely distributed, both across the ocean surface and vertically in the water column. Because of these factors and the low density of materials expended during training, negligible impacts are anticipated under Alternative 2 (same as the No Action Alternative).

Deepwater Benthic Habitats

High-value deepwater benthic habitat represents a very small percentage of the total bottom environment in the Study Area. However, the chances of adversely affecting these habitats with materials expended during training would be minimal under Alternative 2. The deposition of training materials on the ocean bottom under Alternative 2 is judged to have negligible impacts because: 1) expended materials are distributed widely enough that less than two items would be deposited on the bottom per nm^2; and 2) the majority of those items are small caliber rounds that would have little impact. However, if such habitats are struck by a very large, heavy object such as a vessel sent to the bottom during SINKEX, local impacts could be severe, especially given the slow rate of recovery of deepwater benthic communities. On the other hand, such a vessel or other object could also provide new, hard substrate for benthic communities to utilize.

Nearshore Habitats

Like Alternative 1, the Navy has decided to relocate Explosive Ordnance Disposal Mobile Unit Eleven (EODMU Eleven) forces out of the NWTRC Study Area to Imperial Beach, CA. This move is planned to be completed in the fall of 2009. Two EOD Shore Detachments (Bangor and Northwest) will remain in the NWTRC. These Shore Detachments report to Commander, Navy Region Northwest and respond to regional Navy taskings and incidents. As a result of the EODMU Eleven relocation, mine warfare underwater detonation training will decrease from a yearly maximum of 60 underwater detonation as analyzed in the No Action Alternative (the baseline) to no more than four annual underwater detonation as analyzed in Alternatives 1 and 2, a decline of over 90 percent. The maximum charge size of would be 2.5 pounds.

Potential nearshore habitats of concern include eelgrass and kelp beds, but these habitats do not occur within the MCT areas and none would be affected. Little solid material remains during these activities because the bulk of the explosives are consumed in the explosion. Personnel are instructed to retrieve the pieces of inert mine and the housing that settle on the bottom. Based on these factors, impacts under Alternative 2 would be negligible.

Explosions and Impacts

Open Ocean Habitats

Under Alternative 2, an estimated 183,067 explosions and impacts would occur in the open ocean portion of the Study Area, an increase of 93 percent over the No Action Alternative (Table 3.6-4). Over 65 percent of the items would be small caliber rounds. When averaged across the open ocean portion of the Study Area (122,400 nm^2 [420,163 km^2]), there would be 1.5 explosions and impacts per nm^2 (0.4 per km^2) per year.

Pelagic Communities

Based on the abundance and wide-spread distribution of pelagic species, the effects of explosions and impacts under Alternative 2 would be negligible (same as the No Action Alternative).

Deepwater Benthic Habitats

Because all explosions and impacts in the open ocean portion of the Study Area would occur at or near the surface, the impacts to deepwater benthic habitats under Alternative 2 would be negligible (same as the No Action Alternative).

Nearshore Habitats

As noted above, the number of underwater detonations under Alternative 2 would decrease from 60 per year to 4, and the maximum charge size would be 2.5 pounds. Because eelgrass and kelp beds do not occur within the MCT areas, Alternative 2 would not result in any adverse effects on these plants and the communities they support. Explosions at or near the surface or the bottom could harm invertebrates. The degree of harm, including death, would depend on the organism's proximity to the explosion. Given the generally disturbed nature of the MCT sites, the small number of MCT exercises, and the small area in which the exercises are concentrated, impacts would be negligible.

3.6.3 Mitigation Measures

As summarized in Section 3.6.4, the actions proposed under the alternatives described in this EIS/OEIS would have minimal impacts on the marine plant and invertebrate communities of the NWTRC. The Navy would continue to implement protective measures that limit impacts to these resources. Therefore, no additional resource-specific mitigation measures would be required. See Chapter 5 for additional discussion of mitigation measures.

3.6.4 Summary of Effects by Alternative

The proposed action alternatives would have negligible adverse impacts on marine plant or invertebrate resources in the Study Area. These effects would be related to ordnance use and expended materials, and would not be anticipated to be measurable, given the large area over which activities occur and the dynamic nature of the marine environment of the NWTRC. Table 3.6-3 summarizes the effects of the alternatives.

Table 3.6-5: Summary of Effects – Marine Plants and Invertebrates

Alternative	NEPA (U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Releases of munitions constituents from explosives and ordnance used during training exercises have no substantial impacts.	• Munitions constituents and other materials from training activities have minimal effects.
Alternative 1	• Impacts generally the same as under the No Action Alternative.	• Impacts generally the same as under the No Action Alternative.
Alternative 2 (Preferred Alternative)	• Impacts generally the same as under the No Action Alternative.	• Impacts generally the same as under the No Action Alternative.

3.7 Fish

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3.7 FISH

This section provides an overview of the species, distribution, and occurrence of fishes that are either resident or migratory through the Northwest Training Range Complex (NWTRC) Study Area. Many of the finfish species that occur in the affected areas are managed on a region-wide (*e.g.*, Puget Sound), State-wide (Washington), or larger (Pacific Northwest [PACNW]) basis for their importance as both commercial and recreational fisheries.

The Navy will consult, as appropriate, with the National Marine Fisheries Service (NMFS) and United States Fish and Wildlife Service (USFWS), as part of the EIS/OEIS process. As such, additional documentation has been prepared: a Biological Evaluation (BE) for use in consultation regarding federally-listed threatened and endangered species protected under the Endangered Species Act (ESA), and an Essential Fish Habitat (EFH) Assessment for species protected under the Magnuson-Stevens Fishery Conservation and Management Act. A brief discussion of EFH is provided in Section 3.7.1.3 of this EIS/OEIS; a brief discussion of federally-listed threatened and endangered fish species and fish Species of Concern in the NWTRC is provided in Section 3.7.1.4.

3.7.1 Affected Environment

The NWTRC Study Area is located in a region of diverse and highly productive fisheries (Leet et al. 2001). Predominant ecosystems found in the NWTRC include nearshore coastal, continental shelf, and oceanic systems. Important marine species include salmonids (*e.g.*, chinook salmon, trout), coastal pelagic and forage (*e.g.*, mackerels, anchovies, herrings, and jacks), groundfish (*e.g.*, halibut, flounder, rockfish), and highly migratory species (*e.g.*, tuna) (NMFS 2005h, 2005c).

The marine environment off the coasts of Washington, Oregon, and northern California, are part of what is collectively known as the Coastal Upwelling Domain (NMFS-Northwest Regional Office [NWR] 2005). The Coastal Upwelling Domain is part of the California Coastal System. This system can be described as a broad, meandering, southward-flowing current that extends from the northern tip of Vancouver Island (50°N latitude) to Baja California (25°N latitude) and extends westward from the shore to several hundred miles out (NMFS-NWR 2005).

Although the coastal upwelling along the Pacific coast produces high plankton biomass, unique conditions are associated with this environment. The upwelling process transports surface waters and their associated plankton, larval, and juvenile fishes away from the coast and to the south, moving them from nutrient-rich waters to nutrient-poor conditions. As an adaptation to this condition, fish species may spawn during winter months before upwelling occurs (*e.g.*, Dover sole *[Microstomus pacificus]*), migrate to areas where upwelling does not occur (*e.g.*, Pacific hake *[Merluccius productus]* and English sole *[Parophyrus vetulus]*), spawn in rivers (salmonids and eulachon), or give birth to live young (NMFS-NWR 2005).

3.7.1.1 Existing Conditions

The following discussion provides an overview of the predominant fish species and types of habitat known to occur in the NTWRC. Fish are categorized as: salmonids; coastal pelagic and forage; groundfish; and highly migratory species. Habitat is categorized as nearshore, offshore, and Puget Sound.

<u>Salmonids</u>

Pacific salmon are arguably the most important living marine resource within the NWTRC. Salmonid species with known or potential occurrence within the NWTRC include five species of Pacific salmon: the chinook (*Oncorhynchus tshawytscha*), chum (*O. keta*), coho (*O. kisutch*), pink (*O. gorbuscha*), and sockeye (*O. nerka*); and three species of trout: the cutthroat (*O. clarkii*), steelhead (*O. mykiss*), and bull

(*Salvelinus confluentus*). Salmonids found in the NWTRC are anadromous fish species that spend at least part of their adult life in the ocean but return to freshwater environments to spawn. Salmon habitat includes streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon. Salmon habitat extends from the nearshore and tidal submerged environments within State territorial waters out to the full extent of the Exclusive Economic Zone (EEZ), 200 nm offshore (Pacific Fisheries Management Council [PFMC] 2000). Three species of salmon have essential fish habitat in the NWTRC: Chinook, coho, and Puget Sound pink salmon.

In 1993, Washington and western Washington Treaty Tribes published the first state-wide comprehensive inventory of salmon and steelhead stocks. In total, the inventory identified 435 different stocks of salmon and steelhead, and the current status of each stock was reported. Based on these and other data, NMFS and USFWS have listed several salmonid species as threatened. ESA-designated salmonid species with known or potential occurrence in the NWTRC include: Chinook, coho, and chum salmon, and steelhead and bull trout. NMFS has jurisdiction over the salmon and steelhead trout species; USFWS has jurisdiction over the bull trout. Pacific salmon are discussed in more detail in Sections 3.7.1.3 and Section 3.7.1.4.

Coastal Pelagic and Forage Fish

The shorelines of Puget Sound provide habitat for forage fish. These fish and their eggs are an important food source for many organisms (*e.g*., marine mammals, sea birds, and fishes including salmonids) within the Puget Sound ecosystem (Bargmann and Schweigert 2005, Herrera Environmental Consultants Inc. 2005). Forage fish species that are found within Puget Sound include: Pacific herring *(Clupea harengus pallasi)*, northern anchovy *(Engraulis mordax)*, Pacific sardine *(Sardinops sagax)*, surf smelt *(Hypomesus pretiosus)*, eulachon *(Thalichthys pacificus)* (also called Columbia River smelt, or oil fish), and Pacific sand lance *(Ammodytes hexapterus)*. Three Puget Sound forage fish species: Pacific herring, Pacific sand lance, and surf smelt, have documented spawning sites within the NWTRC Study Area. In addition, surf smelt utilizes spawning areas along the Pacific coast (Bargmann 1998) which include W-237A.

Coastal pelagic species in the NWTRC include finfish (*e.g*., northern anchovy, Pacific sardine, Pacific [chub] mackerel [*Scomber japonicus*], and jack mackerel [*Trachurus symmetricus*]), and invertebrates (*e.g*., market squid [*Loligo opalescens*], and krill [*Euphausia pacifica* and *Thysanoessa spinifera*]) (PFMC 2005). Coastal pelagic species inhabit the open, upper portion (surface to approximately 3,280 feet [ft.] (1,000 meters [m])) of marine waters rather than waters adjacent to the land or near the seafloor.

Coastal pelagic species are harvested directly and incidentally (as bycatch) in other fisheries. Usually targeted with “round-haul” gear including purse seines, drum seines, lampara nets, and dip nets, they are also taken as bycatch in midwater trawls, pelagic trawls, gillnets, trammel nets, trolls, pots, hook-and-line, and jigs. Market squid are fished nocturnally using bright lights to attract the squid to the surface. They are pumped directly from the sea into the hold of the boat, or taken with an encircling net (PFMC 2005).

Coastal pelagic species with EFH in the NWTRC include: northern anchovy, Pacific mackerel, jack mackerel, Pacific sardine, market squid, and krill, these species are discussed in more detail in Section 3.7.1.3.

Pacific Coast Groundfish Species

Pacific coast groundfish species (i.e., flatfish, rockfish, thornyheads, roundfish, skates, sharks and chimeras) support important commercial, recreational, and Tribal usual and customary fisheries. Many species of groundfish have EFH in the NWTRC. EFH is discussed in more detail in Section 3.7.1.3.

Most flatfish are demersal species associated with shallow, soft-bottom (sand and mud) habitats in Puget Sound and Washington coast waters (Emmett et al. 1991). They spawn offshore between September and

April (Kruse and Tyler 1983). Larvae are found in nearshore habitats between March and May. Juveniles are found throughout the year in gravel, sand-eelgrass, and mud-eelgrass habitats. English sole is the most numerous flatfish in Puget Sound.

Rockfish on the Pacific coast typically inhabit the continental shelf and upper slope regions and are sometimes described as nearshore, shelf, or slope rockfish. As adults, rockfish inhabit rocky reef habitats, slopes, pinnacles, pilings, or submerged debris and typically remain within 100 to 164 ft (30 to 50 m) of their preferred habitat (Matthews 1990). Rockfish are long-lived and sexual maturity is attained between 5 and 20 years of age. Spawning for most species generally takes place in the early spring (April) or late fall. Once hatched (late winter to mid-summer) the juvenile larvae form part of the pelagic community for up to 3 years and use nearshore habitats. Due to their long lives and late sexual maturity, rockfish are extremely susceptible to over harvest and stock depletion.

Other roundfish of interest are the rock greenling *(Hexagrammos lagocephalus)*, typically caught by recreational fishers, and walleye pollock *(Theragra chalcogramma)*, commonly caught by commercial trawlers (www.wdfw.wa.gov). The Washington Department of Fish and Wildlife (WDFW) recognizes two stocks of walleye pollock in Puget Sound (North Sound and South Sound) which are differentiated by spawning location, growth rates, and other biological characteristics (Palsson et al. 1998). Walleye pollock reportedly form spawning aggregations on localized grounds in Puget Sound during March and April at depths of 361 to 476 ft (110 to 145 m) (Pedersen and DiDonato 1982). Larvae and small juveniles are pelagic, and are generally found in the upper water column to depths of 197 ft (60 m) (Garrison and Miller 1982, Bailey et al. 1999). Juvenile pollock have been found in a variety of habitat types, including eelgrass (over sand and mud), gravel, and cobble (Miller et al. 1976).

Species of sharks and skates that are known to occur in Puget Sound include spiny dogfish, big skate, and longnose skate. Sharks and skates form part of the benthic and near-bottom fish communities in Puget Sound and are not classified as food fish. These species are often caught as bycatch in groundfish fisheries. Stock status of these species in Washington is unknown.

Groundfish range throughout the EEZ and occupy diverse habitats at all stages in their life histories. Some species are broadly dispersed during specific life stages, especially those with pelagic eggs and larvae. The distribution of other species and/or life stages may be relatively limited, as with adults of many nearshore rockfish which show strong affinities to a particular location or substrate type.

While the majority of groundfish on the west coast of Washington are harvested in the commercial trawl fishery, both recreational and Tribal usual and accustomed fisheries also harvest groundfish. Washington coastal treaty Indian tribes (Makah, Quileute, Hoh and the Quinault Indian Nation) hold formal allocations in their “usual and accustomed” fishing areas for sablefish *(Anoplopoma fimbria)*, Pacific hake, and black rockfish *(Sebastes melanops)*.

Highly Migratory Species

The term “highly migratory species” (HMS) derives from Article 64 of the United Nations Convention on the Law of the Sea. Although the Convention does not provide an operational definition of the term, an annex to it lists species considered highly migratory by parties to the Convention. In general, these species have a wide geographic distribution, both inside and outside the 200-nm zones, and undertake migrations of significant but variable distances across oceans for feeding or reproduction. They are pelagic species, which means they do not live near the sea floor, and mostly live in the open ocean, although they may spend part of their life cycle in nearshore waters. Highly migratory species are harvested by U.S. commercial and recreational fishers and by foreign fishing fleets. Only a small fraction of the total harvest is taken within U.S. waters. In the NWTRC, HMS include sharks, tunas, and swordfish, as discussed in more detail in Section 3.7.1.3.

Fish Habitat in the Northwest Training Range Complex

Habitat characteristics include geomorphic, physical, biological, and chemical parameters. Interactions between environmental parameters make up habitat and determine the biological niche of a species. Habitat types along the west coast can be separated into two large provinces: the Oregonian (north of Point Conception) and the Californian (south of Point Conception) (Allen and Smith 1988). The OPAREA and Puget Sound Study Area fall entirely within the Oregonian Province. The Oregonian province can further be defined by physical characteristics (depth, substrate, temperature, salinity) and habitat types utilized by managed fishes (NMFS-NWR 2005).

Nearshore (Estuarine and Intertidal Habitats)

Estuaries

Estuaries include bays and inlets influenced by both the ocean and river and serve as the transitional zone between fresh and saltwater. These habitats fulfill fish/invertebrate needs for reproduction, feeding, refuge, and other physiological necessities. Major estuaries include Puget Sound, Gray's Harbor, Columbia River, and Yaquina Bay.

Nearshore biogenic habitats

Nearshore biogenic habitats include kelp, seagrass, and sponges. The biological component (kelp, seagrass, or sponges) associated with the habitat is generally the feature that makes that habitat suitable for a particular species or life stage (*e.g*., groundfish).

Nearshore unconsolidated bottom (silt, mud, gravel, or mixed)

Composed of small particles (gravel, sand, mud, silt, or mixtures of these particles), these areas contain little to no vegetation due to the lack of stable surfaces for attachment.

Nearshore hardbottom

Nearshore hardbottom is composed of bedrock, boulders, cobble, or gravel/cobble. Nearshore hardbottom is one of the least abundant benthic habitats, but one of the most important for fishes, especially rockfish (*e.g*., *Sebastes* spp.), lingcod, and sculpins. Most Washington State Pacific herring stocks spawn in intertidal and shallow sub-tidal hardbottom.

Nearshore water column

The nearshore water column, or coastal epipelagic zone, includes egg, juvenile, and larval stages of groundfish commonly associated with macrophyte canopies or drift algae. The green sturgeon (*Acipenser medirostris*) is a widely distributed sturgeon found in nearshore marine waters.

Offshore (Shelf and Slope Habitats)

Offshore biogenic habitats (corals, sponges, etc.)

Biogenic habitats include structure-forming invertebrates such as corals, basketstars, brittlestars, demosponges, gooseneck barnacles, sea anemones, sea lilies, sea urchins, sea whips, tube worms, and vase sponges.

Offshore unconsolidated bottom (silt, mud, sand, gravel, or mixed)

Unconsolidated bottom is composed of small particles (gravel, sand, mud, silt, or mixtures of these particles), which contains little to no vegetation due to the lack of stable surfaces for attachment.

Offshore hardbottom

The hardbottom is composed of bedrock, boulders, cobble, or gravel/cobble. Large, mobile, nektobenthic fishes (*e.g*., rockfish, sablefish, Pacific hake, spotted ratfish, spiny dogfish) are typically associated with this habitat.

Offshore artificial structures

Artificial structures include artificial reefs utilized by rockfish. Artificial reefs are often composed of concrete, tires, or sunken ships; these features create habitat for sea life.

Offshore water column: pelagic zone

The pelagic zone is home to the highly migratory species, other relatively large pelagics, and early life stages of groundfish inhabiting the epipelagic/mesopelagic area or that are in association with fronts, current systems, and macrophyte canopies or drift algae.

Puget Sound

Estuaries are among the most productive natural systems and important nursery areas that provide food, refuge from predation, and valuable habitat in supporting commercial and recreational fisheries including salmonids, groundfish, shellfish, and bivalves along the west coast (Emmett et al. 1991, Monaco et al. 1992). Most species utilizing this inshore habitat fall into four categories: (1) diadromous species which use estuaries as migration corridors and in some instances, nurseries; (2) species that use estuaries for spawning, often at specific salinities; (3) species that spawn offshore near the mouth of estuaries and depend on tidal- and wind-driven currents to carry eggs, larvae, or early juveniles into estuarine nursery areas; and (4) species that enter estuaries during certain times of the year to feed on abundant prey (Monaco et al. 1990).

Nearshore marine environments along Puget Sound's inland waters such as Hood Canal exhibit higher species diversity, density, and production than the deeper water marine habitats (Shaffer 2002). Nearshore vegetated habitats consisting of kelp, eelgrass, algae, and salt marsh-salt tolerant, emergent wetlands along with a rocky/cobble shoreline, provide food (infaunal and bottom-dwelling organisms) and/or shelter for several species of fish, invertebrates (mollusks and crustaceans), and seabirds (Berry and Ritter 1995, Shaffer 1998, Frankenstein 2000, Shaffer 2001, Anchor Environmental L.L.C. and People for Puget Sound 2002).

This nearshore habitat functions as a critical feeding, refuge, and migration corridor for many fish species including salmon, forage fish, and rockfish (Triangle Associates Inc. 2004). Adult fish use nearshore marine waters for migration and feeding; whereas juveniles are known to depend upon these nearshore waters for migrations, feeding, and refuge (Brennan and Higgins 2003). Adult salmon use kelp beds extensively as feeding and staging areas before heading into natal streams to spawn. Juvenile salmon require nearshore healthy wetlands as they transition from freshwater to marine water and from eelgrass/kelp beds during their outward migration once they reach marine waters (Shaffer 2003). Forage or bait fish utilize nearshore areas heavily for spawning, feeding, and migration (Meyer 1997, Bargmann 1998). Forage species, such as the surf smelt and Pacific sand lance spawn in sandy gravel on intertidal beaches; whereas Pacific herring spawn on littoral zone plants, mainly native eelgrass and red algae (Penttila 1997, Moulton 2000, Moulton and Penttila 2000, Moriarity et al. 2002a 2002b, Sikes et al. 2002). Adult and juvenile rockfish (*e.g.*, brown, black, quillback, copper, yellowtail, and Puget Sound) depend on rocky reef, eelgrass and kelp beds, and drift algae for food and refuge (Love et al. 2002). Rockfish also rely on drift mats, possibly as transportation between nearshore and benthic habitats (Love et al. 2002; Shaffer 2003).

The inshore marine basins of Puget Sound support 230 species of fish representing 71 families with pelagic fishes (*e.g.*, salmonids, myctophids, etc.), and fish found near or at the bottom (*e.g.*, forage fish and groundfish) being the most abundant groups (DeLacy et al. 1972, Somerton and Murray 1976, Miller and Borton 1980, Garrison and Miller 1982, Buckworth 1996, Venier and Kelson 1996, Anchor Environmental L.L.C. and People for Puget Sound 2002, Brennan and Higgins 2003, Palsson et al. 2003b). Pacific salmonids are represented by nine species of salmon and/or trout (Somerton and Murray 1976). Forage or bait fish, consisting of nine small schooling fish species (*e.g.*, anchovies, sand lances, herrings, sardines, and smelts), are a significant prey base for marine mammals, seabirds, and fish populations including salmonids and groundfish (Bargmann 1998). Groundfish or bottomfish are represented by 86 species dominated by flatfish (15 species), rockfish (26 species), roundfish (including greenlings, sculpins [35 species], sablefish, and cods), and skates, sharks, and chimeras (DeLacy et al. 1972, Somerton and Murray 1976, Miller and Borton 1980, Garrison and Miller 1982, Palsson et al. 1998, Palsson 2001, Palsson et al. 2003b).

3.7.1.2 Socioeconomic Value of Northwest Training Range Complex Fish

The economic values of commercial fishing, sport fishing, and recreational diving are addressed in Section 3.14.

3.7.1.3 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (16 United States Code [U.S.C.] §1801 et seq.), mandates identification and conservation of EFH. The MSFCMA defines EFH as those waters and substrates necessary (required to support a sustainable fishery and the managed species) to fish for spawning, breeding, feeding, or growth to maturity (i.e., full life cycle). These waters include aquatic areas and their associated physical, chemical, and biological properties used by fish, and may include areas historically used by fish. Substrate types include sediment, hard bottom, structures underlying the waters, and associated biological communities.

Federal agencies are required to consult with NMFS and to prepare an EFH Assessment describing potential adverse affects of their activities on EFH. A detailed EFH Assessment has been prepared for the NWTRC.

NMFS and the Fishery Management Council have developed Fishery Management Plans (FMPs) to manage the fishery and address fish habitat issues, specifically the principle that there will be no net loss of the productive capacity of habitats that sustain commercial, recreational, and native fisheries. Fish with designated EFH in the NWTRC are grouped into the Pacific Salmon Species, Coastal Pelagic Species, Pacific Coast Groundfish Species, and Highly Migratory Species, as listed in Table 3.7-1.

Habitat Areas of Particular Concern (HAPCs) are a subset of EFH. Fishery Management Councils are encouraged to designate HAPCs under the MSFCMA. HAPCs are identified based on habitat level considerations rather than species life stages as are identified with EFH. EFH guidelines published in federal regulations identify HAPCs as types or areas of habitat within EFH that are identified based on one or more of the following considerations:

- The importance of the ecological function provided by the habitat.
- The extent to which the habitat is sensitive to human-induced environmental degradation.
- Whether, and to what extent, development activities are or will be stressing the habitat type.
- The rarity of the habitat type (50 CFR 600.815(a)(8))

Based on these considerations, the PFMC has designated both ‘areas’ and ‘habitat types’ as HAPCs. In some cases, HAPCs identified by means of specific habitat type may overlap with the designation of a specific area. Designating HAPCs facilitates the consultation process by identifying ecologically important, sensitive, stressed, or rare habitats that should be given particular attention when considering potential nonfishing impacts. Their identification is the principal way in which the PFMC can address these impacts (PFMC 2005).

Table 3.7-1: The Fish and Invertebrate Species with EFH Designated in the Pacific Northwest OPAREA and Puget Sound Study Area.

PFMC Managed Species by Management Plan	
Pacific Salmon Species	
Chinook salmon (*Oncorhynchus tshawytscha*)	Puget Sound pink salmon (*Oncorhynchus gorbuscha*)
Coho salmon (*Oncorhynchus kisutch*)	
Coastal Pelagic Species	
Northern anchovy (*Engraulis mordax*)	Pacific mackerel (*Scomber japonicus*)
Jack mackerel (*Trachurus symmetricus*)	Market squid (*Loligo opalescens*)
Pacific sardine (*Sardinops sagax*)	
Krill	
Euphausia pacifica	*Thysanoessa spinifera*
Pacific Coast Groundfish Species	
Flatfish	
Arrowtooth flounder (*Atheresthes stomias*)	Petrale sole (*Eopsetta jordani*)
Butter sole (*Isopsetta isolepis*)	Rex sole (*Glyptocephalus zachirus*)
Curlfin sole (*Pleuronichthys decurrens*)	Rock sole (*Lepidopsetta polyxstra*)
Dover sole (*Microstomus pacificus*)	Sand sole (*Psettichthys melanostictus*)
English sole (*Parophrys vetulus*)	Starry flounder (*Platichthys stellatus*)
Flathead sole (*Hippoglossoides elassodon*)	Pacific sanddab (*Citharichthys sordidus*)
Rockfish	
Aurora rockfish (*Sebastes aurora*)	Olive rockfish (*Sebastes serranoides*)
Bank rockfish (*Sebastes rufus*)	Pacific ocean perch (*Sebastes alutus*)
Black rockfish (*Sebastes melanops*)	Pink rockfish (*Sebastes eos*)
Black-and-yellow rockfish (*Sebastes chrysomelas*)	Quillback rockfish (*Sebastes maliger*)
Blackgill rockfish (*Sebastes melanostomus*)	Redbanded rockfish (*Sebastes babcocki*)
Blue rockfish (*Sebastes mystinus*)	Redstripe rockfish (*Sebastes proriger*)
Bocaccio (*Sebastes paucispinis*)	Rosethorn rockfish (*Sebastes helvomaculatus*)
Bronzespotted rockfish (*Sebastes gilli*)	Rosy rockfish (*Sebastes rosaceus*)
Brown rockfish (*Sebastes auriculatus*)	Rougheye rockfish (*Sebastes aleutianus*)
Canary rockfish (*Sebastes pinniger*)	Sharpchin rockfish (*Sebastes zacentrus*)
Chilipepper (*Sebastes goodei*)	Shortbelly rockfish (*Sebastes jordani*)
China rockfish (*Sebastes nebulosus*)	Shortraker rockfish (*Sebastes borealis*)
Copper rockfish (*Sebastes caurinus*)	Silvergray rockfish (*Sebastes brevispinis*)
Cowcod (*Sebastes levis*)	Speckled rockfish (*Sebastes ovalis*)
Darkblotched rockfish (*Sebastes crameri*)	Splitnose rockfish (*Sebastes diploproa*)
Dusky rockfish (*Sebastes variabilis*)	Squarespot rockfish (*Sebastes hopkinsi*)
Flag rockfish (*Sebastes rubrivinctus*)	Stripetail rockfish (*Sebastes saxicola*)
Gopher rockfish (*Sebastes carnatus*)	Tiger rockfish (*Sebastes nigrocinctus*)
Grass rockfish (*Sebastes rastrelliger*)	Vermilion rockfish (*Sebastes miniatus*)
Greenblotched rockfish (*Sebastes rosenblatti*)	Widow rockfish (*Sebastes entomelas*)
Greenspotted rockfish (*Sebastes chlorostictus*)	Yelloweye rockfish (*Sebastes ruberrimus*)
Greenstriped rockfish (*Sebastes elongatus*)	Yellowmouth rockfish (*Sebastes reedi*)
Harlequin rockfish (*Sebastes variegatus*)	Yellowtail rockfish (*Sebastes flavidus*)

Table 3.7-1: The Fish and Invertebrate Species with EFH Designated in the Pacific Northwest OPAREA and Puget Sound Study Area (cont'd)

PFMC Managed Species by Management Plan	
Thornyhead	
Longspine thornyhead (*Sebastolobus altivelis*)	Shortspine thornyhead (*Sebastolobus alascanus*)
Roundfish	
Cabezon (*Scorpaenichthys marmoratus*)	Pacific cod (*Gadus macrocephalus*)
Kelp greenling (*Hexagrammos decagrammus*)	Pacific hake (*Merluccius productus*)
Lingcod (*Ophiodon elongatus*)	Sablefish (*Anoplopoma fimbria*)
Skates, Sharks, and Chimeras	
Big skate (*Raja binoculata*)	Soupfin shark (*Galeorhinus zyopterus*)
California skate (*Raja inornata*)	Spiny dogfish (*Squalus acanthias*)
Longnose skate (*Raja rhina*)	Spotted ratfish (*Hydrolagus colliei*)
Leopard Shark (*Triakis semifasciata*)	
Highly Migratory Species	
Sharks	
Common thresher shark (*Alopias vulpinus*)	Shortfin mako shark (*Isurus oxyrinchus*)
Bigeye thresher shark (*Alopias superciliosus*)	Blue shark (*Prionace glauca*)
Tunas	
Albacore tuna (*Thunnus alalunga*)	Northern bluefin tuna (*Thunnus orientalis*)
Swordfish	
Broadbill swordfish (*Xiphias gladius*)	

SOURCE: TURGEON ET AL. (1998); NELSON ET AL. (2004); MCLAUGHLIN (2005)

Pacific Coast Salmon Plan

Pacific salmon species are managed under the Pacific Coast Salmon Plan. The geographic extent of marine EFH for Pacific salmon extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the EEZ, 200 nautical miles (nm) offshore (PFMC 2000). Freshwater EFH includes all streams, lakes, ponds, wetlands, tributaries, and other water bodies currently viable and historically accessible to salmon. Pacific salmon in the NWTRC are also protected under the ESA, as discussed in Section 3.7.1.4.

Coastal Pelagic Species Fishery Management Plan

Coastal pelagic species fish are managed under the Coastal Pelagic Species FMP and include several species within six families (anchovies, jacks, herrings, mackerels, squids, and krill). All coastal pelagic species have EFH designated within the NWTRC Study Area. Coastal pelagic species with designated EFH in Puget Sound include: northern anchovy, Pacific sardine, Pacific mackerel, and market squid.

Pacific Coast Groundfish Fishery Management Plan

The Pacific Coast Groundfish FMP divides EFH into seven composite habitats including their waters, substrates, and biological communities, and includes:

- Rocky Shelf – includes waters, substrate and associated biological communities living on or within 33 ft (10 m) overlying rocky areas on the continental shelf, excluding canyons, from the high tide line to the continental shelf break;
- Non-Rocky Shelf – includes waters, substrate and associated biological communities living on or within 33 ft (10 m) overlying substrates of the continental shelf, excluding rocky shelf and canyons, from the high tide line to the continental shelf;

- Canyon – submarine canyons;
- Continental Slope/Basin – includes waters, substrate and associated biological communities living in the deepest 66 ft (20 m) of the water column over the continental slope and basin, seaward of the shelf break extending to the westward boundary of the EEZ. The shelf break occurs at an approximate depth of 656 ft (200 m);
- Neritic Zone – includes waters and biological communities living in the water column more than 33 ft (10 m) above the continental shelf; and
- Oceanic Zone – includes waters and biological communities living in the water column more than 66 ft (20 m) above the continental slope and abyssal plain, extending to the westward boundary of the EEZ (PFMC 2006).

The groundfish species, managed by the Pacific Coast Groundfish FMP range throughout the EEZ, occupy diverse habitats at all stages in their life histories. Some species are broadly dispersed during specific life stages, especially those with pelagic eggs and larvae. The distribution of other species and/or life stages may be relatively limited, as with adults of many nearshore rockfish which show strong affinities to a particular location or substrate type. Estuaries, sea grass beds, canopy kelp, rocky reefs, and other “areas of interest” (*e.g*., seamounts, offshore banks, canyons) are designated HAPC for managed groundfish species.

The Pacific halibut (*Hippoglossus stenolepis*) is managed by the United States and Canada in a bilateral commission known as the International Pacific Halibut Commission. Each year, this Commission sets total allowable catch levels for halibut that will be caught in the U.S. and Canadian EEZs in the northeastern Pacific Ocean. The Commission refers to U.S. waters off the States of Washington, Oregon and California collectively as "Area 2A." Regulations for Area 2A are set by the Northwest Regional Office of NMFS. Halibut catch in Area 2A is divided between Tribal and non-Tribal fisheries; within non-tribal fisheries, halibut catch is further divided between commercial and recreational fisheries; within recreational fisheries, halibut catch is also divided between recreational fisheries in different states (Washington, Oregon, and California). The PFMC describes this halibut catch division each year in a catch-sharing plan.

Three species of groundfish: cowcod *(Sebastes levis)*, bocaccio *(S. paucispinis)*, and Pacific hake (also called whiting), are Species of Concern, as discussed in Section 1.7.1.4. A preliminary 2002 assessment of groundfish stocks has shown that over half of key groundfish stocks in South Puget Sound are at or below average abundance (Table 3.7-2) (Puget Sound Water Quality Action Team [PSWQAT] 2002). Some of the species that once dominated the catches of recreational and commercial fishers are now at depressed or critical abundances, resulting in historic low catches and reduced fisheries (Palsson et al. 1998). According to NMFS (2004f from Marine Resource Assessment [MRA]) and PFMC (2003b from MRA), the following groundfish within the Study Area are designated as overfished: widow rockfish (*S. entomelus*), canary rockfish (*S. pinniger*), yelloweye rockfish (S. *ruberrimus*), darkblotched rockfish (*S. crameri*), bocaccio (*S. paucispinis*), and Pacific ocean perch (*S. alutus*).

Table 3.7-2: Status of South Puget Sound Groundfish Stocks (2002).

Species	Status**
Dover sole	Depressed
English sole	Below average
Greenlings	Above average
Lingcod	Above average
Pacific cod	Critical
Pacific whiting (hake)	Critical
Pacific halibut	Above average
Rock sole	Average
Rockfishes	Depressed
Sablefish	Below average
Sand sole	Above average
Sculpins	Above average
Skates	Depressed
Spiny dogfish	Depressed
Spotted ratfish	Above average
Starry flounder	Average
Surfperches	Depressed
Walleye pollock	Critical
Wolf eel	Average
Other groundfish	Below Average

Notes: South Sound includes Hood Canal, Central Sound, Whidbey Basin, and Southern Sound (south of Tacoma Narrows).
**A comparison of the most recent 2-year average indicators was made to historical or long-term averages of the indicators. Percent changes were categorized into five measures of stock status:
• Above average (change greater than 6 percent above average),
• Average (within 5 percent of average),
• Below average (6 to35 percent less than average),
• Depressed (36 to75 percent less than average), and
• Critical (at least 76 percent less than average)
Source: PSWQAT 2002

Highly Migratory Species Fishery Management Plan

EFH for HMS includes all marine waters from the shoreline to 200 nm (370 km) offshore. The HMS FMP authorizes the Fishery Management Council to actively manage the following species in the NWTRC:

- Sharks: common thresher, bigeye thresher, shortfin mako, and blue shark;
- Tunas: albacore and northern bluefin tuna; and
- Billfish/swordfish: broadbill swordfish.

Under the FMP, the Fishery Management Council monitors other species for informational purposes, and some species including great white sharks, megamouth sharks, basking sharks, Pacific halibut, and Pacific salmon are designated as prohibited. If fishers targeting highly migratory species catch these species, they must release them immediately.

3.7.1.4 Threatened and Endangered Species and Species of Concern

A Biological Evaluation (BE) has been prepared for the NWTRC; the BE provides detailed species descriptions and analysis of potential impacts to all threatened or endangered species and critical habitats protected under the ESA.

Federally-listed species of fish are identified by Evolutionarily Significant Units (ESUs) or Distinct Population Segments (DPSs). This policy indicates that one or more naturally reproducing populations will be considered to be distinct population segments and, hence, a species under the ESA, if they represent an ESU or DPS of the biological species. To be considered an ESU, a population must satisfy two criteria: (1) It must be reproductively isolated from other population units of the same species, and (2) it must represent an important component in the evolutionary legacy of the biological species. The first criterion, reproductive isolation, need not be absolute but must have been strong enough to permit evolutionarily important differences to occur in different population units. The second criterion is met if the population contributes substantially to the ecological or genetic diversity of the species as a whole (NMFS 1999). The DPS policy adopts criteria similar to, but somewhat different from, those in the ESU policy for determining when a group of vertebrates constitutes a DPS: the group must be discrete from other populations and it must be significant to its taxon (NMFS 2006b).

Federally-listed species, critical habitat, and Species of Concern that may occur within the NWTRC are listed in Table 3.7-3. A general description of these species, their distribution and occurrence follows Table 3.7-5. The NWTRC BE contains additional information related to ESA-designated fish species.

Chinook Salmon (*Oncorhynchus tshawytscha)*

Chinook salmon are common throughout the PACNW. The California Coastal ESU, Lower Columbia River Washington/Oregon ESU, and Puget Sound ESU are threatened and have critical habitat in the NWTRC Study Area. Individual fish from these ESUs inhabit or migrate through one or more of the action areas. Juvenile Chinook salmon from the Washington coast emigrate to saltwater primarily as subyearlings and use the productive estuary and coastal areas as rearing habitat in part because of the limited size of many coastal watersheds, high summer water temperatures within natal streams, and low flow conditions that may be responsible for early emigration (Myers et al. 1998). Juvenile migration from the freshwater to marine environment occurs anywhere from April through September (Washington Department of Fisheries [WDF] 1993; Quileute Tribe Natural Resources [QTNR] 1995). Ocean-type Chinook salmon reside in estuaries for longer periods as fry and fingerlings than do yearling, stream-type Chinook salmon (Reimers 1973, Kjelson et al. 1982, Healey 1991). Marine tag recoveries for Washington coastal Chinook stocks show an oceanic migration pattern that takes them into British Columbia and Alaskan waters. Returning stocks of Chinook salmon from the Washington coast are primarily composed of 4- and 5-year old fish, with a small proportion of 6-year olds (Myers et al. 1998).

The Puget Sound ESU includes all naturally spawned populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, rivers and streams flowing into Hood Canal, South Sound, North Sound, and the Strait of Georgia in Washington, as well as 26 artificial propagation programs. Critical habitat designated for the Puget Sound ESU includes all marine, estuarine, and river reaches accessible to listed Chinook salmon in Puget Sound (NMFS 2005d).

Table 3.7-3: ESA Designated Fish Species with Known or Potential Occurrence in the Northwest Training Range Study Area

Taxon Group	Scientific Name	ESA Status[a]
Chinook salmon	*Oncorhynchus tshawytscha*	T/CH[b]
Coho salmon	*Oncorhynchus kisutch*	T/CH/C[c]
Chum salmon	*Oncorhynchus keta*	T/CH[d]
Steelhead trout	*Oncorhynchus mykiss*	T/CH/C[e]
Bull trout	*Salvelinus confluentus*	T/CH[f]
Green sturgeon	*Acipenser medirostris*	T/proposed CH/ C[g]
Bocaccio	*Sebastes paucispinus*	C[h]
Pacific hake	*Merluccius productus*	C[i]
Cowcod	*Sebastes levis*	C[j]

[a] E = Endangered, T = Threatened, CH = Critical Habitat, C = Species of Concern.
[b] Chinook salmon: California Coastal, Lower Columbia River Washington/Oregon, and Puget Sound ESUs are threatened and have critical habitat in the NWTRC study area.
[c] Coho salmon: Oregon Coast, and Northern California-Southern Oregon Coasts ESUs are threatened and have critical habitat in the NWTRC Study Area. The Puget Sound/Strait of Georgia ESU is a Species of Concern in the NWTRC Study Area.
[d] Chum salmon: Hood Canal Summer-run and Columbia River ESUs are threatened and have critical habitat in the NWTRC Study Area.
[e] Steelhead trout: Puget Sound DPS is threatened in the NWTRC Study Area. Lower Columbia River and Northern California ESUs are threatened and have critical habitat in the NWTRC Study Area. The Central California Coastal ESU also has critical habitat in the study area. The Oregon Coast DPS is a Species of Concern in the NWTRC study area.
[f] Bull trout: Coastal-Puget Sound ESU is threatened and has critical habitat in the NWTRC (critical habitat units 27 and 28).
[g] Green sturgeon: Southern DPS is threatened and has proposed critical habitat in the NWTRC. The Northern DPS is a Species of Concern along the U.S. Pacific coast.
[h] Bocaccio is a Species of Concern along the California coast.
[i] Pacific hake: Georgia Basin DPS is a Species of Concern in regions of the U.S. Pacific coast.
[j] Cowcod is a Species of Concern along the Oregon and California coast.

SOURCE DON 2006, WWW.NWR.NOAA.GOV

Fisheries catch data for Puget Sound Chinook salmon show that the ocean migration range extends as far north as northern British Columbia and Alaska for some populations. Some apparently spend their entire marine life within Puget Sound, but most migrate to the open ocean and north along the Canadian coast. The majority are caught inside the Strait of Juan de Fuca, the Strait of Georgia, Puget Sound, and off the west coast of Vancouver Island. Less than 1 percent are caught off the west coasts of Washington and Oregon (NMFS 2004a).

Puget Sound adult Chinook are present in nearshore marine waters from mid-July to the end of October for summer/fall-run stocks and from mid-May to late August for spring-run stocks. The majority of populations in the Puget Sound Chinook salmon migrate to the ocean within their first year following emergence, and rear within Puget Sound marine waters for several months. Spring-run juveniles tend to reside longer in natal streams before their ocean migration, and to have different ocean migration patterns than do fall-run juveniles (NMFS 2004b). Chinook stocks in Puget Sound are classified as either early river entry or later river entry depending upon their timing into the river to spawn. Early river entry stocks enter the rivers from April to mid-August and spawn from September to October and later river entry stocks enter rivers from September to late November and spawn from October to December (WDFW 2003).

Many of the rivers in Puget Sound have well-developed estuaries that are important rearing areas for emigrating ocean-type smolts (*i.e.,* juvenile fish) (NMFS 1997). Stream-type Chinook salmon move quickly through the estuary into coastal waters and ultimately to the open ocean (Healey 1991). Very limited data is available concerning the ocean migration of stream-type Chinook salmon; they apparently move quickly offshore and into the central North Pacific, where they make up a disproportionately high percentage of the commercial catch relative to ocean-type fish (Healey 1991, Myers et al. 1987). The majority of Puget Sound Chinook salmon emigrate to the ocean as subyearlings (Myers et al. 1998).

Coho Salmon (*Oncorhynchus kisutch)*

Oregon Coast, and Northern California-Southern Oregon Coasts ESUs are threatened and have critical habitat in the NWTRC. The Puget Sound/Strait of Georgia ESU is a Species of Concern in the NWTRC. The vast majority of adult coho salmon, from central British Columbia south, are 3-year-old fish, having spent approximately 18 months in fresh water and 18 months in salt water. Coded-wire tag recovery information has shown that coho salmon released from Washington coastal hatcheries are recovered primarily in British Columbia (37 to74 percent) and Washington (18 to 53 percent), with few recoveries from Oregon (three to 16 percent) and almost none (less than one percent) from California or Alaska (Weitkamp et al. 1995). Coho adults from coastal Washington rivers return to their natal rivers to spawn from September to January, but have been observed as early as late-July and as late as mid-January (WDF et al. 1993). Approximate timing through nearshore marine waters for juvenile coho from coastal Washington is May through June. Most juvenile coho rear in the freshwater environment for up to two years before migrating to the ocean between mid-February and mid-July.

Chum Salmon (*Oncorhynchus keta)*

Chum salmon are also common throughout the PACNW. The Hood Canal Summer-run ESU and Columbia River ESU are threatened and have critical habitat in the NWTRC.

Chum salmon from rivers draining the western Olympic Peninsula display an early- and late-fall return pattern coincident with increasing fall/winter river flows. In general, river entry occurs from September through December with spawning from October (late October in Grays Harbor) to January. Spawning tends to peak in mid-November. Juvenile chum seaward migration in Washington streams takes place from late January to May (Johnson et al. 1997). Chum salmon usually spawn in coastal areas, and juveniles move to seawater almost immediately after emerging from the gravel that covers their spawning beds (Salo 1991). Chum salmon, along with ocean-type Chinook salmon, usually have longer residence times in estuaries than do other anadromous salmonids (Dorcey et al. 1978, Healey 1991).

The Hood Canal Summer-run ESU includes summer-run chum salmon populations in Hood Canal, Discovery Bay, and Sequim Bay within the Strait of Juan de Fuca region. The Hood Canal Summer-run ESU may also include summer-run chum salmon in the Dungeness River, but the existence of that run is uncertain at this time. Critical habitat was designated for the Hood Canal ESU and includes nearshore areas and various streams in Hood Canal and along the coast of northern Kitsap County (NMFS 2005d).

Puget Sound fall-run adult chum salmon are present in nearshore marine waters from August through January with the peak of migration taking place from October through November. Spawning takes place from November through January. Upon hatching, the juvenile chum salmon migrate rapidly to the ocean environment and spend anywhere from two to seven years in the ocean before returning to their natal streams to spawn and die.

Steelhead Trout (*Oncorhynchus mykiss)*

The Lower Columbia River, and Northern California ESUs and Puget Sound ESU are threatened and have critical habitat in the NWTRC. The Central California Coastal ESU also has critical habitat in the NWTRC. The Oregon Coast DPS is a Species of Concern in the NWTRC.

Steelhead trout range from southern California to the Alaskan Peninsula. Unlike salmon, steelhead may spawn more than once during their lifetime. Life history strategies can be broadly divided into two categories depending upon the season in which they return to spawn: summer-run or winter-run steelhead. Spawning stocks of summer-run and winter-run fish are present within the action area. Puget Sound summer-run fish enter fresh water between May and October and spawning occurs anywhere from December to April of the following year. Puget Sound winter-run fish enter freshwater from December through May with peak spawning occurring between March and May of the following year. Steelhead smolts can be found in the nearshore marine environment from April to June (Busby et al. 1996).

Bull Trout (*Salvelinus confluentus)*

The Coastal/Puget Sound ESU is threatened and has critical habitat in the NWTRC. Bull trout are native to waters of western North America and are found in many streams within Washington. Bull trout can exhibit a number of different life-history strategies. Stream-resident bull trout complete their entire life history in the tributary streams in which they rear and spawn. Some bull trout are migratory, spawning in tributary streams, where juvenile fish usually rear from one to four years before migrating to either a larger river or lake where they spend their adult life, returning to the tributary stream to spawn. Anadromous bull trout, which are reported to only occur in Puget Sound, rear in natal streams for a period of time, migrate to marine environments to mature, and then return to mountain tributaries to spawn. While in marine waters, anadromous bull trout primarily occupy productive estuarine and nearshore habitat. Subadults use marine habitat to forage, generally from late spring to early fall. At maturity, anadromous bull trout begin re-entering mainstream rivers in late spring and early summer to migrate to their spawning tributaries.

Green sturgeon (*Acipenser medirostris)*

The green sturgeon is an anadromous fish species that occupy freshwater rivers from the Sacramento River up through British Columbia. Two distinct populations have been defined for the green sturgeon: a northern DPS, a Species of Concern with spawning populations in the Klamath and Rogue Rivers; and a southern DPS, the threatened population spawning in the Sacramento River. Both Northern and Southern DPS green sturgeon occupy coastal estuaries and coastal marine waters from southern California to Alaska. As such, green sturgeon observed in coastal bays, estuaries, and coastal marine waters outside of natal rivers may belong to either DPS.

On September 8, 2008, NMFS issued a Proposed Rulemaking to designate critical habitat for the Southern DPS (73 Federal Register 52084). Proposed critical habitat includes coastal U.S. marine waters within 360 ft (110 m) depth from Monterey Bay, California north to Cape Flattery, Washington, including the Strait of Juan de Fuca, but excludes Puget Sound.

Green sturgeon spawning occurs in the spring in deep pools below large, turbulent river mainstreams. Individuals spawn every few years beginning about 15 years of age. Adults migrate to the north in spring (generally north of Vancouver Island, Canada). Green sturgeon congregate in coastal waters and estuaries where they are vulnerable to capture in salmon gillnet and other fisheries. They enter estuaries in Washington during summer when estuary water temperatures are warmer than adjacent coastal waters. Green sturgeon have many life history characteristics that make them vulnerable to habitat degradation and overexploitation: large size, late maturity, low productivity, long life span, and an anadromous life history.

Bocaccio (*Sebastes paucispinus)*

Bocaccio is a rockfish thought to consist of two partially isolated populations: the Southern DPS, a Species of Concern off the California coast; and a Northern population off Washington and British Columbia. Bocaccio prefer rocky habitats from 130 to 980 ft (40 to 300 m) deep, but may occur in nearly all marine habitats. Young (one to three years) bocaccio are relatively pelagic, and become more demersal with age (maximum age 45 to 50 years). Adults and large juveniles transition between midwater pelagic and benthic habitats over shelf and slope (Garrison and Miller 1982) in association with kelp beds, eelgrass beds, rocky substrate, and artificial structures (MBC 1987, Love et al. 1990, Sakuma and Ralston 1995, Yoklavich et al. 2000, Love et al. 2005).

Bocaccio school with widow, yellowtail, vermillion, and speckled rockfishes (Love et al. 2002) and occur in large aggregations under drifting kelp beds and over firm sand-mud bottoms (MBC 1987). Bocaccio are ovoviviparous (Hart 1973, Garrison and Miller 1982) with a spawning season that lasts more than 10 months (Love et al. 1990). Parturition *(i.e.,* birthing) occurs off northern and central California from November to March (MBC 1987) with the production of two or more broods (Hart 1973, Love et al. 1990) and off British Columbia and Washington from January to April (MBC 1987).

Bocaccio prey upon small fish, including other species of rockfish, hake, sablefish, northern anchovy, and lanternfish associated with kelp and squid (Sumida and Moser 1984, MBC 1987, Thomas and MacCall 2001). The primary reason for population decline is overfishing that occurred prior to the late 1990s.

Pacific hake (*Merluccius productus)*

Pacific hake or whiting range from the Gulf of California to the Gulf of Alaska (Hart 1973). The offshore stock of Pacific hake is migratory and inhabits the continental slope and shelf within the California current system from Baja California to British Columbia (Quirollo 1992). There are three smaller inshore stocks with much smaller ranges: a Puget Sound stock, a Strait of Georgia stock, and a dwarf stock limited to waters off Baja California (Bailey et al. 1982, Stauffer 1985). In the Strait of Georgia and Puget Sound, Pacific hake are the most abundant resident fish. Inshore stocks spawn in locations near major sources of freshwater inflow and spend their entire lives in these estuaries (McFarlane and Beamish 1985, 1986, Pedersen 1985, Shaw et al. 1990). Pelagic eggs of Puget Sound Pacific hake are found at depths of 164 to 246 ft (50 to 75 m) (Bailey 1982, Moser et al. 1997). Juveniles reside in shallow coastal waters, bays, and estuaries (Bailey 1981, Bailey et al. 1982) and move to deeper water as they get older (NOAA 1990).

Pacific hake biomass in U.S. coastal waters increased to a historical high in 1987, declined for several years after, stabilized briefly between 1995 and 1997, but then declined continuously to its lowest point in 2001 (Helser et al. 2004). Since 2001, stock biomass has increased substantially and rebuilt to the target level of abundance.

Cowcod (*Sebastes levis)*

Cowcod range from Ranger Bank and Guadalupe Island, Baja California to Mendocino County, California and may infrequently occur as far north as Newport, Oregon (Love et al. 2002), but their preferred habitat is located in the Southern California Bight (Barnes 2001). Cowcod can be found between midwater pelagic and benthic habitats in water depths between 130 and 1,600 ft (40 and 490 m) (Love et al. 2005). Adults are common at depths of 235 to 1,600 ft (72 to 490 m) (Orr et al. 1998, 2000) over high-relief rocky areas, in association with large white sea anemones (Casillas et al. 1998), submarine canyons, under ledges, and in crevices of isolated rock outcrops surrounded by mud (Yoklavich et al. 2000). Juveniles occur in waters 130 to 330 ft (40 to 100 m) over sandy and clay (low-relief) bottoms and near oil platforms (Love et al. 2002, Butler et al. 2003, Love et al. 2005). Larvae are almost exclusively found in southern California adjacent to the northern Channel Islands at depths less than 650 ft (200 m) (MacGregor 1983, Moser et al. 2000), but may occur 200 miles (320 kilometers) offshore over the continental shelf from northern California to northern Baja California (Love et al. 2002).

Cowcod are not migratory but may move to some extent to follow food (McCain 2003). They are generally solitary, but occasionally aggregate (Love et al. 1990). Cowcod are ovoviviparous with large females producing up to three broods per season (Love et al. 1990). In central and northern California, a single brood is produced from December to February peaking in December (Love et al. 2002). Cowcod prey upon fish, octopus, and squid (McCain 2003).

3.7.1.5 Hearing in Fish

All fish have two sensory systems that are used to detect sound in the water including the inner ear, which functions very much like the inner ear found in other vertebrates, and the lateral line, which consists of a series of receptors along the body of the fish (Popper 2008). The inner ear generally detects higher frequency sounds while the lateral line detects water motion at low frequencies (below a few hundred Hz) (Hastings and Popper 2005). A sound source produces both a pressure wave and motion of the medium particles (water molecules in this case), both of which may be important to fish. Fish detect particle motion with the inner ear. Pressure signals are initially detected by the gas-filled swim bladder or other air pockets in the body, which then re-radiate the signal to the inner ear (Popper 2008). Because particle motion attenuates relatively quickly, the pressure component of sound usually dominates as distance from the source increases.

The lateral line system of a fish allows for sensitivity to sound (Hastings and Popper 2005). This system is a series of receptors along the body of the fish that detects water motion relative to the fish that arise from sources within a few body lengths of the animal. The sensitivity of the lateral line system is generally from below 1 Hz to a few hundred Hz (Coombs and Montgomery 1999, Webb et al. 2008). The only study on the effect of exposure to sound on the lateral line system (conducted on one freshwater species) suggests no effect on these sensory cells by intense pure tone signals (Hastings et al. 1996). While studies on the effect of sound on the lateral line are limited, Hasting et al.'s (1996) work, showing limited sensitivity to within a few body lengths and to sounds below a few hundred Hz, make the effect of the mid-frequency sonar of the Proposed Action unlikely to affect a fish's lateral line system. Therefore, further discussion of the lateral line in this analysis in unwarranted.

Broadly, fishes can be categorized as either hearing specialists or hearing generalists (Scholik and Yan 2002). Fishes in the hearing specialist category have a broad frequency range with a low auditory threshold due to a mechanical connection between an air filled cavity, such as a swimbladder, and the inner ear. Specialists detect both the particle motion and pressure components of sound and can hear at levels above 1 kHz. Generalists are limited to detection of the particle motion component of low-frequency sounds at relatively high sound intensities (Amoser and Ladich 2005). It is possible that a species will exhibit characteristics of generalists and specialists and will sometimes be referred to as an "intermediate" hearing specialist. For example, most damselfish are typically categorized as generalists, but because some larger damselfish have demonstrated the ability to hear higher frequencies expected of specialists, they are sometimes categorized as intermediate.

Of the fish species with distributions overlapping the NWTRC Study Area for which hearing sensitivities are known, most are hearing generalists.

Although hearing capability data only exists for fewer than 100 of the 29,000 fish species (Popper 2008), current data suggest that most species of fish detect sounds from 0.05 to 1.0 kHz, with few fish hearing sounds above 4 kHz (Popper 2008, NRC 2003). Moreover, studies indicate that hearing specializations in marine species are quite rare and that most marine fish are considered hearing generalists (Popper 2003, Amoser and Ladich 2005). Specifically, the following species are all believed to be hearing generalists: elasmobranchs (i.e., sharks and rays) (Casper et al. 2003, Casper and Mann 2006, Myrberg 2001), scorpaeniforms (i.e., scorpionfishes, searobins, sculpins) (Lovell et al. 2005), scombrids (i.e., albacores, bonitos, mackerels, tunas) (Iversen 1967, Iversen 1969, Popper 1981, Song et al. 2006), damselfishes (Egner and Mann 2005, Kenyon 1996, Wright et al. 2005, Wright et al. 2007), and more specifically, midshipman fish (*Porichthys notatus*) (Sisneros and Bass 2003), Atlantic salmon (*Salmo salar*) (Hawkins and Johnstone 1978), and Gulf toadfish (*Opsanus beta*) (Remage-Healey et al. 2006). Moreover, it is believed that the majority of marine fish have their best hearing sensitivity at or below 0.3 kHz (Popper 2003). However, it has been demonstrated that marine hearing specialists, such as some Clupeidae, can detect sounds above 100 kHz. A list of fish hearing sensitivities is presented in Table 3.7-4.

In contrast to marine fish, several thousand freshwater species are thought to be hearing specialists. Nelson (1994) estimates that 6,600 of 10,000 freshwater species are otophysans (catfish and minnows), which are hearing specialists. Interestingly, many generalist freshwater species, such as perciforms (percids, gobiids) and scorpaeniforms (sculpins) are thought to have derived from marine habitats (Amoser and Ladich 2005). It is also thought that Clupeidae may have evolved from freshwater habitats (Popper et al. 2004). This supports the theory that hearing specializations likely evolved in quiet habitats common to freshwater and the deep sea because only in such habitats can hearing specialists use their excellent hearing abilities (Amoser and Ladich 2005).

Some investigators (e.g., Amoser and Ladich 2005) hypothesize that, within a family of fish, different species can live under different ambient noise conditions, which requires them to adapt their hearing abilities. Under this scenario, a species' probability of survival would be greater if it increased the range over which the acoustic environment, consisting of various biotic (sounds from other aquatic animals) and abiotic (wind, waves, precipitation) sources, could be detected. For the marine environment, Amoser and Ladich (2005) cite the differences in the hearing ability of two species of Holocentridae as a possible example of such environmentally-derived specialization. Both the shoulderbar soldierfish (*Myripristis kuntee*) and the Hawaiian squirrelfish (*Adioryx xantherythrus*) can detect sounds at 0.1 kHz. However, the high-frequency end of the auditory range extends towards 3 kHz for the shoulderbar soldierfish but only to 0.8 kHz for the Hawaiian squirrelfish (Coombs and Popper 1979). Though these two species live in close proximity on the same reefs, it is not certain that differing environmental conditions cause the hearing variations (Popper 2008). Generally, a clear correlation between hearing capability and the environment cannot be asserted or refuted due to limited knowledge of ambient noise levels in marine habitats and a lack of comparative studies.

Susceptibility to the effects of anthropogenic sounds has been shown to be influenced by developmental and genetic differences in the same species of fish. In an exposure experiment, Popper et al. (2007) found that experimental groups of rainbow trout had substantial differences in hearing thresholds. While fish were attained from the same supplier, it is possible different husbandry techniques may be the reason for the differences in hearing sensitivity. These results emphasize that caution should be used in extrapolating data beyond their intent.

Among all fishes studied to date, perhaps the greatest variability is found within the family Sciaenidae (i.e., drumfish, weakfish, croaker), where there is extensive diversity in inner ear structure and the relationship between the swim bladder and the inner ear. Specifically, the Atlantic croaker's (*Micropogonias undulatus*) swim bladder has forwardly directed diverticulae that come near the ear but do not actually touch it. However, the swim bladders in the spot (*Leiostomus xanthurus*) and black drum (*Pogonias cromis*) are further from the ear and lack anterior horns or diverticulae. These differences are associated with variation in both sound production and hearing capabilities (Ladich and Popper 2004, Ramcharitar et al. 2006). Ramcharitar and Popper (2004) discovered that the black drum responded to sounds from 0.1 to 0.8 kHz and was most sensitive between 0.1 and 0.5 kHz, while the Atlantic croaker responded to sounds from 0.1 to 1 kHz and was most sensitive at 0.3 kHz. Additional sciaenid research by Ramcharitar et al. (2006) investigated the hearing sensitivity of weakfish (*Cynoscion regalis*) and spot. Weakfish were found to detect frequencies up to 2 kHz, while spot detected frequencies only up to 0.7 kHz.

Table 3.7-4: Marine Fish Hearing Sensitivities

Family	Description of Family	Common Name	Scientific Name	Hearing Range (kHz)		Greatest Sensitivity (kHz)	Sensitivity Classification
				Low	High		
Albulidae	Bonefishes	Bonefish	*Albula vulpes*	0.1	0.7	0.3	generalist
Anguillidae	Eels	European eel	*Anguilla anguilla*	0.01	0.3	0.04-0.1	generalist
Ariidae	Catfish	Hardhead sea catfish	*Ariopsis felis*	0.05	1	0.1	generalist
Batrachoididae	Toadfishes	Midshipman	*Porichthys notatus*	.065	0.385		generalist
		Gulf toadfish	*Opsanus beta*			<1	generalist
Clupeidae	Herrings, shads, menhadens, sardines	Alewife	*Alosa pseudoharengu s*		0.12		specialist
		Blueback herring	*Alosa aestivalis*		0.12		specialist
		American shad	*Alosa sapidissima*	0.1	0.18	0.2-0.8 and 0.025-0.15	specialist
		Gulf menhaden	*Brevoortia patronus*		0.1		specialist
		Bay anchovy	*Anchoa mitchilli*		4		specialist
		Scaled sardine	*Harengula jaguana*		4		specialist
		Spanish sardine	*Sardinella aurita*		4		specialist
		Pacific herring	*Clupea pallasii*	0.1	5		specialist
Chondrichthyes [Class]	Cartilaginous fishes, rays, sharks, skates			0.2	1		generalist
Gadidae	Cods, gadiforms, grenadiers, hakes	Cod	*Gadus morhua*	0.002	0.5	0.02	generalist
Gobidae	Gobies	Black goby	*Gobius niger*	0.1	0.8		generalist
Holocentridae	Squirrelfish and soldierfish	Shoulderbar soldierfish	*Myripristis kuntee*	0.1	3.0	0.4-0.5	specialist
		Hawaiian squirrelfish	*Adioryx xantherythrus*	0.1	0.8		generalist
Labridae	Wrasses	Tautog	*Tautoga onitis*	0.01	0.5	0.037-0.050	generalist
		Blue-head wrasse	*Thalassoma bifasciatum*	0.1	1.3	0.3-0.6	generalist
Lutjanidae	Snappers	Schoolmaster snapper	*Lutjanus apodus*	0.1	1.0	0.3	generalist
Myctophidae	Lanternfishes	Warming's lanternfish	*Ceratoscopelus warmingii*				specialist
Pleuronectidae	Flatfish	Dab	*Limanda limanda*	0.03	0.27	0.1	generalist
		European plaice	*Pleuronectes platessa*	0.03	0.2	0.11	generalist

Table 3.7-4: Marine Fish Hearing Sensitivities (cont'd)

Family	Description of Family	Common Name	Scientific Name	Hearing Range (kHz)		Greatest Sensitivity (kHz)	Sensitivity Classification
				Low	High		
Pomadasyidae	Grunts	Blue striped grunts	*Haemulon sciurus*	0.1	1.0		generalist
Pomacentridae	Damselfish	Sergeant major damselfish	*Abudefduf saxatilis*	0.1	1.6	0.1-0.4	generalist/ intermediate
		Bicolor damselfish	*Stegastes partitus*	0.1	1.0	0.5	generalist/ intermediate
		Nagasaki damselfish	*Pomacentrus nagasakiensis*	0.1	2.0	<0.3	generalist/ intermediate
Salmonidae	Salmons	Atlantic salmon	*Salmo salar*	<0.1	0.58		generalist
Sciaenidae	Drums, weakfish, croakers	Atlantic croaker	*Micropogonias undulatus*	0.1	1.0	0.3	generalist
		Spotted sea trout	*Cynoscion nebulosus*				generalist
		Kingfish	*Menticirrhus americanus*				generalist
		Spot	*Leiostomus xanthurus*	0.2	0.7	0.4	generalist
		Black drum	*Pogonias cromis*	0.1	0.8	0.1-0.5	generalist
		Weakfish	*Cynoscion regalis*	0.2	2.0	0.5	specialist
		Silver perch	*Bairdiella chrysoura*	0.1	4.0	0.6-0.8	specialist
Scombridae	Albacores, bonitos, mackerels, tunas	Bluefin tuna	*Thunnus thynnus*		1.0		generalist
		Yellowfin tuna	*Thunnus albacares*	0.5	1.1		generalist
		Kawakawa	*Euthynnus affinis*	0.1	1.1	0.5	generalist
		Skipjack tuna	*Katsuwonus pelamis*				generalist
Scorpaenidae	Scorpionfishes, searobins, sculpins	Sea scorpion	*Taurulus bubalis*				generalist
Serranidae	Seabasses, groupers	Red hind	*Epinephelus guttatus*	0.1	1.1	0.2	generalist
Sparidae	Porgies	Pinfish	*Lagodon rhomboides*	0.1	1.0	0.3	generalist
Triglidae	Scorpionfish, searobins, sculpins	Leopard searobin	*Prionotus scitulus*	0.1	0.8	0.39	generalist

Sources: Astrup 1999; Astrup and Mohl 1993; Casper and Mann 2006; Casper et al. 2003; Coombs and Popper 1979; Dunning et al. 1992; Egner and Mann 2005; Gregory and Clabburn 2003; Hawkins and Johnstone 1978; Higgs et al. 2004; Iversen 1967, 1969; Jorgensen et al. 2005; Kenyon 1996; Lovell et al. 2005; Mann et al. 1997, 2001, 2005; Myrberg 2001; Nestler et al. 2002; Popper 1981; Popper and Carlson 1998; Popper and Tavolga 1981; Ramcharitar and Popper 2004; Ramcharitar et al. 2001, 2004, 2006, Remage-Healey et al. 2006; Ross et al. 1996; Sisneros and Bass 2003; Song et al. 2006; Wright et al. 2005, 2007; Popper 2008

The sciaenid with the greatest hearing sensitivity discovered thus far is the silver perch (*Bairdiella chrysoura*), which has demonstrated auditory thresholds similar to goldfish, responding to sounds up to 4 kHz (Ramcharitar et al. 2004). Silver perch swim bladders have anterior horns that terminate close to the ear. The Ramcharitar et al. (2004) research supports the suggestion that the swim bladder can potentially expand the frequency range of sound detection. Furthermore, Sprague and Luczkovich (2004) calculated silver perch are capable of producing drumming sounds ranging from 128 to 135 dB. Since drumming sounds are produced by males during courtship, it can be inferred that silver perch detect sounds within this range.

The most widely noted hearing specialists are otophysans (*i.e.*, members of the super order Ostariophysi), which have bony Weberian ossicles (bones that connect the swim bladder to the ear), along which vibrations are transmitted from the swim bladder to the inner ear (Amoser and Ladich 2003). However, only a few otophysans inhabit marine waters. In an investigation of a marine otophysan, the hardhead sea catfish (*Ariopsis felis*), Popper and Tavolga (1981) determined that this species was able to detect sounds from 0.05 to 1 kHz, which is considered a much lower and narrower frequency range than that common to freshwater otophysans (i.e., above 3 kHz) (Ladich and Bass 2003). The difference in hearing capabilities in the respective freshwater and marine catfish appears to be related to the inner ear structure (Popper and Tavolga 1981).

Experiments on marine fish have obtained responses to frequencies up to the range of ultrasound; that is, sounds between 40 to 180 kHz (University of South Florida 2007). These responses were from several species of the Clupeidae (i.e., herrings, shads, and menhadens) (Astrup 1999); however, not all clupeid species tested have responded to ultrasound. Astrup (1999) and Mann et al. (1998) hypothesized that these ultrasound detecting species may have developed such high sensitivities to avoid predation by odontocetes (*i.e.*, members of the sub-order of cetaceans that have teeth). Studies conducted on the following species showed avoidance to sound at frequencies over 100 kHz: alewife (*Alosa pseudoharengus*) (Dunning et al. 1992, Ross et al. 1996), blueback herring (*A. aestivalis*) (Nestler et al. 2002), Gulf menhaden (*Brevoortia patronus*) (Mann et al. 2001) and American shad (*A. sapidissima*) (Popper and Carlson 1998). The highest frequency to solicit a response in any marine fish was 180 kHz for the American shad (Gregory and Clabburn 2003, Higgs et al. 2004). The *Alosa* species have relatively low thresholds (about 145 dB re 1 µPa), which should enable the fish to detect odontocete clicks at distances up to about 200 m (656 ft) (Mann et al. 1997). For example, echolocation clicks ranging from 200 to 220 dB could be detected by shad with a hearing threshold of 170 dB at distances from 25 to 180 m (82 to 591 ft) (University of South Florida 2007). In contrast, the Clupeidae bay anchovy (*Anchoa mitchilli*), scaled sardine (*Harengula jaguana*), and Spanish sardine (*Sardinella aurita*) did not respond to frequencies over 4 kHz (Gregory and Clabburn 2003, Mann et al. 2001).

Wilson and Dill (2002) demonstrated that there was a behavioral response seen in Pacific herring (*Clupea pallasii*) to energy levels associated with frequencies from 1.3 to 140 kHz, although it was not clear whether the herring were responding to the lower frequency components of the experiment or to the ultrasound. However, Mann et al. (2005) advised that acoustic signals used in the Wilson and Dill (2002) study were broadband and contained energy of less than 4 kHz to ultrasonic frequencies. Mann et al. (2005) found that Pacific herring could not detect ultrasonic signals at received levels up to 185 dB re 1 µPa. Pacific herring had hearing thresholds (0.1 to 5 kHz) that are typical of Clupeidae that do not detect ultrasound signals.

Species that can detect ultrasound do not perceive sound equally well at all detectable frequencies. Mann et al. (1998) reported that the American shad can detect sounds from 0.1 to 180 kHz with two regions of best sensitivity: one from 0.2 to 0.8 kHz, and the other from 25 to 150 kHz. The poorest sensitivity was found from 3.2 to 12.5 kHz.

Although few non-clupeid species have been tested for ultrasound (Mann et al. 2001), the only other non-clupeid species shown to possibly be able to detect ultrasound is the cod (*Gadus morhua*) (Astrup and Mohl 1993). However, in Astrup and Moh's (1993) study it is feasible that the cod was detecting the stimulus using touch receptors that were over driven by very intense fish-finding sonar emissions (Astrup 1999, Ladich and Popper 2004). Nevertheless, Astrup and Mohl (1993) indicated that cod have ultrasound thresholds of up to 38 kHz at 185 to 200 dB re 1 µPa, which likely only allows for detection of odontocete's clicks at distances no greater than 10 to 30 m (33 to 98 ft) (Astrup 1999).

As mentioned above, investigations into the hearing ability of marine fishes have most often yielded results exhibiting poor hearing sensitivity. Experiments on elasmobranch fish (i.e., sharks and rays) have demonstrated poor hearing abilities and frequency sensitivity from 0.02 to 1 kHz, with best sensitivity at lower ranges (Casper et al. 2003, Casper and Mann 2006, Myrberg 2001). Though only five elasmobranch species have been tested for hearing thresholds, it is believed that all elasmobranchs will only detect low-frequency sounds because they lack a swim bladder, which resonates sound to the inner ear. Theoretically, fishes without an air-filled cavity are limited to detecting particle motion and not pressure and, therefore have poor hearing abilities (Casper and Mann 2006).

By examining the morphology of the inner ear of bluefin tuna (*Thunnus thynnus*), Song et al. (2006) hypothesized that bluefin tuna probably do not detect sounds to much over 1 kHz (if that high). This research concurred with the few other studies conducted on tuna species. Iversen (1967) found that yellowfin tuna (T. al*bacares*) can detect sounds from 0.05 to 1.1 kHz, with best sensitivity of 89 dB (re 1 µPa) at 0.5 kHz. Kawakawa (*Euthynnus affinus*) appear to be able to detect sounds from 0.1 to 1.1 kHz but with best sensitivity of 107 dB (re 1 µPa) at 0.5 kHz (Iversen 1969). Additionally, Popper (1981) looked at the inner ear structure of a skipjack tuna (*Katsuwonus pelamis*) and found it to be typical of a hearing generalist. While only a few species of tuna have been studied, and in a number of fish groups both generalists and specialists exist, it is reasonable to suggest that unless bluefin tuna are exposed to very high intensity sounds from which they cannot swim away, short- and long-term effects may be minimal or nonexistent (Song et al. 2006).

Some damselfish have been shown to be able to hear frequencies of up to 2 kHz, with best sensitivity well below 1 kHz. Egner and Mann (2005) found that juvenile sergeant major damselfish (*Abudefduf saxatilis*) were most sensitive to lower frequencies (0.1 to 0.4 kHz); however, larger fish (greater than 50 millimeters) responded to sounds up to 1.6 kHz. Still, the sergeant major damselfish is considered to have poor sensitivity in comparison even to other hearing generalists (Egner and Mann 2005). Kenyon (1996) studied another marine generalist, the bicolor damselfish (*Stegastes partitus*), and found the bicolor damselfish responded to sounds up to 1.6 kHz with the most sensitive frequency at 0.5 kHz. Further, larval and juvenile Nagasaki damselfish (*Pomacentrus nagasakiensis*) have been found to hear at frequencies between 0.1 and 2 kHz, however, they are most sensitive to frequencies less than 0.3 kHz (Wright et al. 2005, Wright et al. 2007). Thus, damselfish appear to be primarily generalists with some ability to hear slightly higher frequencies expected of specialists (Popper 2008).

Female midshipman fish apparently use the auditory sense to detect and locate vocalizing males during the breeding season. Interestingly, female midshipman fish go through a shift in hearing sensitivity depending on their reproductive status. Reproductive females showed temporal encoding up to 0.34 kHz, while nonreproductive females showed comparable encoding only up to 0.1 kHz (Sisneros and Bass 2003).

The hearing capability of Atlantic salmon (*Samo salar*), a hearing generalist, indicates a rather low sensitivity to sound (Hawkins and Johnstone 1978). Laboratory experiments yielded responses only to 0.58 kHz and only at high sound levels. Salmon's poor hearing is likely due to the lack of a link between the swim bladder and inner ear (Jorgensen et al. 2004).

Furthermore, investigations into the inner ear structure of fishes belonging to the order Scorpaeniformes have suggested that these fishes have generalist hearing abilities (Lovell et al. 2005). Although an audiogram (which provides a measure of hearing sensitivity) has yet to be performed, the lack of a swimbladder is indicative of these species having poor hearing ability (Lovell et al. 2005). However, studies of the leopard robin (*Prionotus scitulus*), another species in this order that do contain swim bladders, indicated that they are hearing generalists as well (Tavolga and Wodinski 1963) which makes extrapolation on hearing from this species to all members of the group very difficult to do (Popper 2008).

3.7.1.6 Current Requirements and Practices

Mitigation measures for activities involving underwater detonations, implemented for marine mammals and sea turtles, also offer protections to habitats associated with fish communities. Mitigation is discussed in more detail in Chapter 5. General conservation measures that help minimize impacts to fish include reducing explosive charge size during juvenile salmonid migration season.

3.7.2 Environmental Consequences

This section describes potential environmental effects on fish associated with conducting naval activities for three alternative scenarios in the NWTRC. The activities include active sonar activities; surface vessel, submarine, and aircraft warfare training activities; weapons firing and non-explosives ordnance use; electronic combat; discharges of expendable materials; and mine countermeasure training. These activities are configured in various combinations to define eight warfare areas, as previously described in Section 3.

This section distinguishes between United States territorial waters (shoreline to 12 nm) and non-territorial waters, (seaward of 12 nm) for the purposes of applying the appropriate regulations (National Environmental Policy Act [NEPA] or Executive Order [EO] 12114) to analyze potential environmental effects.

The effects on fish could include direct physical injury, such as potential for death, injury, or failure to reach (or an increase in the time needed to reach) the next developmental stage. Potential effects of fish eggs, larvae, and adult fish were evaluated in the analysis and results presented in the following subsections.

3.7.2.1 Approach to Analysis

In this section, the approach to the assessment of effects on fish is presented, as well as a review of the literature regarding potential effects on fish common to most activities. These include: warfare areas and environmental stressors; acoustic effects of underwater sounds to fish; effects of underwater impulsive sounds; non-explosive ordnance; and expended materials.

Effects on fish and the distances at which behavioral effects can occur depend on the nature of the sound, the hearing ability of the fish, and species-specific behavioral responses to sound. Changes in fish behavior can, at times, reduce their catchability and thus affect fisheries.

Regulatory Framework

The primary laws that make up the regulatory framework for fish and EFH include the MSFCMA and the ESA. These, along with other applicable laws, are briefly described below:

Magnuson-Stevens Fishery Conservation and Management Act

The MSFCMA (Public Law 94-265) (previously the Fishery Conservation and Management Act), established a 200 nm fishery conservation zone in U.S. waters and a network of regional FMC to describe and identify EFH for all species that are federally managed. "EFH" is defined as those waters and the substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. The FMCs are comprised of federal and state officials, including the USFWS, which oversee fishing activities within the fishery management zone. In 1977, exclusive federal management authority over U.S. domestic fisheries resources was vested in the NMFS. The MSFCMA requires federal agencies to consult with NMFS on activities that may adversely affect EFH. The MSFCMA defines an adverse effect as "any impact which reduces quality and/or quantity of EFH [and] may include direct (*e.g.*, contamination or physical disruption), indirect (*e.g.*, loss of prey or reduction in species' fecundity), site-specific or habitat wide impacts, including individual, cumulative, or synergistic consequences of actions" (50 CFR 600.810).

The PFMC manages the fisheries for Groundfish, CPS, and Pacific Salmon through the associated Fisheries Management Plans and has defined EFH for these three groups. All waters that support anadromous fish are considered EFH by NMFS (PFMC 2006c).

EFH located within the Study Area includes: estuarine, rocky shelf, non-rocky shelf, canyon, continental shelf/basin, neritic and oceanic habitats. For the purpose of this analysis, potential effects were considered to determine adverse impacts to EFH. An EFH Assessment has been prepared for the NWTRC.

Sustainable Fisheries Act

In 1996 (later amended in 2002 and 2006), the MSFCMA was reauthorized and amended by the Sustainable Fisheries Act (SFA). The SFA provides a new habitat conservation tool in the form of the EFH mandate. The EFH mandate requires that the regional FMCs, through federal FMP, describe and identify EFH for each federally managed species, minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitats. Authority to implement the SFA is given to the Secretary of Commerce through the NMFS. The SFA requires that the EFH be identified and described for each federally managed species. The SFA requires federal agencies to consult with the NMFS on activities that may adversely affect EFH. For actions that affect a threatened or endangered species, its critical habitat, and its EFH, federal agencies must initiate ESA and EFH consultations.

Endangered Species Act

The ESA (16 USC §§ 1531 to 1543) established protection over and conservation of threatened and endangered species. The ESA applies to federal actions in two separate respects: the ESA requires that federal agencies, in consultation with the responsible wildlife agency, ensure that Proposed Actions are not likely to jeopardize the continued existence of any endangered species or threatened species, or result in the destruction or adverse modification of a critical habitat. Regulations implementing the ESA expand the consultation requirement to include those actions that "may affect" a listed species or adversely modify critical habitat.

If an agency's Proposed Action would take a listed species, the agency must obtain an incidental take statement from the responsible wildlife agency. The ESA defines the term "take" to mean "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt any such conduct." A BE has been prepared for the NWTRC; the BE provides detailed species descriptions and analysis of potential impacts to all threatened or endangered species and critical habitats protected under the ESA with known or potential occurrence in the NWTRC Study Area.

Executive Order 12114

EO 12114 directs federal agencies to provide for informed decision making for major federal actions outside the United States, including the global commons, the environment of a non participating foreign nation, or impacts on protected global resources. An OEIS is required when an action has the potential to significantly harm the environment of the global commons. "Global commons" are defined as "geographical areas that are outside of the jurisdiction of any nation, and include the oceans outside territorial limits (outside 12 nm from the coast) and Antarctica. Global commons do not include contiguous zones and fisheries zones of foreign nations" (32 CFR 187.3).

Unlike NEPA, EO 12114 does not require a scoping process. However, the EIS and OEIS have been combined into one document, as permitted under NEPA and EO 12114, in order to reduce duplication. Therefore, the scoping requirements found in NEPA were implemented with respect to actions occurring seaward of U.S. territorial waters, and discussions regarding scoping requirements will reference the combined NWTRC EIS/OEIS.

Executive Order 12962

EO 12962 on Recreational Fisheries (60 Federal Register 30769) was enacted in 1995 to ensure that federal agencies strive to improve the "quantity, function, sustainable productivity, and distribution of U.S. aquatic resources" so that recreational fishing opportunities nationwide can increase. The primary goal of this order is to promote the conservation, restoration, and enhancement of aquatic systems and fish populations by increasing fishing access, education and outreach, and multi-agency partnerships. The National Recreational Fisheries Coordination Council, co-chaired by the Secretaries of the Interior and Commerce, is charged with overseeing federal actions and programs that are mandated by this order.

Northern Pacific Halibut Act

The Northern Pacific Halibut Act of 1982 (16 USC §§ 773-773k) calls for the U.S. and Canada to implement the 1979 Protocol for the Preservation of the Halibut Fishery of the Northern Pacific Ocean and the Bering Sea. The Act provides for the appointment of U.S. Commissioners to the International Pacific Halibut Commission. In addition, the Act authorizes the PFMC to develop regulations to limit access and govern the Pacific halibut catch in waters off Washington, Oregon, and California. All Council action must be approved and implemented by the U.S. Secretary of Commerce.

National Fishery Enhancement Act

In 1984, Congress passed the National Fishery Enhancement Act (NFEA) (33 USC §§ 2101 et seq.) in recognition of the social and economic value of artificial reefs in enhancing fishery resources. Under this act, the Secretary of Commerce and the U.S. Army Corps of Engineers are charged with the responsibility for encouraging and regulating artificial reefs in the navigable waters of the U.S. One of the primary directives of the NFEA was the preparation of a long-term National Artificial Reef Plan (33 USC §§ 2103).

Pacific Salmon Treaty

The Pacific Salmon Treaty (PST) of 1985 (16 USC §§ 3631 et seq.) was established between Canada and the U.S. to establish a framework for managing salmon populations between the two countries. The Treaty principles were to (a) prevent overfishing and provide for optimum production; and (b) provide equivalent production benefits from salmon originating from the respective country's waters. The Treaty requires the U.S. and Canada to meet international conservation and allocation objectives by taking into account ways of reducing interceptions and avoiding disruption of existing fisheries and stock abundances.

This Treaty also called for the establishment of the Pacific Salmon Commission (PSC), to oversee the implementation of the Treaty. The PSC is comprised of representatives of both countries to provide regulatory and technical advice. Fisheries regulation is a shared responsibility of the U.S. and Canada.

On June 30, 1999, the following PST provisions were implemented: (a) establish abundance-based fishing regimes for Pacific salmon fisheries under the jurisdiction of the PSC; (b) create two bilaterally-based funds to promote cooperation, improve fishery management, and aid stock and habitat enhancement.

Additionally, the PST includes provisions to enhance bilateral cooperation, improve the scientific basis for salmon management, and apply institutional changes to the PSC.

Washington State Laws

Washington Administrative Code 232-12-297 is the primary law for the protection and management of endangered species in Washington State. It aims to identify and classify native wildlife species that are in need of protection and/or management and to define the process by which listing, management, recovery, and delisting of those species can be achieved. This law was established to ensure that consistent procedures and criteria are followed when classifying wildlife as endangered, threatened, or sensitive. In many ways, this law mirrors the federal ESA.

Revised Code of Washington 77.110.030 is Washington State’s policy for the management of natural resources. It declares that conservation, enhancement, and proper utilization of the State's natural resources, including but not limited to lands, waters, timber, fish, and game, are responsibilities of the State of Washington and shall remain within the express domain of the State of Washington.

The Wild Salmonid Policy was developed in response to the depressed status of wild salmonid populations in Washington. The purpose is to protect, restore, and enhance the productivity, production, and diversity of wild salmonids and their ecosystems to sustain ceremonial, subsistence, commercial, and recreational fisheries; non-consumptive fish benefits; and other related cultural and ecological values.

Oregon State Laws

The Oregon Ocean Resources Management Act of 1991 designated the Oregon Department of Land Conservation and Development as the lead agency for ocean planning and created the Oregon Ocean Resources Management Program to ensure the conservation and development of Oregon’s ocean resources.

California State Laws

The California Endangered Species Act of 1970, amended in 1984, is part of the California Fish and Game Code and is administered by the California Department of Fish and Game. The provisions generally parallel those in the federal ESA although, unlike its federal counterpart, the California Endangered Species Act also applies take prohibitions to state candidate species petitioned for listing.

The California Coastal Act of 1976 created a unique partnership between the state’s coastal management agency, the California Coastal Commission, and local governments (the state’s 15 coastal counties and 58 coastal cities) to manage the conservation and development of coastal resources through a comprehensive planning and regulatory program.

Study Area

The Study Area for fish and EFH includes the marine environments of the NWTRC.

Data Sources

A comprehensive and systematic review of relevant literature and data has been conducted in order to complete this analysis for fish and EFH. Of the available scientific literature (both published and unpublished), the following types of documents were utilized in the assessment: journals, books, periodicals, bulletins, Department of Defense operations reports, EISs, and other technical reports published by government agencies, private businesses, consulting firms, or non-governmental conservation organizations. The scientific literature was also consulted during the search for geographic location data on the occurrence of resources within the Study Area. The primary sources of information used to describe the affected environment for fish and EFH were in the U.S. Pacific Fleet MRA for the

Pacific Northwest Operating Area (DoN 2006), and the Biological Assessment of U.S. Navy Explosive Ordnance Disposal Operations, Puget Sound, Washington (DoN 2000). The MRA report provides compilations of the most recent data and information on the occurrence of marine resources in the Study Area.

3.7.2.2 Assessment Methods

The following methods were used to assess potential effects of noise on fish. Received noise levels that correspond to the various types of effects on fish were evaluated. Effects include physical damage to fish, short-term behavioral reactions, and long-term behavioral reactions.

There are two types of sound sources that are of major concern to fish and fisheries: (1) strong underwater shock pulses that can cause physical damage to fish, and (2) underwater sounds that could cause disturbance to fish and affect their behavior.

Impact Thresholds

This EIS/OEIS analyzes potential effects to fish and EFH in the context of the MSFCMA (federally managed species and EFH), ESA (species listed under the ESA only), NEPA, and EO 12114. The factors used to assess the significance of effects vary under these Acts. Under the MSFCMA an "adverse effect" is defined as any impact that reduces the quality and/or quantity of EFH (NMFS 2004a, 2004b). The EFH regulations in 50 CFR 600.815(a)(2)(ii) (NMFS 2002a) establish a threshold for determining adverse effects (NMFS 2002b). Adverse effects are more than minimal and not temporary in nature. Temporary effects are those that are limited in duration and allow the particular environment to recover without measurable impact (NMFS 2002b). Minimal effects are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions. To help identify Navy activities falling within the adverse effect determination, the Navy has determined that temporary or minimal impacts are not considered to "adversely affect" EFH. The EFH Final Rule (67 Federal Register 2354) and 50 CFR 600.815(a)(2)(ii) were used as guidance for this determination, as they highlight activities with impacts that are more than minimal and not temporary in nature, as opposed to those activities resulting in inconsequential changes to habitat. Whether an impact is minimal will depend on a number of factors:

- The intensity of the impact at the specific site being affected;
- The spatial extent of the impact relative to the availability of the habitat type affected;
- The sensitivity/vulnerability of the habitat to the impact;
- The habitat functions that may be altered by the impact (*e.g*., shelter from predators); and
- The timing of the impact relative to when the species or life stage needs the habitat.

The factors outlined above were also considered in determining the significance of effects under NEPA and EO 12114. For purposes of ESA compliance, effects of the action were analyzed to make the Navy's determination of effect for listed species. The definitions used in making the determination of effect under Section 7 of the ESA are based on the USFWS and NMFS *Endangered Species Consultation Handbook* (USFWS 1998).

Warfare Areas and Associated Environmental Stressors

The Navy used a screening process to identify aspects of the Proposed Action that could act as stressors to fish and EFH. Navy subject matter experts de-constructed the warfare areas and activities included in the Proposed Action to identify specific activities that could act as stressors. Public and agency scoping comments, previous environmental analyses, previous agency consultations, laws, regulations, Executive Orders, and resource-specific information were also evaluated. This process was used to focus the information presented and analyzed in the affected environment and environmental consequences sections of this EIS/OEIS. Potential stressors to fish and EFH include: vessel movements (disturbance and collisions); aircraft overflights (disturbance); underwater detonations and explosive ordnance; sonar training (disturbance); weapons firing/non-explosive ordnance use (disturbance and strikes); and expended materials (ordnance related materials, targets, sonobuoys, and marine markers).

Acoustic Effects of Underwater Sounds to Fish

There have been very few studies on the effects that human-generated sound may have on fish; these have been reviewed in a number of places (*e.g.*, NRC, 1994, 2003, Popper 2003, Popper et al. 2004, Hastings and Popper 2005, Popper 2008), and some more recent experimental studies have provided additional insight into the issues (*e.g.*, Govoni et al. 2003, McCauley et al. 2003, Popper et al. 2005, 2007, Song et al., submitted). Most investigations, however, have been in the gray literature (non peer-reviewed reports – see Hastings and Popper 2005, and Popper 2008 for extensive critical reviews of this material). While some of these studies provide insight into effects of sound on fish, the majority of the gray literature studies often lack appropriate controls, statistical rigor, and/or expert analysis of the results.

There are a wide range of potential effects on fish that range from no effect at all (*e.g.*, the fish does not detect the sound or it "ignores" the sound) to immediate mortality. In between these extremes are a range of potential effects that parallel the potential effects on marine mammals that were illustrated by Richardson et al. (1995). These include, but may not be limited to:

- No effect behaviorally or physiologically: The animal may not detect the signal, or the signal is not one that would elicit any response from the fish.
- Small and inconsequential behavioral effects: Fish may show a temporary "awareness" of the presence of the sound but soon return to normal activities.
- Behavioral changes that result in the fish moving from its current site: This may involve leaving a feeding or breeding ground. This affect may be temporary, in that the fish return to the site after some period of time (perhaps after a period of acclimation or when the sound terminates), or permanent.
- Temporary loss of hearing (often called Temporary Threshold Shift – TTS): This recovers over minutes, hours, or days.
- Physical damage to auditory or non-auditory tissues (*e.g.*, swim bladder, blood vessels, brain): The damage may be only temporary, and the tissue "heals" with little impact on fish survival, or it may be more long-term, permanent, or may result in death. Death from physical damage could be a direct effect of the tissue damage or the result of the fish being more subject to predation than a healthy individual.

Studies on effects on hearing have generally been of two types. In one set of studies, the investigators exposed fish to long-term increases in background noise to determine if there are changes in hearing, growth, or survival of the fish. While data are limited to a few freshwater species, it appears that some increase in ambient noise level, even to above 170 dB re 1 μPa does not permanently alter the hearing ability of the hearing generalist species studied, even if the increase in sound level is for an extended period of time. However, this may not be the case for all hearing generalists, though it is likely that any temporary hearing loss in such species would be considerably less than for specialists receiving the same noise exposure. It is critical to note that more extensive data are needed on additional species, and if there are places where the ambient levels exceed 170 to 180 dB, it would be important to do a quantitative study of effects of long-term sound exposure at these levels. It is also clear that there is a larger temporary hearing loss in hearing specialists. Again, however, extrapolation from the few freshwater species to other species (freshwater or marine) must be done with caution until there are data for a wider range of species, and especially species with other types of hearing specializations than those found in the species studied to date (all of which are otophysan fishes and have the same specializations to enhance hearing).

In the second type of studies, fish were exposed to short duration but high intensity signals such as might be found near a high intensity sonar, pile driving, or seismic air gun survey. The investigators in such studies were examining whether there was not only hearing loss and other long-term effects, but also short-term effects that could result in death to the exposed fish. Because study results vary, it is difficult to speculate why there are many differences in the studies, including species, precise sound source, and spectrum of the sound (Popper 2008).

One study tested effects of seismic air guns, a highly impulsive and intense sound source. This study demonstrated differences in the effects of air guns on the hearing thresholds of different species. In effect, these results substantiate the argument made by Hastings et al. (1996) and McCauley et al. (2003) that it is difficult to extrapolate between species with regard to the effects of intense sounds.

Another study examined the effects of Surveillance Towed Array Sensor System Low-Frequency Active (SURTASS LFA) sonar; this study determined there was no effect on ear tissue (Popper et al. 2007).

Other earlier studies suggested that there may be some loss of sensory hair cells due to high intensity sources. However, these studies did not concurrently investigate effects on hearing or non-auditory tissues (Enger 1981, Hastings et al. 1996). In neither study was the hair cell loss more than a relatively small percent of the total sensory hair cells in the hearing organs (Popper 2008).

Effects of Underwater Impulsive Sounds

Air gun studies on very few species resulted in a small hearing loss in several species, with complete recovery within 18 hours (Popper et al. 2005). Other species showed no hearing loss with the same exposure. There appeared to be no effects on the structure of the ear (Song et al., submitted), and a limited examination of non-auditory tissues, including the swim bladder, showed no apparent damage (Popper et al. 2005). One other study of effects of an air gun exposure showed some damage to the sensory cells of the ear (McCauley et al. 2003); it is difficult to differentiate these two studies. However, the two studies employed different methods of exposing fish, and used different species. Other studies have demonstrated some behavioral effects on fish during air gun exposure used in seismic exploration (*e.g.*, Pearson et al. 1987, 1992, Engås et al. 1996, Engås and Løkkeborg 2002, Slotte et al. 2004), but the data are limited and it would be very difficult to extrapolate to other species, as well as to other sound sources.

Explosive Sources

A number of studies have examined the effects of explosives on fish; these are reviewed in detail in Hastings and Popper (2005). However, these studies are often variable, so extrapolation from one study to another, or to other sources, such as those used by the Navy, is not really possible. While many of these studies show that fish are killed if they are near the source, and there are some suggestions that there is a correlation between size of the fish and death (Yelverton et al. 1975), little is known about the very important issues of non-mortality damage in the short- and long-term, and nothing is known about effects on behavior of fish.

The major issue in explosives is that the gas oscillations induced in the swim bladder or other air bubble in fishes caused by high sound pressure levels can potentially result in tearing or rupturing of the chamber. This has been suggested to occur in some (but not all) species in several gray literature unpublished reports on effects of explosives (*e.g.*, Aplin, 1947, Coker and Hollis, 1950, Gaspin, 1975, Yelverton et al. 1975), whereas other published studies do not show such rupture (*e.g.*, the peer reviewed study by Govoni et al. 2003). Key variables that appear to control the physical interaction of sound with fishes include the size of the fish relative to the wavelength of sound, mass of the fish, anatomical variation, and location of the fish in the water column relative to the sound source (*e.g.*, Yelverton et al. 1975, Govoni et al. 2003).

Explosive blast pressure waves consist of an extremely high peak pressure with very rapid rise times (< 1 ms). Yelverton et al. (1975) exposed eight different species of freshwater fish to blasts of 1-lb spheres of Pentolite (high explosive) in an artificial pond. The test specimens ranged from 0.02 g (guppy) to 744 g (large carp) body mass and included small and large animals from each species. The fish were exposed to blasts having extremely high peak overpressures with varying impulse lengths. The investigators found what appears to be a direct correlation between body mass and the magnitude of the "impulse," characterized by the product of peak overpressure and the time it took the overpressure to rise and fall back to zero (units in psi-ms), which caused 50 percent mortality (see Hastings and Popper 2005 for detailed analysis).

One issue raised by Yelverton et al. (1975) was whether there was a difference in lethality between fish which have their swim bladders connected by a duct to the gut and fish which do not have such an opening. The issue is that it is possible that a fish with such a connection could rapidly release gas from the swim bladder on compression, thereby not increasing its internal pressure. However, Yelverton et al. (1975) found no correlation between lethal effects on fish and the presence or lack of connection to the gut.

While these data suggest that fishes with both types of swim bladders are affected in the same way by explosive blasts, this may not be the case for other types of sounds, and especially those with longer rise or fall times that would allow time for a biomechanical response of the swim bladder (Hastings and Popper 2005). Moreover, there is some evidence that the effects of explosives on fishes without a swim bladder are less than those on fishes with a swim bladder (*e.g.*, Gaspin 1975, Goertner et al. 1994, Keevin et al. 1997). Thus, if internal damage is, even in part, an indirect result of swim bladder (or other air bubble) damage, fishes without this organ may show very different secondary effects after exposure to high sound pressure levels. Still, it must be understood that the data on effects of impulsive sources and explosives on fish are limited in number and quality of the studies, and in the diversity of fish species studied. Thus, extrapolation from the few studies available to other species or other devices must be done with the utmost caution.

In a more recent published report, Govoni et al. (2003) found damage to a number of organs in juvenile pinfish (*Lagodon rhomboids*) and spot (*Leiostomus xanthurus*) when they were exposed to submarine detonations at a distance of 11.8 ft (3.6 m), and most of the effects, according to the authors, were sublethal. Effects on other organ systems that would be considered irreversible (and presumably lethal) only occurred in a small percentage of fish exposed to the explosives. Moreover, there was virtually no effect on the same sized animals when they were at a distance of 24.6 ft (7.5 m), and more pinfish than spot were affected.

Based upon currently available data it is not possible to predict specific effects of Navy impulsive sources on fish. At the same time, there are several results that are at least suggestive of potential effects that result in death or damage. First, there are data from impulsive sources such as pile driving and seismic air guns that indicate that any mortality declines with distance, presumably because of lower signal levels. Second, there is also evidence from studies of explosives (Yelverton et al. 1975) that smaller animals are more affected than larger animals. Finally, there is also some evidence that fish without an air bubble, such as flatfish and sharks and rays, are less likely to be affected by explosives and other sources than are fish with a swim bladder or other air bubble.

Yet, as indicated for other sources, the evidence of short- and long-term behavioral effects, as defined by changes in fish movement, etc., is non-existent. Thus, it is unknown if the presence of an explosion or an impulsive source at some distance, while not physically harming a fish, will alter its behavior in any significant way.

Non-explosive Ordnance

Mines, inert bombs, and intact missiles and targets could impact the water with great force and produce a large impulse and loud noise. Physical disruption of the water column by the shock wave and bubble pulse is a localized, temporary effect, and would be limited to within tens of meters of the impact area and would persist for a matter of minutes. Physical and chemical properties would be temporarily affected (*e.g*., increased oxygen concentrations due to turbulent mixing with the atmosphere), but there would be no lasting adverse effect on the water column habitat from this physical disruption. Large objects hitting the water produce noises with source levels on the order of 240 to 271 dB re 1 µPa and pulse durations of 0.1 to 2 milliseconds, depending on the size of the object (McLennan 1997). A remote possibility exists that some individual fish at or near the surface may be directly impacted (*i.e.*, direct strike) if they are in the target area at the point of physical impact at the time of non-explosive ordnance delivery. Therefore, effects of shock waves from mines, inert bombs, and intact missiles and targets hitting the water surface on fish are expected to be localized and minimal.

Expended Materials

Falling Debris and Small Arms Rounds

Most missiles hit their target or are disabled before hitting the water. Thus, most of these missiles and targets hit the water as fragments, which quickly dissipate their kinetic energy within a short distance from the surface. Similarly, expended small-arms rounds may also strike the water surface with sufficient force to cause injury. Most fish swim some distance below the surface of the water. Therefore, fewer fish are exposed to mortality from falling fragments whose effects are limited to the near surface, than mortality from intact missiles and targets whose effects can extend well below the water surface.

Hazardous Materials

Hazardous materials can be released from sonobuoys, submarine targets, torpedoes, missiles, aerial targets, and underwater explosions. Petroleum hydrocarbons released during an accident are harmful to fish. Jet fuel is toxic to fish but floats and vaporizes very quickly. Assuming that a target disintegrates on contact with the water, any residual unburned fuel may be spread over a large area and dissipate quickly. In addition, fuel spills and material released from weapons and targets could occur at different locations and at different times.

Potential impacts from Navy explosives training include degradation of substrate and introduction of toxic chemicals into the water column. Combustion products from the detonation of high explosives – carbon monoxide (CO), carbon dioxide (CO_2), hydrogen (H_2), water (H_2O), nitrogen (N_2), and ammonia (NH_3) - are commonly found in sea water. The primary constituents that would be released from explosives training are nitroaromatic compounds such as trinitrotoluene (TNT), cyclonite (Royal Demolition Explosive or RDX), and octogen (High Melting Explosive or HMX) (URS 2000). Initial concentrations of explosion by-products are not expected to be hazardous to marine life (DoN 2001a) and would not accumulate in the training area because exercises are spread out over time and the chemicals disperse in the ocean. The water quality effects of the explosions would be infrequent, temporary, and localized, and would have no long-term adverse effect on water quality. Furthermore, charges at the Crescent Harbor Underwater EOD Range are raised off the bottom to minimize impacts to the sea floor. Effects on marine fish associated with the release of hazardous materials, carbon, and Kevlar pieces and other materials are expected to be minimal.

3.7.2.3 No Action Alternative

Under the No Action Alternative, baseline levels of activities would remain unchanged from current conditions. Fish would have the potential to be affected by vessel movement, aircraft overflights, underwater detonations and explosive ordnance, sonar, non-explosive ordnance use, weapons firing disturbance, and expended materials.

Vessel Movements

Many of the ongoing and proposed activities within the Study Area involve maneuvers by various types of surface ships and submarines (collectively referred to as vessels). Currently, the number of Navy vessels operating in the NWTRC Study Area varies based on training schedules. Most activities include up to 2 vessels, with an average of one vessel per activity. During a year of activities, 6,940 steaming hours occur in the NWTRC, with 4,320 of those in transit, and 2,610 during training activities. Speeds for activities and training typically range from 10 to 14 knots. Activities involving vessel movements occur intermittently and are short in duration, generally a few hours in duration. These activities are widely dispersed throughout the OPAREA, which is a vast area encompassing 122,400 square nautical miles (approximately 430,000 square kilometers) of surface/subsurface ocean. The Navy logs about 289 total vessel days within the Study Area during a typical year (approximately 0.06 hours of steaming per square nautical mile).

Vessel movements have the potential to expose fish to noise and general disturbance, which could result in short-term behavioral and/or physiological responses (swimming away, increased heart rate). Such responses would not be expected to compromise the general health or condition of individual fish. The probability of collisions between vessels and adult fish, which could result in injury or mortality, would be extremely low because this life stage is highly mobile and Navy vessel density in the Study Area is low. Vessel movements would result in short-term and localized disturbances to the water column, but benthic habitats would not be affected. Ichthyoplankton (fish eggs and larvae) in the upper portions of the water column could be displaced, injured, or killed by vessel and propeller movements. However, no measurable effects on fish recruitment would occur because the number of eggs and larvae exposed to vessel movements would be low relative to total ichthyoplankton biomass. Vessel movements under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, vessel movements in territorial waters under the No Action Alternative would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from vessel movements in non-territorial waters would be minimal in accordance with EO 11214.

Aircraft Overflights

Under the No Action Alternative, 6,855 overflights occur in the NWTRC annually. Of these, 84 would be helicopter flights, conducted primarily over land. The majority of the remaining non-helicopter overflights would occur over marine environments of the NWTRC at elevations in excess of 3,000 ft above sea level, and over 3 nm from shore.

Aircraft overflights produce airborne noise and some of this energy would be transmitted into the water. However, sound does not transmit well from air to water. Predicted sound levels resulting from HC-130 aircraft flying at 1,000 ft and 250 ft were 110 and 121 dB re 1 µPa, respectively, directly under the flight path at a depth of 1 ft (maximum one-third octave level for frequencies 20 Hz–5 kHz). The same sound levels resulting from an HH-60 helicopter flying at 1,000 ft, flying at 100 ft, and hovering 10 ft were 110, 129, and 143 dB re 1 µPa (respectively) directly under the helicopter at a depth of 1 ft (USAF 1999). The sound levels would decline at increasing lateral distances from the aircraft's track or location and with increasing depth in the water, and the underwater sounds originating from the aircraft would decline rapidly after the aircraft has passed. It is unlikely that these sound levels would cause physical damage or even behavioral effects in fish based on the sound levels that have been found to cause such effects.

Such responses would not compromise the general health or condition of individual fish. Aircraft overflights under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under MSFCMA. In accordance with NEPA, aircraft overflights in territorial waters under the No Action Alternative would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from aircraft overflights movements in non-territorial waters would be minimal in accordance with EO 11214.

Underwater Detonations and Explosive Ordnance

Explosions that occur in the offshore portions of the Study Area are associated with training exercises that use explosive ordnance, including bombs (BOMBEX), missiles (MISSILEX), sink exercises (SINKEX) and naval gun shells (GUNEX, 5-inch high explosive rounds), as well as underwater detonations associated with EOD training.

As shown in Table 2-9, under the No Action Alternative approximately 108 bombs, 10 missiles, and 9,132 sonobuoys (includes 124 explosive sonobuoys) would be used in the OPAREA training area each year. This would produce a very low density of offshore explosions per year in the Study Area of 0.002 explosions per nm^2.

Underwater detonation is limited to a few specific training areas: Crescent Harbor Underwater EOD range, Floral Point Underwater EOD Range, and Indian Island Underwater EOD Range. As discussed in Chapter 2, the No Action Alternative represents baseline conditions. With respect to EOD activities, the No Action Alternative represents approximately 60 annual EOD activities in nearshore environments (Table 3.7-5).

Table 3.7-5: Mine Countermeasure Training Activities Under the No Action Alternative

Location	Charge Size Net Explosive Weight (NEW)	Number	Number of Activities
Crescent Harbor Underwater EOD Range	< 2.5 lb .	3	
	2.5 lb.	45	
	5 lb	1	
	20 lb	4	
	Subtotal	**53**	**53**
Floral Point Underwater EOD Range		0	
	2.5 lb.	3	
	Subtotal	**3**	**3**
Indian Island Underwater EOD Range	2.5 lb.	3	
	20 lb.	1	
	Subtotal	**4**	**4**
	TOTAL	**60**	**60**

In April 2008, the Navy made the decision to relocate EOD Mobile Unit Eleven (EODMU Eleven) forces out of the NWTRC Study Area to a new homebase in Imperial Beach, CA. This move is planned to be completed in the fall of 2009. Two EOD Shore Detachments (Bangor and Northwest) will remain in the NWTRC. As a result of the EODMU Eleven relocation, mine warfare underwater detonation training will significantly decrease from a yearly maximum of 60 underwater detonations as analyzed in the No Action Alternative (the baseline) to no more than four annual underwater detonations as analyzed in Alternatives 1 and 2.

Fish exposed to underwater explosions would suffer temporary effects, sub-lethal or lethal injuries, or direct mortality, in proportion to the proximity to the explosion and size of the detonation. For example, based on the analysis methods presented in Section 3.7.2.4, physical injury to fish could occur within the following distances of a detonation site for detonation of 20-lb. and 5-lb. charges, as shown in Table 3.7-6. These distances should be used to define “not properly functioning habitat” for noise/impulse conditions.

Table 3.7-6: Distances from Detonation Resulting in No Injury or 1% Mortality to Fish

Fish	Weight	Approximate No Effects (no injury) Distance (m)	
		20-lb. Charge	5-lb. Charge
Juvenile chum	0.011 lb (0.005 kg)	850	580
Juvenile chinook	0.022 lb (0.01 kg)	780	527
Adult chum	11 lb (5kg)	350	235
Adult chinook	22 lb (10kg)	320	216

During their migration and rearing, juvenile salmon occur almost exclusively in shallow water directly adjacent to the shoreline. Therefore, the potential for injury effects on juveniles depends on the size of the charge and the distance from the EOD training area at any site to the nearest shoreline. This distance indicates that there is a potential for injury or mortality of juvenile fish at both of the underwater detonation sites, if detonations occur when juvenile fish are present along the nearest shorelines. The number of juveniles potentially affected would be small, because of the infrequent nature of the detonations. For some detonations, it is possible that no fish would be injured, because none would be closer than the no-effects distances.

As shown above, the distances over which adult Chinook or chum salmon could be injured or killed are considerably smaller than the injury distances for juveniles. When adults are in the general vicinity of the training areas, they could be injured or killed as a result. The number of adult salmon expected to be affected depends on the frequency of the detonations, and the likelihood of adult salmon to be present at the sites. The Crescent Harbor Underwater EOD Range is outside the major migration corridor for river systems in the area. The Indian Island Underwater EOD Range lies on a migration corridor for Chinook, chum, and other salmon species in the Hood Canal system. As such, the Indian Island Underwater EOD Range area is expected to support larger numbers of adult salmon than Crescent Harbor Underwater EOD Range area. Resident Chinook (blackmouth) may occur in low densities. At any time of the year, small numbers of adult salmon are expected to occur within the injury distances of the detonation sites at the time of detonation. Therefore, juvenile and adult salmon could be injured or killed by EOD detonations.

Effects to steelhead or bull trout would be similar to those described for salmon. Regarding the potential for physical injury, Table 3.7-7 shows “safe distances,” based on no injury and 90 percent survival for adult and juvenile bull trout, using the method of Young (1991). As with juvenile salmon, juvenile bull or steelhead trout could be injured by explosions of the largest charges at the detonations sites, if the juveniles were present at nearby shorelines when an explosion occurred. However, juvenile bull or steelhead trout are less likely to be present near the explosion sites than juvenile salmon. Anadromous juvenile trout are most likely to stay within their natal estuaries (none of which are near the detonation sites) to feed and mature before moving back upriver. Anadromous juvenile trout are much less likely than juvenile salmon to migrate long distances in the marine environment, which would bring them into the vicinity of the EOD training areas. Therefore, juvenile and adult trout could be injured or killed by EOD explosions; trout injury is expected to be less than salmon, as discussed above.

Table 3.7-7: Approximate Distances from Detonation Resulting in No Injury or 90% Survival to Bull Trout

Fish	Weight	No Effects (no injury) Distance (m)		90% Survival Distance (m)	
		5-lb. Charge	20-lb. Charge	5-lb. Charge	20-lb. Charge
Juvenile bull trout	0.44 lb (0.02 kg)	480	710	161	237
Adult bull trout	6 lb (2.7 kg)	250	375	85	125
Note: Based on method of Young (1991). Assumes charge is at a depth of 50 ft and fish are in "shallow" water. No injury distances are estimated from 90% survival distances.					

The evidence of short- and long-term behavioral effects, as defined by changes in fish movement, etc., is non-existent (Popper 2008). It is unknown if the presence of an explosion or impulsive source at some distance, while not physically harming a fish, will alter its behavior in any significant way (Popper 2008).

Impacts to fish from explosions would be possible, but have a low potential for occurrence. While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of underwater detonations and high explosive ordnance use, explosions under the No Action Alternative would not result in impacts to fish populations based on the low number of fish that would be affected. Disturbances to water column and benthic habitats from explosions would be short-term and localized. The Navy conducts a limited number of training activities over a large area (112,241 nm^2 [430,000 km^2]). Habitat disturbance and fish injury and mortality from explosions are reduced by Navy mitigation measures, as discussed in Section 3.7.1.6.

Sonar

Effects to fish populations and EFH from sonar use could potentially result from acoustic impacts. Antisubmarine warfare (ASW) and mine warfare (MIW) exercises include training sonar operators to detect, classify, and track underwater objects and targets. There are two basic types of sonar: passive and active. Passive sonars only listen to incoming sounds and, since they do not emit sound energy in the water, lack the potential to acoustically affect the environment. Active sonars emit acoustic energy to obtain information about a distant object from the reflected sound energy. Active sonars are the most effective detection systems against modern, ultra-quiet submarines and sea mines in shallow water.

Modern sonar technology has developed a multitude of sonar sensor and processing systems. In concept, the simplest active sonars emit acoustic pulses ("pings") and time the arrival of the reflected echoes from the target object to determine range. More sophisticated active sonars emit a ping and then scan the received beam to provide directional as well as range information. Only about half of the Navy's ships are equipped with active sonar and their use is generally limited to training and maintenance activities - 90 percent of sonar activity by the Navy is passive (DoN 2007).

Active sonars operate at different frequencies, depending on their purpose. High-frequency sonar (>10 kHz) is mainly used for establishing water depth, detecting mines, and guiding torpedoes. At higher frequencies, sound energy is greatly attenuated by scattering and absorption as it travels through the water. This results in shorter ranges, typically less than five nautical miles. Mid-frequency sonar is the primary tool for identifying and tracking submarines. Mid-frequency sonar (1 kHz - 10 kHz) suffers moderate attenuation and has typical ranges of 1-10 nautical miles. Low-frequency sonar (<1 kHz) has the least attenuation, achieving ranges over 100 nautical miles. Low-frequency sonars are primarily used for long-range search and surveillance of submarines. Surveillance Towed Array Sensor System Low-Frequency Active (SURTASS LFA) is the U.S. Navy's low-frequency sonar system (DoN 2001b), it employs a vertical array of 18 projectors using the 100-500 Hz frequency range.

Sonars used in ASW are predominantly in the mid-frequency range (DoN 2007). ASW sonar systems may be deployed from surface ships, submarines, and rotary and fixed wing aircraft. The surface ships are typically equipped with hull mounted sonar but may tow sonar arrays as well. Helicopters are equipped with dipping sonar (lowered into the water). Helicopters and fixed wing aircraft may also deploy both active and passive sonobuoys and towed sonar arrays to search for and track submarines.

Submarines also use sonars to detect and locate other subs and surface ships. A submarine’s mission revolves around stealth, and therefore submarines use their active sonar very infrequently since the pinging of active sonar gives away their location. Submarines are also equipped with several types of auxiliary sonar systems for mine avoidance, for top and bottom soundings to determine the submarine’s position in the water column, and for acoustic communications. ASW training targets simulating submarines may also emit sonic signals through acoustic projectors.

Sonars employed in MIW training are typically high-frequency (greater than 10 kHz). They are used to detect, locate, and characterize mines that are moored, laid on the bottom, or buried. MIW sonars can be deployed from multiple platforms including towed systems or surface ships.

Torpedoes use high-frequency, low-power, active sonar. Their guidance systems can be autonomous or electronically controlled from the launching platform through an attached wire. The autonomous guidance systems are acoustically based. They operate either passively, exploiting the emitted sound energy by the target, or actively, ensonifying the target and using the received echoes for tracking and targeting.

Military sonars for establishing depth and most commercial depth sounders and fish finders operate at high frequencies, typically between 24 and 200 kHz.

Low-Frequency Sonar

Low-frequency sound travels efficiently in the deep ocean and is used by whales for long-distance communication (Richardson et al. 1995, NRC 2003, 2005). Concern about the potential for low-frequency sonar (<1 kHz) to interfere with cetacean behavior and communication has prompted extensive debate and research (DoN 2001b, 2007, NRC 2000, 2003).

Some studies have shown that low-frequency noise will alter the behavior of fish. For example, research on low-frequency devices used to deter fish away from turbine inlets of hydroelectric power plants showed stronger avoidance responses from sounds in the infrasound range (5-10 Hz) than from 50 and 150 Hz sounds (Knudsen et al. 1992, 1994). In test pools, wild salmon exhibit an apparent avoidance response by swimming to a deeper section of the pool when exposed to low-frequency sound (Knudsen et al. 1997).

Turnpenny et al. (1994) reviewed the risks to marine life, including fish, of high intensity, low-frequency sonar. Their review focused on the effects of pure tones (sine waves) at frequencies between 50-1000 Hz. Johnson (2001) evaluated the potential for environmental impacts of employing the SURTASS LFA sonar system. While concentrating on the potential effects on whales, the analysis did consider the potential effects on fish, including bony fish and sharks. It appears that the swimbladders of most fish are too small to resonate at low frequencies and that only large pelagic species such as tunas have swimbladders big enough to resonate in the low-frequency range. However, investigations by Sand and Hawkins (1973) and Sand and Karlsen (1986) revealed resonance frequencies of cod swim bladders from 2 kHz down to 100 Hz.

Popper et al. (2005, 2007) investigated the impact of Navy SURTASS LFA sonar on hearing and on non-auditory tissues of several fish species. In this study, three species of fish in Plexiglas cages suspended in a freshwater lake were exposed to high intensity LFA sonar pulses for periods of time considerably longer than likely LFA exposure. Results showed no mortality and no damage to body tissues either at the gross or histological level. Some individuals exhibited temporary hearing loss but recovered within several days of exposure. The study suggests that SURTASS LFA sonar does not kill or damage fish even in a worst case scenario.

Although some behavioral modification might occur (i.e., startle, avoidance, etc.), adverse effects from low-frequency sonar on fish, including sensitive life stages (juvenile fish, larvae and eggs) are not expected. If they occur, behavioral responses would be brief, reversible, and not biologically significant. The use of Navy low-frequency sonar would not compromise the productivity of fish or adversely affect their habitat.

Mid-Frequency Sonar

ASW training activities use mid-frequency (1-10 kHz) sound sources. Most fish only detect sound within the 1-3 kHz range (Popper 2003, Hastings and Popper 2005). Thus, it is expected that most fish species would be able to detect the ASW mid-frequency sonar at the lower end of its frequency range.

Some investigations have been conducted on the effect on fish of acoustic devices designed to deter marine mammals from gillnets (Gearin et al. 2000, Culik et al. 2001). These devices generally have a mid-frequency range, similar to the sonar devices that would be used in ASW exercises. Adult sockeye salmon exhibited an initial startle response to the placement of inactive acoustic alarms designed to deter harbor porpoise. The fish resumed their normal swimming pattern within 10 to 15 seconds. After 30 seconds, the fish approached the inactive alarm to within 30 cm (1 ft). The same experiment was conducted with the alarm active. The fish exhibited the same initial startle response from the insertion of the alarm into the tank; however, within 30 seconds, the fish were swimming within 30 cm (1 ft) of the active alarm. After five minutes of observation, the fish did not show any reaction or behavior change except for the initial startle response. This demonstrated that the alarms were either inaudible to the fish, or the fish were not disturbed by the mid-frequency sound.

Jørgensen et al. (2005) carried out experiments examining the effects of mid-frequency (1 to 6.5 kHz) sound on survival, development, and behavior of fish larvae and juveniles. Experiments were conducted on the larvae and juveniles of Atlantic herring, Atlantic cod, saithe (*Pollachius virens)*, and spotted wolfish (*Anarhichas minor)*. Swimbladder resonance experiments were attempted on juvenile Atlantic herring, saithe, and Atlantic cod. Sound exposure simulated Naval sonar signals. These experiments did not cause any significant direct mortality among the exposed fish larvae or juveniles, except in two (of a total of 42) experiments on juvenile herring where significant mortality (20 to 30 percent) was observed. Among fish kept in tanks one to four weeks after sound exposure, no significant differences in mortality or growth related parameters (length, weight and condition) between exposed groups and control groups were observed. Some incidents of behavioral reactions were observed during or after the sound exposure - ‘panic’ swimming or confused and irregular swimming behavior. Histological studies of organs, tissues, or neuromasts from selected Atlantic herring experiments did not reveal obvious differences between control and exposed groups.

The work of Jørgensen et al. (2005) was used in a study by Kvadsheim and Sevaldsen (2005) to examine the possible ‘worst case’ scenario of sonar use over a spawning ground. They conjectured that normal sonar operations would affect less than 0.06 percent of the total stock of a juvenile fish of a species, which would constitute less than 1 percent of natural daily mortality. However, these authors did find that the use of continuous-wave transmissions within the frequency band corresponding to swim bladder resonance will escalate this impact by an order of magnitude. The authors therefore suggested that modest restrictions on the use of continuous-wave transmissions at specific frequencies in areas and at time periods when there are high densities of Atlantic herring present would be appropriate.

The results of several studies have indicated that acoustic communication and orientation of fish, in particular of hearing specialists, may be limited by noise regimes in their environment (Wysocki and Ladich 2004). Most marine fish are hearing generalists, though a few have been shown to detect sounds in the mid-frequency and ultrasonic range. While these species can detect mid-frequency sounds, their best hearing sensitivities are not in the mid-frequency range. If a sound is at the edge of a fish's hearing range, the sound must be louder in order for it to be detected than if in the more sensitive range.

Experiments on fish classified as hearing specialists (but not those classified as hearing generalists) have shown that exposure to loud sound can result in temporary hearing loss, but it is not evident that this may lead to long-term behavioral disruptions in fish that are biologically significant (Amoser and Ladich 2003, Smith et al. 2004a,b). There is no information available that suggests that exposure to non-impulsive acoustic sources results in fish mortality.

In summary, some marine fish may be able to detect mid-frequency sounds, most marine fish are hearing generalists and have their best hearing sensitivity below mid-frequency sonar. If they occur, behavioral responses would be brief, reversible, and not biologically significant. Sustained auditory damage is not expected. Sensitive life stages (juvenile fish, larvae and eggs) very close to the sonar source may experience injury or mortality, but area-wide effects would likely be minor. The use of Navy mid-frequency sonar would not compromise the productivity of fish or adversely affect their habitat.

High-Frequency Sonar

Although most fish cannot hear sound frequencies over 10 kHz, some shad and herring species can detect sounds in the ultrasonic range, i.e., over 20 kHz. (Mann 2001, Higgs et al. 2004). Ross et al. (1996) reviewed the use of high-frequency sound to deter alewives from entering power station inlets. The alewife, a member of the shad family (Alosinae) which can hear sounds at ultrasonic frequencies (Mann et al. 2001), uses high-frequency hearing to detect and avoid predation by cetaceans. Wilson and Dill (2002) demonstrated that exposure to broadband sonar-type sounds with high frequencies cause behavioral modification in Pacific herring.

Since high-frequency sound attenuates quickly in water, high levels of sound from mine hunting sonars would be restricted to within a few meters of the source. Even for fish able to hear sound at high frequencies, only short-term exposure would occur, thus high-frequency military sonars are not expected to have significant effects on resident fish populations.

Because a torpedo emits sonar pulses intermittently and is traveling through the water at a high speed, individual fish would be exposed to sonar from a torpedo for a brief period. At most, an individual animal would hear one or two pings from a torpedo and would be unlikely to hear pings from multiple torpedoes over an exercise period. Most fish hear best in the low- to mid-frequency range and, therefore are unlikely to be disturbed by torpedo pings.

The effects of high-frequency sonar on fish behavior for species that can hear high-frequency sonar, would be transitory and of little biological consequence. Most species would probably not hear these sounds and would therefore experience no disturbance.

Conclusion – Sonar Use

While the impact of anthropogenic noise on marine mammals has been extensively studied, the effects of noise on fish are largely unknown (Popper 2003, Hastings and Popper 2005, Popper 2008). There is a dearth of empirical information on the effects of exposure to sound, let alone sonar, for the vast majority of fish. The few studies on sonar effects have focused on behavior of individuals of a few species and it is unlikely their responses are representative of the wide diversity of other marine fish species (Jorgensen et al. 2005). The literature on vulnerability to injury from exposure to loud sounds is similarly limited, relevant to particular species, and, because of the great diversity of fish, not easily extrapolated. More well-controlled studies are needed on the hearing thresholds for fish species and on temporary and permanent hearing loss associated with exposure to sounds. The effects of sound may not only be species specific, but also depend on the mass of the fish (especially where any injuries are being considered) and life history phase (eggs and larvae may be more or less vulnerable to exposure than adult fish). The use of sounds during spawning by some fish, and their potential vulnerability to masking by anthropogenic sound sources, also requires further investigation. No studies have established effects of cumulative exposure of fish to any type of sound or have determined whether subtle and long-term effects on behavior or physiology could have an impact upon survival of fish populations. The use of sounds during spawning by some fish and their potential vulnerability to masking by anthropogenic sound sources requires closer investigation.

With these caveats and qualifications in mind, the limited information currently available suggests that populations of fish are unlikely to be affected by the projected rates and areas of use of military sonar. Thus, sonar use in NWTRC training is not anticipated to result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, sonar use in territorial waters under the No Action Alternative would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from sonar use movements in non-territorial waters would be minimal in accordance with EO 11214.

Non-Explosive Ordnance Use

Current Navy training activities in the NWTRC study area include firing a variety of weapons and employ a variety of non-explosive training rounds, including bombs, missiles, naval gun shells, cannon shells, and small caliber ammunition. These materials are used in the OPAREA located in the open ocean beyond 12 nm. Direct ordnance strikes from firing weapons are potential stressors to fish.

Inert bombs, intact missiles or some targets fall into the waters of the OPAREA during the following exercises:

- Missile Firing
- Bombing Exercise
- Sinking Exercise
- Gunnery Exercise

Non-explosive bombs and intact missiles and targets could impact the water with great force and produce a large impulse and loud noise. Physical disruption of the water column by the shock wave and bubble pulse is a localized, temporary effect, and would be limited to within tens of meters of the impact area and would persist for a matter of minutes. Physical and chemical properties would be temporarily affected (*e.g.*, increased oxygen concentrations due to turbulent mixing with the atmosphere), but there would be no lasting adverse effect on the water column habitat from this physical disruption.

Large objects hitting the water produce noises with source levels on the order of 240 to 271 dB re 1 µPa and pulse durations of 0.1 to 2 milliseconds, depending on the size of the object (McLennan 1997). Impulses of this magnitude could potentially injure fish. Because the rise times of these shock waves are very short, the impulses causing injury and mortality derived for explosive sources were used to estimate effects of shock pulses created by missile and target effects.

While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of non-explosive ordnance use, under the No Action Alternative ordnance use would not result in significant impacts to fish populations based on the low density of ordnance use (2.5

pieces/square nautical mile). Fish injury and mortality from ordnance use are reduced by Navy mitigation measures, as discussed in Section 3.7.1.6. Disturbances to water column and benthic habitats from ordnance use would be short-term and localized. Non-explosive ordnance use under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, non-explosive ordnance use in territorial waters under the No Action Alternative would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from non-explosive ordnance use movements in non-territorial waters would be minimal in accordance with EO 11214.

Weapons Firing Disturbance

When a gun is fired from a surface ship, a blast wave propagates away from the gun muzzle. When the blast wave meets the water, most of the energy is reflected back into the air, but some energy is transmitted into the water. A series of pressure measurements were taken during the firing of a 5-inch gun aboard the USS Cole in June 2000 (Dahlgren 2000). The average peak pressure measured was about 200 dB re 1 µPa at the point of the air and water interface. Down-range peak pressure level, estimated for spherical spreading of the sound in water**,** would be 160 dB re 1 µPa at 100 m (328 ft) and 185 dB re 1 µPa at ~5.5 m (18 ft). The resulting ensonified areas (semi-circles with radius 100 and 5.5 m) would be 0.015 km^2 and ~50 m^2 (respectively).

Because fish apparently only react to impulsive sounds greater than 160 dB, only those in the immediate vicinity (0.015 km^2 area) would be affected and effects would be limited to short-term, transitory alarm or startle responses. Weapons firing under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, weapons firing disturbance in territorial waters under the No Action Alternative would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from weapons firing disturbance movements in non-territorial waters would be minimal in accordance with EO 11214.

Expended Materials

The Navy uses a variety of expended materials during training exercises conducted in the NWTRC Study Area. The types and quantities of expended materials used and information regarding fate and transport of these materials within the marine environment are discussed in Sections 3.1, 3.3, and 3.4. The analyses presented in these sections predict that the majority of the expended materials would rapidly sink to the sea floor, become encrusted by natural processes, and incorporated into the sea floor, with no significant accumulations in any particular area and no significant negative effects to water quality or marine benthic communities.

Ordnance Related Materials

Ordnance related materials include various sizes of non-explosive training rounds and shrapnel from explosive rounds. These solid metal materials would quickly move through the water column and settle to the sea floor where they could be available for ingestion by foraging fish.

The probability of fish ingesting expended ordnance would depend on factors such as the location of the spent materials, size of the materials, and the level of benthic foraging that occurs in the impact area, which is a function of benthic habitat quality, prey availability, and species-specific foraging strategies. It is possible that persistent expended ordnance could be colonized by benthic organisms (such as clams and oysters) and mistaken for prey, or that expended ordnance could be accidentally ingested while foraging for natural prey items.

Under the No Action Alternative, the total number of expended ordnance in the Study Area would be just under 85,700 pieces per year. Assuming all ordnance would be expended throughout the OPAREA in an even distribution, the concentration of expended rounds would be 0.7 per nm^2 (2.4 per km^2).

Under the No Action Alternative, ingestion of expended ordnance may affect fish, but this affect would be minimal. Ordnance related expended materials under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, ordnance related materials in territorial waters under the No Action Alternative would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from ordnance related materials in non-territorial waters would be minimal in accordance with EO 11214.

Target Related Materials

A variety of at-sea targets would potentially be used in the OPAREA, ranging from high-tech remotely operated airborne and surface targets (such as airborne drones) to low-tech floating at-sea targets (such as inflatable targets) and airborne towed banners. Many of the targets are designed to be recovered for reuse and are not destroyed during training. The expendable targets used in the study area are the Expendable Mobile ASW Training Target (EMATT) and the MK-58 Marine Marker. These units are 2 and 3 ft in length, respectively, and sink to the bottom intact; these targets present no ingestion hazard to fish.

EMATTs are not recovered; they scuttle themselves and sink to the sea floor to be left in place. The EMATTs are unlikely to result in any physical impacts to the sea floor. They would sink into a soft bottom or would lie on a hard bottom, where they may provide a substrate for benthic colonization or eventually be covered by shifting sediments. Metal components are corroded by seawater at slow rates. Natural encrustation of exposed surfaces would eventually occur as invertebrates grow on the surfaces of the sunken objects. As the exterior becomes progressively more encrusted, the rates at which the metals will dissolve into the surrounding water will also decrease. Rates of deterioration would vary, depending on material and conditions in the immediate marine and benthic environment. Factors such as oxygen content, salinity, temperature and pH all contribute to the manner and speed at which metals will dissolve. Over a period of years, the EMATTs would degrade, corrode, and become encrusted or incorporated into the sediments, thus precluding adverse effects to fish. Under the No Action Alternative, 121 EMATTs would be used annually.

EMATTs use lithium sulfur dioxide batteries. An important component of the thermal battery is a hermetically-sealed casing of welded stainless steel 0.03 to 0.1-inches thick that is resistant to the battery electrolytes. As previously described in Section 3.3.2, in the evaluation of the potential effects associated with seawater batteries, it is expected that in the marine environment, lithium potentially released from these batteries would be essentially nontoxic in seawater. Because of these factors, lithium batteries would not adversely affect fish.

MK-58 marine markers produce chemical flames and regions of surface smoke and are used in various training exercises to mark a surface position to simulate divers, ships, and points of contact on the surface of the ocean. The smoke dissipates in the air having little effect on the marine environment. The marker burns similar to a flare, producing a flame until all burn components have been used. While the light generated from the marker is bright enough to be seen up to three miles away in ideal conditions, the resulting light would either be reflected off the water’s surface or would enter the water and attenuate in brightness over depth. Approximately 208 marine markers would be used in the Study Area under the No Action Alternative. Given the size of the Study Area and the low number of markers used, it would be very unlikely that fish would be affected by use of marine markers.

Target and marine marker use under the No Action Alternative may affect fish, but the effects would be considered minimal because of the low number of markers used. Target related materials under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, target related materials in territorial waters under the No Action Alternative would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from target related materials in non-territorial waters would be minimal in accordance with EO 11214.

Threatened and Endangered Species, and Critical Habitat

Threatened and Endangered Species. As discussed in Section 3.7.1.4, species of ESA-designated salmonids with known or potential occurrence in the NWTRC include: chinook, coho, and chum salmon; and steelhead and bull trout. Chinook, coho, and chum salmon; and steelhead trout are under the jurisdiction of NMFS. Bull trout are under the jurisdiction of USFWS. Both Northern and Southern DPS green sturgeon occupy coastal estuaries and coastal marine waters in the NWTRC. Green sturgeon are under the jurisdiction of NMFS.

On November 7, 2008, USWFS issued a Biological Opinion (USFWS 2008) for Navy EOD Operations, Puget Sound. The Biological Opinion applies to Navy's ongoing EOD training conducted from the date of the Biological Opinion through December 31, 2009. The Navy has determined that EOD training through December 31, 2009 will include six underwater detonations (each limited to 2.5 lb charge) and two surface or floating mine detonations (each limited to 2.5 lb charge), and will only occur at Crescent Harbor. The Biological Opinion determined that these EOD training activities would result in the following:

- incidental take in the form of harm (through death or physical injury from the direct effects of the pressure wave resulting from detonation of the explosive during the EOD training) to a total of five juvenile, sub-adult or adult bull trout in the Crescent Harbor action area.

The USFWS Biological Opinion concluded that this level of anticipated take is not likely to jeopardize the continued existence of the bull trout. USFWS also stated that "…no reasonable and prudent measure(s) are necessary and appropriate to minimize impacts of incidental take of bull trout. Measures that are designed to minimize impacts to bull trout have been incorporated by the Navy…" The terms and conditions included in USFWS' Biological Opinion require Navy to monitor the impacts of the incidental take.

Since ESA-listed fish in the NWTRC are in either USFWS or NMFS jurisdiction, both agencies were included in the consultation process for the Navy EOD Operations in Puget Sound. NMFS issued a separate Biological Opinion in June 2008 (NMFS 2008). The NMFS Biological Opinion states "the National Marine Fisheries Service concludes that the proposed action is not likely to jeopardize the continued existence of the Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*), Hood Canal summer-run chum salmon (*O. keta*), Puget Sound steelhead (*O. mykiss*), or southern resident killer whales (*Orcinus orca*); and not likely to adversely modify critical habitat for Puget Sound Chinook salmon, Hood Canal summer-run chum salmon or southern resident killer whales."

The findings of these Biological Opinions have been used in the analysis for this EIS/OEIS. Utilizing criteria and analysis methodology as presented previously for non-listed species, vessel movements, aircraft overflight, underwater detonations, explosive ordnance use, sonar, non-explosive ordnance use, weapons firing, and expended materials may affect individual ESA-listed fish in the NWTRC, However, these activities would not have community or population level effects.

As part of the EIS/OEIS process, the Navy has prepared a BE for the NWTRC for use, as appropriate, in consultation with NMFS and USFWS. The BE provides detailed descriptions and analysis of the potential impacts to all threatened or endangered species and critical habitats protected under the ESA.

Critical Habitat. The potential effects of the Proposed Action on the habitat of ESA-designated species within the NWTRC are analyzed in the BE two ways: First, using a matrix of pathways approach developed by NMFS (1996) and USFWS (1998), second, using an approach that relies upon habitat primary constituent elements (PCEs).

The matrix of pathway approach is an analysis that develops a matrix of pathways (water quality and physical and biological habitat elements) and indicators (various elements of the pathway categories) for fish habitat present in the NWTRC and then characterizes the baseline environmental conditions. The potential effects of the No Action Alternative on habitat present in the action area are characterized by their potential to restore, maintain, or degrade existing environmental baseline conditions for each habitat indicator within the matrix of pathways. The matrix of pathways analysis indicates implementation of the No Action Alternative would maintain baseline environmental conditions, as presented in Table 3.7-8.

Table 3.7-8: Summary of No Action Alternative Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area

Pathway	Indicator	Effects of No Action Alternative
Water Quality	Turbidity, Dissolved Oxygen, Water Contamination/Nutrients, Sediment Contamination	Implementation of the No Action Alternative would maintain baseline water quality conditions.
Physical Habitat Features	Substrate/Armoring, Depth/Slope, Tideland Conditions, Marsh Prevalence, Refugia, Physical Barriers, Current Patterns, Salt/Fresh Water Mixing Patterns and Locations	Implementation of the No Action Alternative would maintain existing environmental baseline conditions for fish habitat.
Biological Habitat Features	Fish Prey Availability, Forage Fish Community, Aquatic Vegetation, Exotic Species	Implementation of the No Action Alternative would maintain existing environmental baseline conditions for fish prey availability, forage fish community, aquatic vegetation and exotic species. Underwater detonations and ordnance use would result in potential injury or mortality to individual fish, prey, and forage fish.

The second method of analysis, the PCE method, determines whether Navy activities are likely to substantially change one or more of the biological, physical, or chemical elements essential for the conservation of the fish species and habitat. PCEs are defined for each species in the Federal Register at the time the species is ESA-listed. The BE provides detailed descriptions of the PCEs for each fish species analyzed; Table 3.7-9 provides a summary of the results of the PCE analysis.

Table 3.7-9: Summary of No Action Alternative Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area

Species and Critical Habitat Designation Location	PCE Source (Federal Register)	Effect	Basis for Effect Determination
Chinook Salmon California Coastal ESU, California	FR 70(170):52537; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine PCEs.
Chinook Salmon Puget Sound ESU, Washington Chinook Salmon Lower Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas; Navy training will occur in critical habitats but will not substantially affect the designated estuarine, nearshore marine, and offshore marine PCEs.

Table 3.7-9: Summary of No Action Alternative Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area (cont'd)

Species and Critical Habitat Designation Location	PCE Source (Federal Register)	Effect	Basis for Effect Determination
Steelhead Trout Northern California ESU Steelhead Trout Central California Coastal ESU, California	FR 70(170):52537; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine PCEs.
Steelhead Trout Lower Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Chum Salmon Hood Canal ESU Washington Chum Salmon Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas; Navy training will occur in critical habitats but will not substantially affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Coho Salmon Oregon Coast ESU, Oregon	FR 73(28):7832; (2/11/08)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Coho Salmon Northern California-Southern Oregon Coasts ESU, California and Oregon	FR 64(86): 24050, 24053, 24059; (5/5/99)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater and riparian components of critical habitat areas and will not adversely affect the designated PCEs.
Bull Trout Coastal Puget Sound, Washington (CHU 28) Bull Trout Olympic Peninsula River Basins Washington (CHU 27)	FR 70(185):56266; (9/26/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will occur in the critical habitat area, but the level of activity would be too small to substantially affect the PCEs; DOD lands where the most intensive Navy training and other activities will occur are excluded from critical habitat designation, thereby further reducing total effects on the PCEs.
Green Sturgeon Southern DPS	FR 73(174):52084; (9/8/08)	No destruction or adverse modification of designated critical habitat	Navy training activities and operations will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.

Based on the matrix of pathways analysis, implementation of the No Action Alternative would maintain baseline water quality, physical habitat features, and biological habitat features. As previously stated, the June 2008 NMFS Biological Opinion for Navy EOD Operations concluded that EOD activities are not likely to adversely modify critical habitat of Puget Sound Chinook salmon or Hood Canal summer-run chum salmon (NMFS 2008). The USFWS also considered habitat in their analysis of EOD activities impacts on bull trout. Based on the agency findings and the PCE analysis presented above, the Navy finds the NWTRC activities associated with implementation of the No Action Alternative would result in no destruction or adverse modification of designated critical habitat.

Essential Fish Habitat

This section discusses the potential impacts by the No Action Alternative to EFH and managed species. Despite nearshore and offshore designations of the Study Area, species within all FMPs may utilize both nearshore and offshore areas during their lives, as eggs and larvae for most species are planktonic and can occur in nearshore and offshore waters, while adults may be present in nearshore and/or offshore waters. Therefore, all project activities under the No Action Alternative can potentially affect a lifestage of a managed species.

Adverse effects mean any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810(a)).

The proposed activities in the NWTRC have the potential to result in the following impacts:

- Physical disruption of habitat;
- Physical destruction or adverse modification of benthic habitats;
- Alteration of water or sediment quality from debris or discharge; and
- Cumulative impacts.

Impacts and activities associated with those impacts are discussed below, and a more comprehensive analysis is available in the associated EFH Assessment. Permanent, adverse impacts to EFH components are not anticipated since activities are conducted to avoid sensitive habitats and potential impacts; however, there are temporary unavoidable impacts associated with several activities that may result in localized adverse impacts.

Effects to EFH could potentially result from either acoustic impacts, or from explosive forces and material introduced into the water column and sediments from explosive source sonobuoy activities. Therefore, no effects to EFH due to active sonar are anticipated.

Impacts to EFH from explosions would be possible, but have a low potential for occurrence. Habitat disturbance from explosions is reduced by Navy mitigation measures, as discussed in Section 3.7.1.6. Disturbances to water column and benthic habitats from explosions would be short-term and localized. The Navy conducts a limited number of training activities over a large area (112,400 nm^2 [approximately 430,000 km^2]).

Explosive source sonobuoys could affect water quality by the release of explosive byproducts, and could affect bottom habitats releasing chemicals (primarily from batteries) into the sediment. The sonobuoy explosive package consists primarily of HLX (*i.e.,* explosive cord) and small amounts of plastic-bonded molding powder. Explosions create gaseous byproducts, many of which travel to the surface and escape into the atmosphere. A small amount of the gas, however, dissolves into the water column. Although several byproducts are produced, the products with greatest potential to result in toxicity are hydrogen fluoride compounds. However, only a minute amount of these substances are expected to be introduced, and they would be rapidly diluted by water movement. It is therefore considered unlikely that the explosive reactions associated with sonobuoys will result in contamination to EFH.

Sonobuoys use various types of batteries to power different components. Typical batteries employed include seawater, lithium, and thermal batteries. Soluble battery constituents of potential concern that may be released into the water column or sediments include lead, silver, and copper. Several other constituents such as chloride, bromide, and lithium may be released as well. Several investigations into the potential effects of battery constituents on seawater and sediment conditions found acceptable levels of such substances (ESG 2005, Kszos 2003, Borener and Maughan, 1998, U.S. Coast Guard, 1994, NAVFAC, 1993). Little accumulation of battery constituents occurred in sediments, and mixing and diffusion resulted in low concentrations in the water column. Therefore, there are no significant impacts to EFH anticipated from sonobuoy batteries.

Lithium sulfur dioxide batteries provide power for propulsion of EMATTs. The final battery byproducts include lithium ions, hydroxide (which combines with hydronium to form water), and sulfate. All of these substances are considered benign in the marine environment. In addition, the chemical reactions of the batteries will be highly localized and short-lived, and ocean currents will diffuse concentrations of the chemicals leached by the batteries. Due to the rapid dilution of chemical releases, accumulation of chemicals in sediments is not likely. Therefore, there are no significant impacts to EFH anticipated from or EMATTs.

Vessel movements, aircraft overflights, underwater detonations and explosive ordnance use, sonar activities, non-explosive ordnance use, weapons firing disturbance, expended materials, and target related materials under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA.

3.7.2.4 Alternative 1

Under Alternative 1, the general level of some activities in the NWTRC Study Area would increase relative to the baseline No Action Alternative; however, underwater detonation exercises would decrease, as described in Chapter 2.

Vessel Movements

As described for the No Action Alternative, the number of Navy vessels operating during training exercises varies, but generally includes up to two vessels, with an average of one vessel. Under Alternative 1, steaming hours would increase four percent from current conditions. During a year of activities, 7,228 steaming hours would occur in the NWTRC. Vessel movements would be widely dispersed throughout the OPAREA, with approximately 0.06 hours of steaming per square nautical mile.

The small increase in steaming hours would not measurably increase potential effects to fish. Disturbance impacts to fish from vessel movements under Alternative 1 would be the same as those described for the No Action Alternative.

Vessel movements under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, vessel movements in territorial waters under the Alternative 1 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from vessel movements in non-territorial waters would be minimal in accordance with EO 11214.

Aircraft Overflights

Under Alternative 1, approximately 8,077 overflights would occur above the NWTRC annually. This would represent an 18 percent increase from current conditions. Of these, 93 would be helicopter flights, conducted primarily over land. The majority of the remaining non-helicopter overflights would occur over marine environments of the NWTRC, at elevations in excess of 3,000 ft above sea level, and over 3 nm from shore.

This increase in overflights would produce an annual distribution of 0.01 overflights per square nautical mile over the NWTRC. This modest increase in potential exposure to visual and noise disturbance would not measurably increase effects to fish. Thus, the impacts of overflights under Alternative 1 would be the same as those for the No Action Alternative.

Aircraft overflights under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under MSFCMA. In accordance with NEPA, aircraft overflights in territorial waters under Alternative 1 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from aircraft overflights in non-territorial waters would be minimal in accordance with EO 11214.

Underwater Detonations and Explosive Ordnance

As shown in Table 2-9, underwater explosions that occur in the offshore areas of the NWTRC are associated with explosive ordnance use. Under Alternative 1, approximately 144 bombs, 35 missiles, and 9,422 sonobuoys (includes 136 explosive sonobuoys) would be used in the OPAREA training area each year. This would produce a very low density of offshore explosions per year in the Study Area of less than 0.003 explosions per nm^2. Explosive ordnance use would increase under Alternative 1, compared to the No Action Alternative, as described in Chapter 2. Fish exposed to underwater explosions would suffer temporary effects, sub-lethal or lethal injuries, or direct mortality, in proportion to the proximity to the explosion and size of the detonation.

Under Alternative 1, the number of underwater detonations and net explosive weight of underwater detonations would decrease by more than 90 percent. Under Alternative 1, two detonations (2.5-lb net explosive weight each) would occur per year at the Crescent Harbor Underwater EOD Range; one detonation (2.5-lb net explosive weight) would occur at the Floral Point Underwater EOD Range; and one detonation (2.5-lb net explosive weight) would occur at the Indian Island Underwater EOD Range. Detonations would occur either at water surface, or underwater at depth. As such, fewer and smaller detonations would reduce the potential to affect fish in the Study Area, compared to the No Action Alternative.

As described for the No Action Alternative, impacts to fish from explosions would be possible, but have a low potential for occurrence. Habitat disturbance and fish injury and mortality from explosions are reduced by Navy mitigation measures, as discussed in Section 3.7.1.6. While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of underwater detonations and high explosive ordnance use, explosions under the Alternative 1 would not result in impacts to fish populations based on the low number of fish that would be affected. Disturbances to water column and benthic habitats from explosions would be short-term and localized.

Sonar

Under Alternative 1, sonar would have the potential to affect fish in the Study Area. Most fish species would be able to detect mid-frequency sonar at the lower end of its range. Short-term behavioral responses such as startle and avoidance may occur, but are not likely to adversely affect indigenous fish communities. Auditory damage from sonar signals is not expected and there is no indication that non-impulsive acoustic sources would result in fish mortality. Sonar use under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, sonar use in territorial waters under the Alternative 1 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from sonar use in non-territorial waters would be minimal in accordance with EO 11214.

Non-Explosive Ordnance Use

Under Alternative 1, non-explosive ordnance use would increase over the No Action Alternative by approximately 12 percent. The Navy conducts a limited number of training activities over a large area, therefore the rate of ordnance use would result in a spent ordnance density of approximately 0.78 pieces/nm^2 in the OPAREA. This modest increase in potential exposure would not measurably increase effects to fish. Thus, the impacts of ordnance strikes on fish would be the same as those for the No Action Alternative.

Impacts to fish from non-explosive ordnance use would be possible, but have a low potential for occurrence. Habitat disturbance and fish injury and mortality from ordnance use are reduced by Navy mitigation measures, as discussed in Section 3.7.1.6. While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of non-explosive ordnance use, implementation of Alternative 1 would not result in impacts to fish populations based on the low number of fish that would be affected. Disturbances to water column and benthic habitats from explosions would be short-term and localized. Non-explosive ordnance use under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, non-explosive ordnance use in territorial waters under the Alternative 1 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from non-explosive ordnance use in non-territorial waters would be minimal in accordance with EO 11214.

Weapons Firing Disturbance

Under Alternative 1, weapons firing activities would continue, but because fish apparently only react to impulsive sounds greater than 160 dB, only those in the immediate vicinity (0.015 km^2 area) would be affected and effects would be limited to short-term, transitory alarm or startle responses. The impacts to fish would be the same as those described for the No Action Alternative.

Under the Alternative 1, weapons firing may affect fish, but this affect would be minimal. Weapons firing under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, these activities would have minimal impact on fish in territorial waters. Furthermore, harm to fish from weapons firing would not be likely in non-territorial waters in accordance with EO 12114.

Expended Materials

Under Alternative 1, expended ordnance in the Study Area would increase approximately eleven percent over the No Action Alternative. Assuming all ordnance would be expended throughout the OPAREA in an even distribution, the concentration of expended rounds would be approximately 0.86 per nm^2 (0.25 per km^2). Under Alternative 1, the use of targets would increase by approximately four percent. The impacts to fish would be the same as those described for the No Action Alternative.

Under Alternative 1, ingestion of expended materials is possible, but has a low potential for occurrence, as described for the No Action Alternative. Expended materials under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, expended materials in territorial waters under the Alternative 1 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from expended materials in non-territorial waters would be minimal in accordance with EO 11214.

Threatened and Endangered Species and Critical Habitat

Threatened and Endangered Species. As discussed in Section 3.7.1.4, species of ESA-designated salmonids with known or potential occurrence in the NWTRC include: chinook, coho, and chum salmon; and steelhead and bull trout. Chinook, coho, and chum salmon; and steelhead trout are under the jurisdiction of NMFS. Bull trout are under the jurisdiction of USFWS. Both Northern and Southern DPS green sturgeon occupy coastal estuaries and coastal marine waters in the NWTRC. Green sturgeon are under the jurisdiction of NMFS.

Underwater detonations under Alternative 1 would be similar to those analyzed by NMFS and USFWS for Navy EOD Operations, Puget Sound. The June 2008 NMFS Biological Opinion states "the National Marine Fisheries Service concludes that the proposed action is not likely to jeopardize the continued existence of the Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*), Hood Canal summer-run chum salmon (*O. keta*), Puget Sound steelhead (*O. mykiss*), or southern resident killer whales (*Orcinus orca*); and not likely to adversely modify critical habitat for Puget Sound Chinook salmon, Hood Canal summer-run chum salmon or southern resident killer whales."

The November 2008 USFWS Biological Opinion determined that these EOD training activities would result in the incidental take in the form of harm (through death or physical injury from the direct effects of the pressure wave resulting from detonation of the explosive during the EOD training) to a total of five juvenile, sub-adult or adult bull trout in the Crescent Harbor action area. The USFWS Biological Opinion concluded that this level of anticipated take is not likely to jeopardize the continued existence of the bull trout. USFWS also stated that "…no reasonable and prudent measure(s) are necessary and appropriate to minimize impacts of incidental take of bull trout. Measures that are designed to minimize impacts to bull trout have been incorporated by the Navy…" The terms and conditions included in USFWS' Biological Opinion require Navy to monitor the impacts of the incidental take.

The findings of these Biological Opinions have been used in the analysis for this EIS/OEIS. Utilizing criteria and analysis methodology as presented previously for non-listed species, vessel movements, aircraft overflight, underwater detonations, explosive ordnance use, sonar, non-explosive ordnance use, weapons firing, and expended materials may affect individual ESA-listed fish in the NWTRC, However, these activities would not have community or population level effects.

As part of the EIS/OEIS process, Navy has prepared a BE for the NWTRC for use, as appropriate, in consultation with NMFS and USFWS. The BE provides detailed descriptions and analysis of the potential impacts to all threatened or endangered species and critical habitats protected under the ESA.

Critical Habitat. The potential effects of the Proposed Action on the habitat of ESA-designated species within the NWTRC are analyzed in the BE two ways: first, using a matrix of pathways approach developed by NMFS (1996) and USFWS (1998), and second, using an approach that relies upon habitat primary constituent elements (PCEs).

The matrix of pathways analysis indicates implementation of Alternative 1 could improve baseline environmental conditions, as Table 3.7-10 presents.

The second method of analysis, the PCE method, determines whether Navy activities are likely to substantially change one or more of the biological, physical, or chemical elements essential for the conservation of the fish species and habitat. PCEs are defined for each species in the Federal Register at the time the species is ESA-listed. The BE provides detailed descriptions of the PCEs for each fish species analyzed; Table 3.7-11 provides a summary of the results of the PCE analysis.

Table 3.7-10: Summary of Alternative 1 Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area

Pathway	Indicator	Effects of Alternative 1
Water Quality	Turbidity, Dissolved Oxygen, Water Contamination/Nutrients, Sediment Contamination.	Implementation of Alternative 1 would maintain off shore baseline water quality conditions. Implementation of Alternative 1 has the potential to restore existing near shore environmental baseline conditions due to the >90% reduction in underwater detonation activities.
Physical Habitat Features	Substrate/Armoring, Depth/Slope, Tideland Conditions, Marsh Prevalence, Refugia, Physical Barriers, Current Patterns, Salt/Fresh Water Mixing Patterns and Locations.	Implementation Alternative 1 would maintain existing environmental baseline conditions for fish habitat.
Biological Habitat Features	Fish Prey Availability, Forage Fish Community, Aquatic Vegetation, Exotic Species.	Implementation of Alternative 1 would maintain existing environmental baseline conditions for prey availability, forage fish community, aquatic vegetation and exotic species. Underwater detonations and ordnance use would result in potential injury or mortality to individual fish, prey, and forage fish.

Table 3.7-11: Summary of Alternative 1 Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area

Species and Critical Habitat Designation Location	PCE Source (Federal Register)	Effect	Basis for Effect Determination
Chinook Salmon California Coastal ESU, California	FR 70(170):52537; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine PCEs.
Chinook Salmon Puget Sound ESU, Washington Chinook Salmon Lower Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas; Navy training will occur in critical habitats but will not substantially affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Steelhead Trout Northern California ESU Steelhead Trout Central California Coastal ESU, California	FR 70(170):52537; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine PCEs.
Steelhead Trout Lower Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.

Table 3.7-9: Summary of Alternative 1 Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area (cont'd)

Species and Critical Habitat Designation Location	PCE Source (Federal Register)	Effect	Basis for Effect Determination
Chum Salmon Hood Canal ESU Washington Chum Salmon Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas; Navy training will occur in critical habitats but will not substantially affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Coho Salmon Oregon Coast ESU, Oregon	FR 73(28):7832; (2/11/08)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Coho Salmon Northern California-Southern Oregon Coasts ESU, California and Oregon	FR 64(86): 24050, 24053, 24059; (5/5/99)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater and riparian components of critical habitat areas and will not adversely affect the designated PCEs.
Bull Trout Coastal Puget Sound, Washington (CHU 28) Bull Trout Olympic Peninsula River Basins Washington (CHU 27)	FR 70(185):56266; (9/26/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will occur in the critical habitat area, but the level of activity would be too small to substantially affect the PCEs; DOD lands where the most intensive Navy training and other activities will occur are excluded from critical habitat designation, thereby further reducing total effects on the PCEs.
Green Sturgeon Southern DPS	FR 73(174):52084; (9/8/08)	No destruction or adverse modification of designated critical habitat	Navy training activities and operations will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.

Based on the matrix of pathways analysis, implementation of Alternative 1 would maintain (or potentially improve, since there would be fewer underwater detonations under Alternative 1 than current conditions) baseline water quality, and maintain physical and biological habitat features. Based on the PCE analysis, implementation of Alternative 1 would result in no destruction or adverse modification of designated critical habitat. Based analysis methods presented in Section 3.7.2.4, physical injury to fish could occur within the distances of a detonation site shown in Tables 3.7-5 and 3.7-6. Fish injury and mortality from explosions are reduced by Navy protective measures, as discussed in Section 3.7.1.6.

As previously stated, the June 2008 NMFS Biological Opinion for Navy EOD Operations concluded that EOD activities are not likely to adversely modify critical habitat of Puget Sound Chinook salmon or Hood Canal summer-run chum salmon (NMFS 2008). The USFWS also considered habitat in their analysis of EOD activities impacts on bull trout. Based on the agency findings and the PCE analysis presented above, the Navy finds the NWTRC activities associated with implementation of Alternative 1 would result in no destruction or adverse modification of designated critical habitat.

Essential Fish Habitat

Under Alternative 1, increased vessel movement and aircraft over-flights would cause brief, reversible disruptions in fish distribution. Additional expended materials are not expected to measurably increase exposure to toxic chemicals, through contact with or ingestion of debris, or from entanglement. The quantity of material expended over a large area, combined with the rapid dilution of dissolved constituents, the relatively non-toxic nature of the debris, and its eventual encrustation and incorporation into the sediments, would minimize adverse affects on resident marine communities.

Underwater detonations and weapons training could kill or injure marine life, affect hearing organs, modify behavior, and have indirect effects on prey species and other components of the food web. Under Alternative 1, annual underwater detonations would be decreased by >90%. Beyond the range of direct, lethal or sub-lethal impacts to individual fish, minor, short-term behavioral reactions would not be ecologically substantial. No lasting adverse effect of underwater detonations or weapons training on prey availability or on the food web is expected.

Most munitions used in the NWTRC would not have explosive warheads. The shock force from inert bombs and missiles hitting the sea surface would not substantially affect local species or habitats. Munitions use is not anticipated to have adverse regional consequences.

The EFH assessment concludes that vessel movements, aircraft overflights, underwater detonations and explosive ordnance use, sonar activities, non-explosive ordnance use, weapons firing disturbance, expended materials, and target related materials under Alternative 1 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA.

3.7.2.5 Alternative 2, the Preferred Alternative

Under Alternative 2, the general level of activities in the NWTRC Study Area would increase relative to the baseline No Action Alternative.

Vessel Movements

As described for the other alternatives, the number of Navy vessels operating during training exercises varies and would average one vessel per exercise. During a year of activities, steaming hours would increase, relative to current conditions, by 10 percent to 7,628 hours. Vessel movements would be widely dispersed throughout the OPAREA, with approximately 0.06 hours of steaming per nm^2.

The small increase in steaming hours would not measurably increase potential effects to fish. Disturbance impacts to fish from vessel movements under Alternative 2 would be the same as those described for the No Action Alternative, and Alternative 1.

Vessel movements under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, vessel movements in territorial waters under Alternative 2 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from vessel movements in non-territorial waters would be minimal in accordance with EO 11214.

Aircraft Overflights

Under Alternative 2, 10,582 overflights would occur annually which would represent a 54 percent increase over current conditions. As described for the other alternatives, the majority of these overflights would occur over marine environments of the NWTRC, at elevations in excess of 3,000 ft above sea level, and beyond 12 nm.

Under Alternative 1, overflights would produce an annual distribution of 0.086 overflights per square nautical mile over the NWTRC. This modest increase in potential exposure to visual and noise disturbance would not measurably increase effects to fish populations over existing conditions. Thus, the impacts of overflights under Alternative 2 would be the same as those for the No Action Alternative and Alternative 1.

Aircraft overflights under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under MSFCMA. In accordance with NEPA, aircraft overflights in territorial waters under the Alternative 2 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from aircraft overflights in non-territorial waters would be minimal in accordance with EO 11214.

Underwater Detonations and Explosive Ordnance

Underwater explosions that occur in the offshore areas of the NWTRC are associated with explosive ordnance use. As shown in Table 2-9, under Alternative 2, approximately 144 bombs, 57 missiles, and 9,651 sonobuoys (includes 149 explosive sonobuoys) would be used in the OPAREA training area each year. This would produce a very low density of offshore explosions per year in the Study Area of less than 0.003 explosions per nm^2. Explosive ordnance use under Alternative 2 would increase over baseline conditions, as described in Chapter 2. Fish exposed to underwater explosions would suffer temporary effects, sub-lethal or lethal injuries, or direct mortality, in proportion to the proximity to the explosion and size of the detonation.

Underwater detonations under Alternative 2 would be the same as under Alternative 1; underwater detonations under Alternative 2 would be approximately 93 percent less than the No Action Alternative.

Impacts to fish from explosions would be possible, but have a low potential for occurrence. Habitat disturbance and fish injury and mortality from explosions are reduced by Navy mitigation measures, as discussed in Section 3.7.1.6. While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of underwater detonations and high explosive ordnance use, explosions under the Alternative 2 would not result in impacts to fish populations based on the low number of fish that would be affected. Disturbances to water column and benthic habitats from explosions would be short-term and localized. The Navy conducts a limited number of training activities over a large area (112,400 nm^2 [430,000 km^2]).

Sonar

Under Alternative 2, sonar would have the potential to affect fish in the Study Area. Most fish species would be able to detect mid-frequency sonar at the lower end of its range. Short-term behavioral responses such as startle and avoidance may occur, but are not likely to adversely affect indigenous fish communities. Auditory damage from sonar signals is not expected and there is no indication that non-impulsive acoustic sources result in fish mortality. Sonar use under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, sonar use in territorial waters under the Alternative 2 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from sonar use in non-territorial waters would be minimal in accordance with EO 11214.

Non-Explosive Ordnance Use

Under Alternative 2, non-explosive ordnance would increase (approximately 200%) above current baseline conditions. The Navy conducts training activities over a large area; as such, the rate of ordnance use would result in a spent ordnance density of approximately 0.44 pieces per nm^2 in the OPAREA. This increase in potential exposure would not measurably increase effects to fish. Thus, the impacts of non-explosive ordnance use on fish would be essentially the same as those for the No Action Alternative and Alternative 1.

Impacts to fish from non-explosive ordnance use would be possible, but have a low potential for occurrence. Habitat disturbance as well as fish injury and mortality are reduced by Navy mitigation measures, as discussed in Section 3.7.1.6. While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of non-explosive ordnance use, implementation of Alternative 2 would not result in impacts to fish populations based on the low number of fish that would be affected. Disturbances to water column and benthic habitats from non-explosive ordnance use would be short-term and localized. Non-explosive ordnance use under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, non-explosive ordnance use in territorial waters under the Alternative 2 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from non-explosive ordnance use in non-territorial waters would be minimal in accordance with EO 11214.

Weapons Firing Disturbance

Under Alternative 2, weapons firing activities would continue, but because fish apparently only react to impulsive sounds greater than 160 dB, only those in the immediate vicinity (0.015 km^2 area) would be affected and effects would be limited to short-term, transitory alarm or startle responses. The impacts to fish would be the same as those described for the No Action Alternative.

Under the Alternative 2, weapons firing may affect fish, but this affect would be minimal. Weapons firing under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, these activities would have minimal impact on fish in territorial waters. Furthermore, harm to fish from weapons firing would not be likely in non-territorial waters in accordance with EO 12114.

Expended Materials

Under Alternative 2, the expended materials in the study area would increase over current baseline conditions by approximately 93 percent. The Navy conducts training activities over a large area; as such, the rate of ordnance use would result in an annual spent ordnance density of approximately 1.5 pieces per nm^2 in the OPAREA. This increase in potential exposure would not measurably increase effects to fish. Thus, the impacts of expended materials on fish would be similar to those for the No Action Alternative and Alternative 1. The use of targets would be the same as Alternative 1.

Under Alternative 2, ingestion of expended materials is possible, but has a low potential for occurrence, as described for the No Action Alternative. Expended materials under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. In accordance with NEPA, expended materials in territorial waters under the Alternative 2 would not have considerable impact on fish populations or habitat. Furthermore, harm to fish populations or habitat from expended materials in non-territorial waters would be minimal in accordance with EO 11214.

Threatened and Endangered Species and Species of Concern

Threatened and Endangered Species. As discussed in Section 3.7.1.4, species of ESA-designated salmonids with known or potential occurrence in the NWTRC include: chinook, coho, and chum salmon; and steelhead and bull trout. Chinook, coho, and chum salmon; and steelhead trout are under the jurisdiction of NMFS. Bull trout are under the jurisdiction of USFWS. Both Northern and Southern DPS green sturgeon occupy coastal estuaries and coastal marine waters in the NWTRC. Green sturgeon are under the jurisdiction of NMFS.

Underwater detonations under Alternative 2 would be similar to those analyzed by NMFS and USFWS for Navy EOD Operations, Puget Sound. The June 2008 NMFS Biological Opinion states "the National Marine Fisheries Service concludes that the proposed action is not likely to jeopardize the continued existence of the Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*), Hood Canal summer-run chum salmon (*O. keta*), Puget Sound steelhead (*O. mykiss*), or southern resident killer whales (*Orcinus orca*); and not likely to adversely modify critical habitat for Puget Sound Chinook salmon, Hood Canal summer-run chum salmon or southern resident killer whales."

The November 2008 USFWS Biological Opinion determined that these EOD training activities would result in the incidental take in the form of harm (through death or physical injury from the direct effects of the pressure wave resulting from detonation of the explosive during the EOD training) to a total of five juvenile, sub-adult or adult bull trout in the Crescent Harbor action area. The USFWS Biological Opinion concluded that this level of anticipated take is not likely to jeopardize the continued existence of the bull trout. USFWS also stated that "…no reasonable and prudent measure(s) are necessary and appropriate to minimize impacts of incidental take of bull trout. Measures that are designed to minimize impacts to bull trout have been incorporated by the Navy…" The terms and conditions included in USFWS' Biological Opinion require Navy to monitor the impacts of the incidental take.

The findings of these Biological Opinions have been used in the analysis for this EIS/OEIS. Utilizing criteria and analysis methodology as presented previously for non-listed species, vessel movements, aircraft overflight, underwater detonations, explosive ordnance use, sonar, non-explosive ordnance use, weapons firing, and expended materials may affect individual ESA-listed fish in the NWTRC. However, these activities would not have community or population level effects.

As part of the EIS/OEIS process, Navy has prepared a BE for the NWTRC for use, as appropriate, in consultation with NMFS and USFWS. The BE provides detailed descriptions and analysis of the potential impacts to all threatened or endangered species and critical habitats protected under the ESA.

Critical Habitat. The potential effects of the Proposed Action on the habitat of ESA-designated species within the NWTRC are analyzed in the BE two ways: first, using a matrix of pathways approach developed by NMFS (1996) and USFWS (1998), and second, using an approach that relies upon habitat primary constituent elements (PCEs).

Based on the matrix of pathways analysis, implementation of Alternative 2 would maintain (or potentially improve, since there would be fewer underwater detonations under Alternative 2 than current conditions) baseline water quality, and maintain physical and biological habitat features, as Table 3.7-12 presents. Based on the PCE analysis, implementation of Alternative 2 would result in no destruction or adverse modification of designated critical habitat (Table 3.7-13). Based analysis methods presented in Section 3.7.2.4, physical injury to fish could occur within the distances of a detonation site shown in Tables 3.7-5 and 3.7-6. Fish injury and mortality from explosions are reduced by Navy protective measures, as discussed in Section 3.7.1.6.

As previously stated, the June 2008 NMFS Biological Opinion for Navy EOD Operations concluded that EOD activities are not likely to adversely modify critical habitat of Puget Sound Chinook salmon or Hood Canal summer-run chum salmon (NMFS 2008). The USFWS also considered habitat in their analysis of EOD activities impacts on bull trout. Based on the agency findings and the PCE analysis presented above, the Navy finds the NWTRC activities associated with implementation of Alternative 2 would result in no destruction or adverse modification of designated critical habitat

Table 3.7-12: Summary of Alternative 2 Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area

Pathway	Indicator	Effects of Alternative 2
Water Quality	Turbidity, Dissolved Oxygen, Water Contamination/Nutrients, Sediment Contamination	Implementation of Alternative 2 would maintain off shore baseline water quality conditions. Implementation of Alternative 2 has the potential to restore existing near shore environmental baseline conditions due to the >90% reduction in underwater detonation activities.
Physical Habitat Features	Substrate/Armoring, Depth/Slope, Tideland Conditions, Marsh Prevalence, Refugia, Physical Barriers, Current Patterns, Salt/Fresh Water Mixing Patterns and Locations	Implementation Alternative 2 would maintain existing environmental baseline conditions for fish habitat.
Biological Habitat Features	Fish Prey Availability, Forage Fish Community, Aquatic Vegetation, Exotic Species	Implementation of Alternative 2 would maintain existing environmental baseline conditions for prey availability, forage fish community, aquatic vegetation and exotic species. Underwater detonations and ordnance use would result in potential injury or mortality to individual fish, prey, and forage fish.

Table 3.7-13: Summary of Alternative 2 Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area

Species and Critical Habitat Designation Location	PCE Source (Federal Register)	Effect	Basis for Effect Determination
Chinook Salmon California Coastal ESU, California	FR 70(170):52537; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine PCEs.
Chinook Salmon Puget Sound ESU, Washington Chinook Salmon Lower Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas; Navy training will occur in critical habitats but will not substantially affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Steelhead Trout Northern California ESU Steelhead Trout Central California Coastal ESU, California	FR 70(170):52537; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine PCEs.
Steelhead Trout Lower Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.

Table 3.7-9: Summary of Alternative 1 Effects of Proposed NWTRC Activities on Fish Habitat Elements within or in the Vicinity of the NWTRC Study Area (cont'd)

Species and Critical Habitat Designation Location	PCE Source (Federal Register)	Effect	Basis for Effect Determination
Chum Salmon Hood Canal ESU Washington Chum Salmon Columbia River ESU, Washington/Oregon	FR 70(170):52684; (9/2/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas; Navy training will occur in critical habitats but will not substantially affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Coho Salmon Oregon Coast ESU, Oregon	FR 73(28):7832; (2/11/08)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.
Coho Salmon Northern California-Southern Oregon Coasts ESU, California and Oregon	FR 64(86): 24050, 24053, 24059; (5/5/99)	No destruction or adverse modification of designated critical habitat	Navy training activities will not occur in the freshwater and riparian components of critical habitat areas and will not adversely affect the designated PCEs.
Bull Trout Coastal Puget Sound, Washington (CHU 28) Bull Trout Olympic Peninsula River Basins Washington (CHU 27)	FR 70(185):56266; (9/26/05)	No destruction or adverse modification of designated critical habitat	Navy training activities will occur in the critical habitat area, but the level of activity would be too small to substantially affect the PCEs; DOD lands where the most intensive Navy training and other activities will occur are excluded from critical habitat designation, thereby further reducing total effects on the PCEs.
Green Sturgeon Southern DPS	FR 73(174):52084; (9/8/08)	No destruction or adverse modification of designated critical habitat	Navy training activities and operations will not occur in the freshwater components of critical habitat areas and will not adversely affect the designated estuarine, nearshore marine, and offshore marine PCEs.

Essential Fish Habitat

Under Alternative 2, increased vessel movement and aircraft over-flights would cause brief, reversible disruptions in fish distribution. Additional expended materials are not expected to measurably increase exposure to toxic chemicals, through contact with or ingestion of debris, or from entanglement. The quantity of material expended over a large area, combined with the rapid dilution of dissolved constituents, the relatively non-toxic nature of the debris, and its eventual encrustation and incorporation into the sediments, would minimize adverse affects on resident marine communities.

Underwater detonations and weapons training could kill or injure marine life, affect hearing organs, modify behavior, and have indirect effects on prey species and other components of the food web. Under Alternative 2, annual underwater detonations would be decreased by more than 90%. Beyond the range of direct, lethal or sub-lethal impacts to individual fish, minor, short-term behavioral reactions would not be ecologically substantial. No lasting adverse effect of underwater detonations or weapons training on prey availability or on the food web is expected.

Most munitions used in the NWTRC would not have explosive warheads. The shock force from inert bombs and missiles hitting the sea surface would not substantially affect local species or habitats. Munitions use is not anticipated to have adverse regional consequences.

The EFH assessment concludes that vessel movements, aircraft overflights, underwater detonations and explosive ordnance use, sonar activities, non-explosive ordnance use, weapons firing disturbance, expended materials, and target related materials under Alternative 2 would not result in adverse effects to fish populations or EFH as defined under the MSFCMA.

3.7.3 Mitigation Measures

As summarized in Section 3.7.4, the alternatives proposed in the EIS/OEIS would be expected to affect individual fish and have localized affects on their habitats, but would not affect communities or populations of species or their use of the NWTRC. The current protective measure described in Chapter 5 would continue to be implemented; and no further mitigation measures would be needed to protected fish in the NWTRC.

3.7.4 Summary of Effects by Alternative

Table 3.7-14 presents a summary of effects on fish and EFH for the No Action, Alternative 1, and Alternative 2.

Table 3.7-14: Summary of Effects – Fish and Essential Fish Habitat

Alternative	NEPA (Inland Waters and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Aircraft overflight, weapons firing disturbance, and expended materials associated with the No Action Alternative would result in minimal effects to fish and EFH. • Because only a few species of fish may be able to hear the relatively higher frequencies of mid-frequency sonar, effects of sonar used in Navy exercises on fish and EFH are minimal. • Effects of non-explosive ordnance use on fish populations or EFH would be minimal. • Explosive ordnance use may result in injury or mortality to individual fish but would not result in impacts to fish populations. Baseline environmental conditions of critical habitat would remain the same. The No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. • Underwater explosions may affect ESA-listed fish species.	• Aircraft overflight, weapons firing disturbance, and expended materials would result in minimal harm to fish or EFH. • Because only a few species of fish may be able to hear the relatively higher frequencies of mid-frequency sonar, sonar used in Navy exercises would result in minimal harm to fish or EFH. • Non-explosive ordnance use would result in minimal harm to fish populations or EFH. • Explosive ordnance use may result in injury or mortality to individual fish but would not result in impacts to fish populations. Baseline environmental conditions of critical habitat would remain the same. • No effect to threatened and endangered species or critical habitat.
Alternative 1	• Impacts similar to those described in the No Action Alternative. Environmental conditions of critical habitat would be improved compared to current baseline conditions, since underwater detonations would be reduced from current conditions by greater than 90 percent.	• Impacts similar to those described in the No Action Alternative.
Alternative 2 (Preferred Alternative)	• Impacts similar to those described in the No Action Alternative. Environmental conditions of critical habitat would be improved compared to current baseline conditions, since underwater detonations would be reduced from current conditions by greater than 90 percent.	• Impacts similar to those described in the No Action Alternative.

3.8 Sea Turtles

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3.8 SEA TURTLES

Sea turtles are long-lived reptiles that can be found throughout the world's tropical, subtropical, and temperate seas (CCC 2008). There are seven living species of sea turtles from two taxonomic families, the Cheloniidae (hard-shelled sea turtles six species) and the Dermochelyidae (leatherback turtles; one species). All sea turtles are listed under the Endangered Species Act (ESA).

Sea turtles are highly adapted for life in the marine environment. Sea turtles possess powerful, modified forelimbs (or flippers) that enable them to swim continuously for extended periods of time (Wyneken 1997). Sea turtles are among the longest and deepest diving of the air-breathing marine vertebrates, spending as little as three to six percent of their time at the water's surface (Lutcavage and Lutz 1997). Sea turtles often travel thousands of miles between their nesting beaches and feeding grounds (Ernst et al. 1994; Meylan 1995). Sea turtles cannot withdraw their head or limbs into their shell, so growing to a large size as adults is important to avoid predation.

Although they are specialized for life at sea, sea turtles begin their lives on land. Aside from this brief terrestrial period, which lasts approximately three months during egg incubation and hatching, sea turtles are rarely encountered out of the water. Sea turtles bask on the water surface to regulate their body temperatures, elude predators, possibly accelerate the development of their eggs, and destroy aquatic algae growth on their shells, known as carapaces (Whittow and Balazs 1982; Spotila et al. 1997). Mature females return to land to nest (Carr 1995; Spotila et al. 1997). Occasionally, sea turtles can also end up on the shore if they are dead, sick, injured, or cold-stressed. These events, known as strandings, can be caused by either biological factors (e.g., predation and disease) or environmental factors (e.g., water temperature).

The distribution of sea turtles in ocean waters off the U.S. west coast is strongly affected by seasonal changes in water temperature. Throughout much of the year, the Pacific coast of North America experiences cool water temperatures (less than 68°F [20°C]). Sea turtles are far less abundant in cool water temperatures than in warm waters (i.e., off southern California and Hawaii). Cool water temperatures also prevent sea turtles from nesting on U.S. west coast beaches and may also inhibit reproductive activity by reducing the quality and availability of food resources in the area (Fuentes et al. 2000). The northernmost known nesting sites of leatherbacks and olive ridley sea turtles in the eastern Pacific Ocean occur along the coast of Baja California (Fritts et al. 1982; Sarti-M. et al. 1996; López-Castro et al. 2000).

Over the last few centuries, sea turtle populations have declined dramatically because of human activities such as coastal development, oil exploration, commercial fishing, marine-based recreation, pollution, and over-harvesting (Natural Research Council 1990, Eckert 1995). As a result, all four species of sea turtles found in Northwest Training Range Complex (NWTRC) waters are currently listed as either threatened or endangered under the ESA. However, only the leatherback sea turtle occurs with any regularity in the open ocean portion of the NWTRC, referred to as the PACNW OPAREA. As such, this EIS/OEIS contains impact analysis for only the leatherback sea turtle. Although members of the Cheloniidae family occur in the warm, subtropical areas of southern California and Hawaii, the PACNW OPAREA is considered beyond their normal range of occurrence because of cold water temperatures. Although sightings of these species in the Study Area have been documented, most of these involve individuals that were either cold-stressed, likely to become cold-stressed, or already deceased (Hodge and Wing 2000; McAlpine et al. 2002). Thus, the PACNW OPAREA is considered to be outside the normal range for species of the Cheloniidae family, and they are not considered further for analysis in this EIS/OEIS.

The issues of concern for sea turtles include potential effects of sounds in the water, and impacts related to vessel movements, ordnance use, and possible entanglement or contact with expended materials that are not recovered. The analysis of effects addresses these issues by grouping effects based on activities with common components such as vessel movement, ordnance use, and debris release.

3.8.1 Affected Environment

In general, sea turtle sightings off the U.S. west coast peak during July through September and in abnormally warm water years such as in El Niño years. During El Niño years, changes in ocean currents bring warmer waters north, which can bring more sea turtles (and their preferred prey) to the region (NMFS 2003). There is no known sea turtle nesting in the NWTRC Study Area.

3.8.1.1 Species Accounts and Life History

Leatherback Turtle (*Dermochelys coriacea*)

The leatherback is the only species of sea turtle expected to occur regularly in the Study Area. The leatherback, which is the largest living sea turtle, has a unique carapace structure. The carapace lacks the outer layer of bony external plates or scales possessed by all other sea turtles. Instead, it is composed of a flexible layer of dermal bones underlying tough, oily connective tissue and smooth skin. The body of a leatherback is barrel-shaped, tapered to the rear, with seven longitudinal dorsal ridges; the body is almost completely black with variable spotting (McDonald and Dutton 1996). Carapace lengths in adults range from about 50 to 70 inches (1.2 to 1.8 meters), with an average around 57 inches (1.4 meters). Adult leatherbacks weigh between 450 and 1,575 pounds (200 to 700 kilograms) (NMFS and USFWS 1998b).

The leatherback turtle was listed under the ESA as endangered throughout its range in June 1970. Critical habitat has not been identified for this species in the Pacific, largely because no nesting areas or important foraging areas have been identified in the Pacific (NMFS and USFWS 1998). As such, there is no designated critical habitat in the NWTRC Study Area for the leatherback turtle. However, because of the high potential for interactions between leatherback turtles and drift gillnet fisheries off the U.S. west coast during periods of warmer water, the NMFS has designated the eastern north Pacific Ocean area shown in Figure 3.9-1 as a Pacific Leatherback Conservation Zone, which has been proposed for critical habitat designation (Center for Biological Diversity et al. 2007). Within the Conservation Zone from August 15 through November 15 every year, fishing with drift gillnets with a mesh size equal to or greater than 14 inches (36 centimeters) is prohibited. The Conservation Zone is roughly located between Point Conception, California (34 27’N) and northern Oregon (45 N), and is described fully in 50 CFR 660.713(c). The Pacific Leatherback Conservation Zone provides this species with a strong level of protection from gillnets at the time of the year when they are known to reside off the U.S. west coast.

In December 2007, the NMFS issued a 90-day finding, concluding sufficient evidence had been provided by the petitioners (Center for Biological Diversity et al. 2007) to warrant revising critical habitat for the leatherback turtle to include the Conservation Zone (NMFS 2007). There is a recovery plan for this species (NMFS and USFWS 1998).

Leatherbacks are seriously declining at all major Pacific basin nesting beaches, including those in Indonesia, Malaysia, and southwestern Mexico (NMFS and USFWS 1998b). Lewison et al. (2004) estimated that more than 50,000 leatherbacks were taken worldwide as pelagic longline bycatch in 2000, and that thousands of these turtles die each year from longline gear interactions in the Pacific Ocean. Incidental capture of leatherbacks by the north Pacific high seas driftnet fleet, which targets squid and tuna, was also a source of mortality during the 1980s and early 1990s (Eckert 1993).

The leatherback turtle is distributed globally in tropical and subtropical waters throughout the year. Individuals will often move into cooler temperate and sometimes cold northern waters during late summer and early fall (Keinath and Musick 1990; James et al. 2005b).

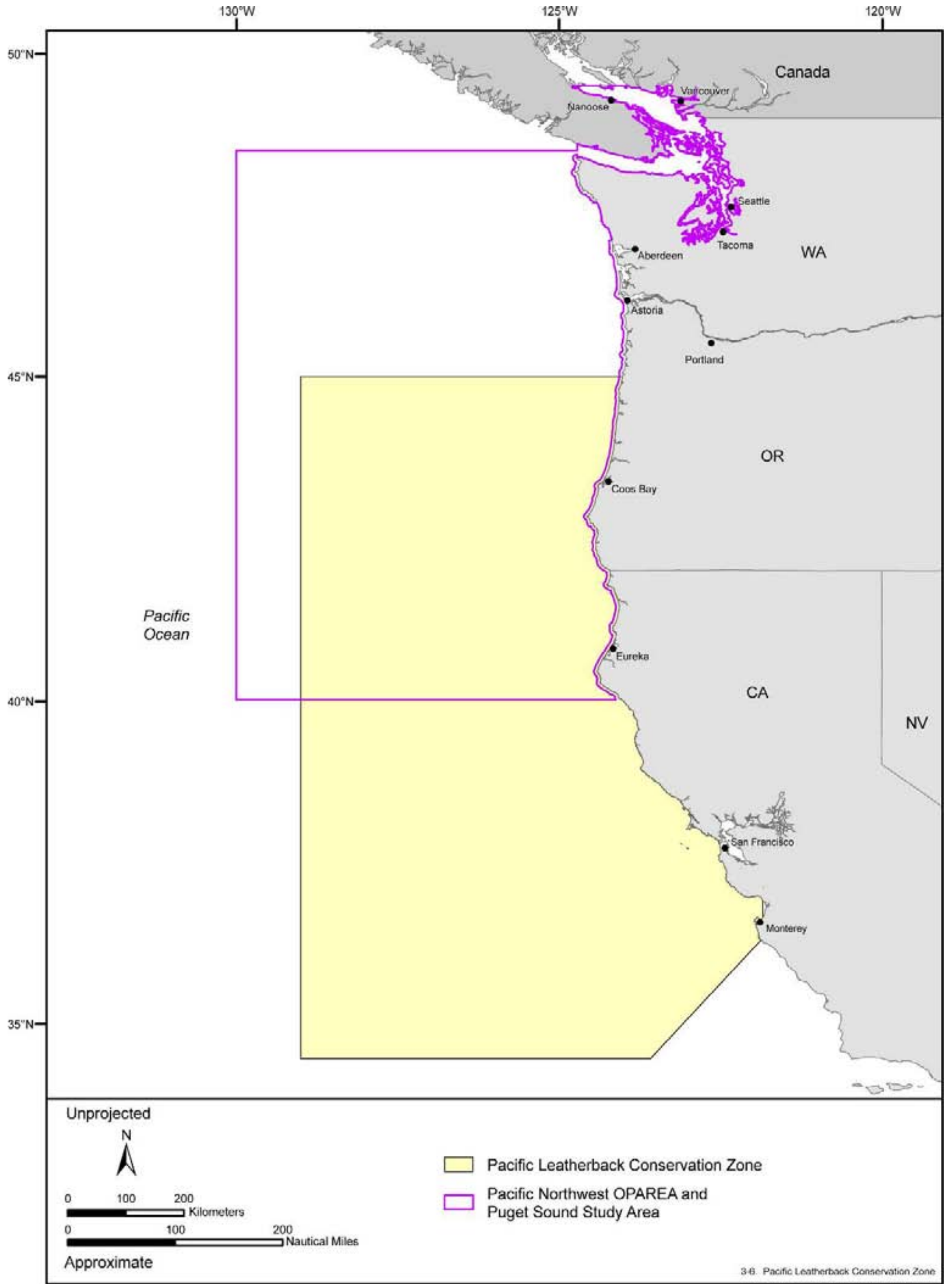

Figure 3.8-1: Location of the Pacific Leatherback Conservation Zone off the Coasts of California and Oregon

Of the seven living species of sea turtles, the leatherback is the most oceanic and has the widest range (Boulon et al. 1988). This can be attributed to the turtle's thermoregulatory capabilities, which enable leatherbacks to maintain body core temperatures well above the ambient water temperatures (Mrosovsky and Pritchard 1971; Greer et al. 1973; Neill and Stevens 1974; Goff and Stenson 1988; Paladino et al.

1990). As a result, they are more capable of surviving for extended periods of time in cooler waters than the hard-shelled sea turtles (Bleakney 1965; Lazell 1980).

Leatherback turtles primarily feed on gelatinous zooplankton such as cnidarians (jellyfish and siphonophores) and tunicates (salps and pyrosomas) (Bjorndal 1997; NMFS and USFWS 1998b). They have also been known to ingest longline hooks used to catch tuna and swordfish (Davenport and Balazs 1991; Skillman and Balazs 1992; Grant 1994; Work and Balazs 2002).

The leatherback is one of the deepest divers in the ocean, with dives deeper than 3,200 feet (975 meters) (Eckert et al. 1988). The leatherback dives continually and spends short periods of time on the surface between dives (Eckert et al. 1986; Southwood et al. 2003). Typical dive durations averaged 6.9 to 14.5 minutes per dive, with a maximum of 42 minutes (Eckert et al. 1996). During migrations or long distance movements, leatherbacks maximize swimming efficiency by traveling within 15 feet (5 meters) of the surface (Eckert 2002).

Historically, some of the world's largest nesting populations of leatherback turtles were found in the Pacific Ocean, although nesting on Pacific beaches under U.S. jurisdiction has always been rare (NMFS and USFWS 1998b). The northernmost nesting sites in the eastern Pacific Ocean are located in the Mexican states of Baja California Sur and Jalisco (Fritts et al. 1982). Other principal nesting sites in the Pacific Ocean indicate that gene flow between eastern and western Pacific nesting populations is restricted (Dutton et al. 1998, 1999, 2000a, 2000b).

In the northern Pacific Ocean, leatherback turtles are broadly distributed from the tropics to as far north as Alaska, where 19 occurrences were documented between 1960 and 2001 (Eckert 1993; Wing and Hodge 2002). After analyzing 363 records of sea turtles sighted along the Pacific coast of North America (from northern Mexico, northward), Stinson (1984) concluded that the leatherback was the most common sea turtle in eastern Pacific waters north of Mexico. Aerial surveys off the coasts of California, Oregon, and Washington have shown that most leatherback turtles occur in continental slope waters. (Green et al. 1992, 1993; Bowlby et al. 1994). Leatherbacks have also been sighted in shelf edge waters off Newport, Oregon, and Humboldt Bay, California (Smith and Houck 1984).

NMFS has indicated that during warm months, leatherbacks have the potential to occur in inshore waters of the Puget Sound. Stinson (1984) and McAlpine et al. (2004) reported inshore sightings of leatherbacks from waters as far north as Vancouver Island, British Columbia, and Cordova, Alaska. More recent studies (Dutton et al. 2000; Benson et al. 2007a, 2007b) have established that leatherbacks found off the U.S. west coast are part of the western Pacific population, which nests in Indonesia, Papua New Guinea, the Solomon Islands, and Vanuatu. The generalized migration of leatherback turtles in the northern Pacific Ocean is shown in Figure 3.8-2.

The western Pacific leatherback population was recently estimated to contain 2,700 to 4,500 nesting females (Dutton et al. 2007). A subset of these females, and an unknown number of males, forage off the U.S. west coast each year from about May to November, when dense aggregations of jellyfish (leatherback prey) are present (Benson et al. 2007a, 2007b). Foraging abundance estimates are only available for nearshore waters off California, where the estimated minimum leatherback abundance has ranged from 12 to 379 individuals per year, based on aerial surveys.

The PACNW OPAREA is an area of regular leatherback occurrence during the warm summer months. They forage on jellyfish while enroute to their nesting grounds on western Pacific island chains. The number of leatherback potentially occurring in the Study Area has not been estimated, but is expected to be less than that found to the south in warmer waters.

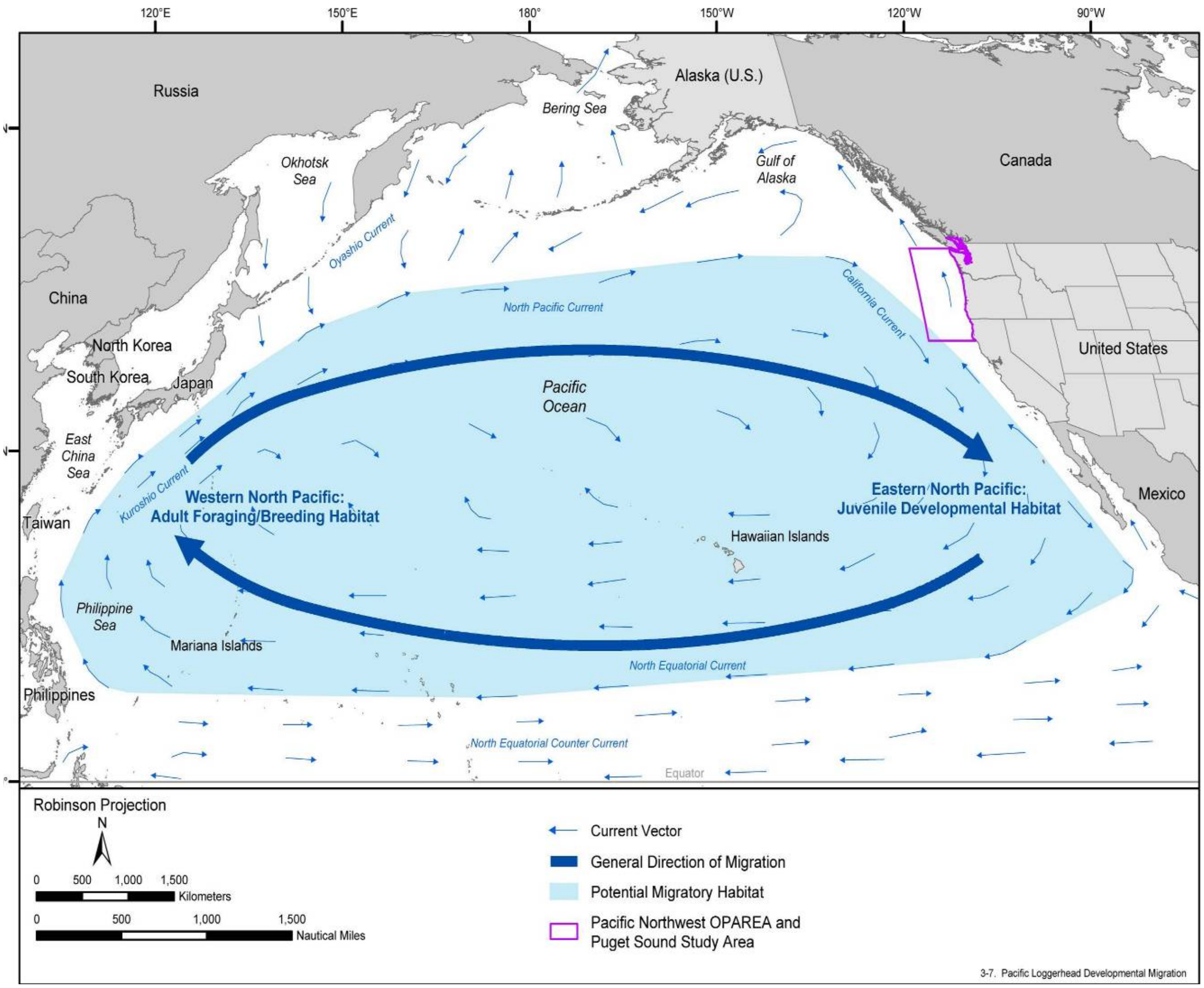

Figure 3.8-2: The Generalized Migration of Leatherback Turtles in the Northern Pacific Ocean

3.8.1.2 Sea Turtle Hearing

Sea turtles do not have an ear or eardrum. Instead, they have a cutaneous layer and underlying subcutaneous fatty layer that function as a tympanic membrane. The subcutaneous fatty layer receives and transmits sounds to the middle ear and into the cavity of the inner ear (Ridgway et al., 1969). Sound also arrives by bone conduction through the skull.

Little is known about the role of sound and hearing in sea turtle survival and only rudimentary information is available about responses to man-made noise. Sea turtles appear to be most sensitive to low frequencies. The effective hearing range for marine turtles is generally considered to be between 100 and 1000 Hz (Bartol et al. 1999; Lenhardt 1994; Moein et al. 1994; Ridgway et al., 1969). Hearing thresholds below 100 Hz were found to increase rapidly (Lenhardt 1994). Additionally, calculated in-water hearing thresholds at best frequencies (100 to 1000 Hz) appear to be high— 160 to 200 dB re 1µPa (Lenhardt 1994; Moein et al. 1994).

Sea turtle auditory capabilities and sensitivity is not well studied, though a few investigations suggest that it is limited to low-frequency bandwidths, such as the sounds of waves breaking on a beach. The role of underwater low-frequency hearing in sea turtles is unclear. It has been suggested that sea turtles may use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Lenhardt et al. 1983).

Ridgway et al. (1969) used aerial and mechanical stimulation to measure the cochlea in three specimens of green turtle, and concluded that they have a useful hearing span of perhaps 60 to 1,000 Hz, but hear best from about 200 Hz up to 700 Hz, with their sensitivity falling off considerably below 200 Hz. The maximum sensitivity for one animal was at 300 Hz, and for another was at 400 Hz. At the 400 Hz frequency, the turtle's hearing threshold was about 64 dB in air (approximately 126 dB in water). At 70 Hz, it was about 70 dB in air (approximately 132 dB in water). These values probably apply to all four of the hard-shell turtles (i.e., the green, loggerhead, hawksbill, and Kemp's ridley turtles). No audiometric data are available for the leatherback sea turtle, but based on other sea turtle hearing capabilities, they probably also hear best in the low frequencies.

Lenhardt et al. (1983) also applied audio-frequency vibrations at 250 Hz and 500 Hz to the heads of loggerheads and Kemp's ridleys submerged in salt water to observe their behavior, measure the attenuation of the vibrations, and assess any neural-evoked response. These stimuli (250 Hz, 500 Hz) were chosen as representative of the lowest sensitivity area of marine turtle hearing (Wever 1978). At the maximum upper limit of the vibratory delivery system, the turtles exhibited abrupt movements, slight retraction of the head, and extension of the limbs in the process of swimming. Lenhardt et al. (1983) concluded that bone-conducted hearing appears to be a reception mechanism for at least some of the sea turtle species, with the skull and shell acting as receiving surfaces.

A recent study on the effects of airguns on sea turtle behavior also suggests that sea turtles are most likely to respond to low-frequency sounds (McCauley et al. 2000). The pressure level is measured at a standard reference point such as 1 meter with a reference pressure of 1 µPa at 1 m (i.e., re 1 µPa-m). Green and loggerhead sea turtles will avoid air-gun arrays at 2 km and at 1 km, with received levels of 166 dB re 1 µPa at 1 m and 175 dB re 1 µPa, respectively (McCauley et al. 2000). The sea turtles' response was consistent: Above a level of about 166 dB re 1 µPa, the turtles noticeably increased their swimming activity. Above 175 dB re 1 µPa, their behavior became more erratic, possibly indicating that the turtles were agitated (McCauley et al. 2000).

Extrapolation from human and marine mammal data to turtles may be inappropriate given the morphological differences between the auditory systems of mammals and turtles. Currently it is believed that the range of maximum sensitivity for sea turtles is 0.1 to 0.8 kHz, with an upper limit of about 2.0 kHz (Lenhardt, 1994). Hearing below 0.08 kHz is less sensitive but still potentially usable to the animal. Green turtles are most sensitive to sounds between 0.2 and 0.7 kHz, with peak sensitivity at 0.3 to 0.4 kHz (Ridgway et al. 1997). They possess an overall hearing range of approximately 0.1 to 1.0 kHz (Ridgway et al., 1969). Juvenile loggerhead turtles hear sounds between 0.25 and 1.0 kHz and, therefore, often avoid these low frequency sounds (Bartol et al. 1999). Finally, sensitivity even within the optimal hearing range is apparently low—threshold detection levels in water are relatively high at 160 to 200 dB re 1 µPa-m (Lenhardt 1994). Given the lack of audiometric information, the potential for temporary threshold shifts among leatherback turtles must be classified as unknown but would likely follow those of other sea turtles. In terms of sound emission, nesting leatherback turtles produce sounds in the 0.3 to 0.5 kHz range (Mrosovsky 1972).

Mid-Frequency and High-Frequency Active Sonar

Any potential role of long-range acoustical perception in sea turtles has not been studied and is unclear at this time. The concept of sound masking (the ability of one sound to make the ear incapable of perceiving another) is difficult, if not impossible, to apply to sea turtles. Hearing has been studied minimally in sea turtles and those that have been tested exhibited low audiometric and behavioral sensitivity to low-frequency sound. It appears that if there were the potential for mid and high frequency sonar to increase masking effects for any sea turtle species, it would be minimal as these sound sources are expected to be outside the normal hearing sensitivity of sea turtles.

Therefore, there will be no effect to sea turtles from mid and high frequency active sonar activities in the PACNW OPAREA under any of the proposed alternatives analyzed in the EIS/OEIS. These impacts are dismissed from further consideration.

3.8.1.3 Current Requirements and Practices

As summarized in Chapter 5, the comprehensive suite of protective measures and SOPs implemented by the Navy to reduce impacts to marine mammals also serves to mitigate potential impacts on sea turtles. In particular, personnel and watchstander training, establishment of turtle-free exclusion zones for underwater detonations of explosives, and pre- and post-exercise surveys, all serve to reduce or eliminate potential impacts of Navy activities on sea turtles that may be present in the vicinity.

3.8.2 Environmental Consequences

3.8.2.1 Approach to Analysis

Regulatory Framework

Endangered Species Act

This EIS/OEIS analyzes potential effects to the leatherback sea turtle in the context of the ESA, the National Environmental Policy Act (NEPA), and Executive Order (EO) 12114. For purposes of ESA compliance, effects of the action were analyzed to make the Navy's determination of effect for listed species (that is, no effect or may affect). The definitions used in making the determination of effect under Section 7 of the ESA are based on the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) *Endangered Species Consultation Handbook* (USFWS and NMFS 1998).

“No effect” is the appropriate conclusion when a listed species will not be affected, either because the species will not be present or because the project does not have any elements with the potential to affect the species. “No effect” does not include a small effect or an effect that is unlikely to occur.

If effects are insignificant (in size) or discountable (extremely unlikely), a “may affect” determination is appropriate. Insignificant effects relate to the magnitude or extent of the impact (that is, they must be small and would not rise to the level of a take of a species). Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur. These factors were also considered in determining the significance of effects under the NEPA and EO 12114.

Pacific Northwest Turtle Protection Area

On March 11, 2004, NMFS issued a final rule to prohibit shallow longline fishing of the type normally targeting swordfish on the high seas in the Pacific Ocean east of 150ºW longitude by vessels managed under the Fishery Management Plan (FMP) for U.S. West Coast Fisheries for Highly Migratory Species. This action was intended to protect endangered and threatened sea turtles from the adverse impacts of shallow longline fishing by U.S. fishing vessels in the Pacific Ocean and operating out of the west coast. The FMP was partially approved by NMFS on February 4, 2004. Together, the final rule and FMP are expected to conserve leatherback and loggerhead sea turtles as required under the ESA.

Assessment Methods and Data Used

The Navy used a screening process to identify aspects of the proposed action that could act as stressors to sea turtles. Public and agency scoping comments, previous environmental analyses, previous agency consultations, laws, regulations, Executive Orders, and resource-specific information were also evaluated. This process was used to focus the information presented and analyzed in the affected environment and environmental consequences sections of this EIS/OEIS. Potential stressors to sea turtles include vessel movements (disturbance and collisions), aircraft overflights (disturbance), weapons firing and ordnance use (disturbance and strikes), explosions, and expended materials (ordnance related materials, targets, and marine markers).

As discussed in sections 3.3, Hazardous Materials, and 3.4, Water Resources, potential pollutants in sediments, water, and air would be released into the environment as a result of the alternatives. The analyses presented in those sections indicate that any increases in pollutants resulting from Navy training in the NWTRC Study Area would be negligible and localized, and impacts would not be significant. Based on these analyses, water quality changes would have negligible effects on sea turtles. Accordingly, the effects of water quality changes on sea turtles were not addressed further in this EIS/OEIS.

Study Area

The Study Area for sea turtles includes both the offshore and inshore waters of the NWTRC.

Data Sources

A systematic review of relevant literature and data was conducted of both published and unpublished sources. The following types of documents were used in the assessment: journals, books, periodicals, bulletins, DoD operations reports, theses, dissertations, endangered species recovery plans, species management plans, and other technical reports published by government agencies, private businesses, and consulting firms. The scientific literature was also consulted during the search for geographic location data (geographic coordinates) on the occurrence of sea turtles within the Study Area.

Turtle Density

There are no formal density estimates for sea turtles in the PACNW OPAREA. The marine mammal and sea turtle density study undertaken to support the analysis presented in the EIS/OEIS (ManTech-SRS 2007) estimated the average density of sea turtles along the Southern California coast to be 3.6 animals per 30 square nautical mile (nm^2) (100 square kilometers [km^2]), equal to an estimated maximum of 7.7 animals over the same area (0.12 to 0.26 animals per nm^2). Although the cold water temperatures of the Pacific Northwest make occurrence of several hard-shelled species unlikely, the density estimate for Southern California is employed here as a potential maximum range of occurrence for sea turtles in the Study Area. Thus, the assumed density of 0.12 to 0.26 turtles per nm^2 (3.4 km^2) is an extrapolation that represents a high rate of occurrence that may exceed actual conditions.

Sound in the Water

As discussed in section 3.8.1.2 (Sea Turtle Hearing) above, no effects on sea turtles are anticipated from mid-frequency or high-frequency active sonar, and this topic is not carried through the analysis.

Underwater Explosions and Detonations

Criteria and thresholds for estimating the impacts to sea turtles from a single underwater detonation event were determined from information on cetaceans used for the environmental assessments for the two Navy ship-shock trials: the *Seawolf* Final EIS (DoN 1998) and the *Churchill* Final EIS (DoN 2001). During the analysis of the effects of explosions on marine mammals and sea turtles conducted by the Navy for the *Churchill* EIS, analysts compared the injury levels reported by these experiments to the injury levels that would be predicted using the modified-Goertner method and found them to be similar (DoN 2001; Goertner 1982). The criteria and thresholds for injury and harassment are summarized in Table 3.8-1.

Table 3.8-1: Summary of Criteria and Acoustic Thresholds for Underwater Detonation Impacts to Marine Mammals but Also Used for Sea Turtles Because No Other Criteria Exists

Impact to Marine Mammal	Criterion	Threshold
Level A Harassment Mortality	Onset of Severe Lung Injury	Goertner Modified Positive Impulse Indexed to 31 psi-ms
Injury	Tympanic membrane rupture Onset of slight lung injury	50 percent rate of rupture; 205 dB re 1 μPa^2-s (Energy Flux Density) Goertner Modified Positive Impulse Indexed to 13 psi-ms
Level B Harassment Non-Injury	Temporary Threshold Shift (TTS)	182 dB re 1 μPa^2-s maximum Energy Flux Density level in any 1/3-octave band at frequencies above 100 Hz for sea turtles.
Dual Criteria	Onset Temporary Threshold Shift	23 psi peak pressure level (for small explosives)
psi-ms = pounds per square inch-milliseconds, μPa^2-s = squared micropascal-second		

The criteria for non-injurious harassment include acoustic annoyance and physical discomfort (Viada et al. 2007). Temporary threshold shift (TTS) is the criterion for acoustic annoyance; TTS is a temporary, recoverable, loss of hearing sensitivity (NMFS 2001; DoN 2001). There are two criteria for TTS: 1) 182 dB re 1 squared micropascal-second (μPa^2-s) maximum Energy Flux Density Level (EL) level in any 1/3-octave band at frequencies greater than 100 Hz for sea turtles; and 2) 12 pounds per square inch (psi) peak pressure. Navy policy is to use the 23 psi criterion for explosive charges less than 2,000 pounds (900 kg) and the 12 psi criterion for explosive charges larger than 2,000 pounds. It was introduced to provide a safety zone for TTS when the explosive or the animal approaches the sea surface (for which case the explosive energy is reduced but the peak pressure is not). In addition to acoustic annoyance, non-injurious harassment may also include physical discomfort and tactile detection, particularly in areas around the eyes, mouth, external nares, and vent (Viada et al. 2007).

Two criteria are used for injury: onset of slight lung hemorrhage and 50 percent eardrum (tympanic membrane [TM]) rupture. These criteria are considered indicative of the onset of injury. The threshold for onset of slight lung injury is calculated for a small animal (a dolphin calf weighing 27 pounds [12 kg]), and is given in terms of the "Goertner modified positive impulse," indexed to 13 psi-millisecond (ms) (DoN 2001). In the absence of analagous data in chelonids, the criteria developed for marine mammals is also applied to sea turtles. This threshold is conservative since the positive impulse needed to cause injury is proportional to animal mass, and therefore, larger animals require a higher impulse to cause the onset of injury. The threshold for TM rupture corresponds to a 50 percent rate of rupture (i.e., 50 percent of animals exposed to the level are expected to suffer TM rupture); this is stated in terms of an EL value of 205 dB re 1 μPa^2-s. The criterion reflects the fact that TM rupture is not necessarily a serious or life-threatening injury, but is a useful index of possible injury that is well correlated with measures of permanent hearing impairment (e.g., Ketten 1998) indicates a 30 percent incidence of permanent threshold shift [PTS] at the same threshold. Another slight injury that may result from underwater explosion shock waves includes hemorrhage of the gastrointestinal tract. This is caused by excitation of radial oscillations of small gas bubbles normally present in the intestine. Hemorrhage of the gastrointestinal tract is not expected to be debilitating and a sea turtle would be expected to recover on its own (Viada et al. 2007).

The criterion for mortality for marine mammals used in the *Churchill* Final EIS is "onset of severe lung injury." This is conservative in that it corresponds to a 1 percent chance of mortal injury, and yet any animal experiencing onset severe lung injury is counted as a lethal exposure. The threshold is stated in terms of the Goertner (1982) modified positive impulse with value "indexed to 31 psi-ms." Since the Goertner approach depends on propagation, source/animal depths, and animal mass, the actual impulse value corresponding to the 31 psi-ms index is a complicated calculation. Again, to be conservative, the *Churchill* analysis used the mass of a calf dolphin (27 pounds [12 kg]), so that the threshold index is 30.5 psi-ms. Gastrointestinal tract injuries are associated with lung hemorrhage and would be expected to include contusions with ulcerations throughout the tract, ultimately resulting in tract ruptures. Mortality is highly likely under these conditions (Viada et al. 2007). Lethal injuries may also result from shock waves with high peak pressure. These high peak pressure shock waves may result in concussive brain damage; cranial, skeletal, or shell fractures; hemorrhage; or massive inner ear trauma, leading either directly or indirectly to mortality (Viada et al. 2007).

Weapons Firing Disturbance

A gun fired from a vessel on the surface of the water propagates a blast wave away from the gun muzzle. As the blast wave hits the water, sound is carried into the water in proportion to the blast strike. Propagating energy is transmitted into the water in a finite region below the gun. A critical angle (about 13°, as measured from the vertical) can be calculated to determine the region of transmission in relation to a vessel and gun (DoN 2006d).

The largest proposed shell size for NWTRC training activities is a 5-inch shell. This will produce the greatest pressure of all ammunition used in the NWTRC Study Area. All analysis will be done using the 5-inch shell as a source of produced and transmitted pressure, with the recognition that smaller ammunition sizes would have lesser impacts.

In June 2000, the Navy collected a series of pressure measurements during the firing of a 5-inch gun. Average pressure measured approximately 200 decibels with reference pressure of one micro Pascal (200 dB re 1 µPa) at the point of the air and water interface. Based on these values, down-range peak pressure levels were calculated to be less than 186 dB re 1 µPa at 100 meters (DoN 2000), and as the distance increased, the pressure decreased. The rapid dissipation of the sound pressure wave, the low potential for occurrence of sea turtles in the PACNW OPAREA, and the protective measures implemented by the Navy (see Chapter 5 for details) to detect sea turtles in an area prior to implementing training activities, would result in the gun muzzle blasts having no effect on sea turtle species. This topic is not addressed further in the analyses of effects on sea turtles.

3.8.2.2 No Action Alternative

Under the No Action Alternative, baseline levels of activities would remain unchanged from current conditions. Turtles would have the potential to be affected by vessel movements, aircraft overflights, ordnance strikes, explosions, and expended materials.

Vessel Movements

Training activities within the Study Area involve maneuvers by various types of surface vessels and submarines (collectively referred to as vessels). Vessel movements have the potential to affect sea turtles by directly striking or disturbing individual animals. The probability of vessel and sea turtle interactions in the PACNW OPAREA depends factors such as the presence or absence and density of sea turtles;

numbers, types, and speeds of vessels; duration and spatial extent of activities; and protective measures implemented by the Navy.

Currently, the number of Navy vessels operating in the PACNW OPAREA varies based on training schedules. Most training activities average one vessel per activity. During a year of training activities, 6,940 steaming hours occur in the NWTRC, with 4,320 of those in transit, and 2,620 during training activities. Although Navy vessels are capable of much faster speeds, specific training activities generally dictate slower speeds – generally in the range of 10 to 14 knots.

Training activities involving vessel movements occur intermittently and are short in duration (generally a few hours). These activities are widely dispersed throughout the PACNW OPAREA, which encompasses 122,241 nm^2 (419,287 km^2) of surface and subsurface ocean. The Navy logs about 289 total vessel days within the Study Area during a typical year, which equates to about 0.06 hours (or 3 minutes) of steaming per nm^2 (3.4 km^2) annually. The estimated density of turtle occurrence in the Study Area is from 0.012 to 0.26 animals per nm^2 (3.4 km^2).

Disturbance from Vessel Movement

The ability of turtles to detect approaching vessels via auditory or visual cues would be expected based on knowledge of their sensory biology (Bartol and Musick 2003; Ketten and Bartol 2006; Moein Bartol and Ketten 2006; Levenson et al. 2004). Little information is available on how turtles respond to vessel approaches. Hazel et al. (2007) reported that greater vessel speeds increased the probability turtles would fail to flee from an approaching vessel. Turtles fled frequently in encounters with a slow-moving (2.2 knots) vessel, but infrequently in encounters with a moderate-moving (5.9 knots) vessel, and only rarely in encounters with a fast-moving (10.3 knots) vessel. It is difficult to differentiate whether a sea turtle reacts to a vessel due to the produced sound, the presence of the vessel itself, or a combination of both.

Sea turtles possess an overall hearing range of approximately 100 to 1,000 Hz, with an upper limit of 2,000 Hz (Ridgway et al. 1969; Lenhardt et al. 1994; Bartol et al. 1999; Ketten and Moein Bartol 2006). Although it is difficult to determine whether sea turtle response to vessel traffic is visual or auditory in nature, it is assumed sea turtles can hear approaching vessels given their hearing range.

Hazel et al. (2007) found that sea turtles reacted to approaching vessels in a variety of ways and that those reactions were short-term. Benthic turtles launched upwards at a shallow angle and began swimming. The majority of the turtles swam away from the vessel while some swam along the vessel's track and some crossed in front of the vessel's track before swimming away. Sea turtle reaction time depends on the speed of the vessel; sea turtles were able to react faster to slower moving vessels than to faster moving vessels.

Human disturbance to wild animals may elicit similar reactions to those caused by natural predators (Gill et al. 2001; Beale and Monaghan 2004). Behavioral responses may also be accompanied by a physiological response (Romero 2004), although this is difficult to study in the wild. Immature Kemp's ridley turtles have shown physiological responses to the acute stress of capture and handling through increased levels of corticosterone (Gregory and Schmid 2001). In the short term, exposure to stressors results in changes in immediate behavior (Frid 2003). For turtles, this can include intense behavioral reactions such as biting and rapid flipper movement (Gregory and Schmid 2001). Repeated exposure to stressors, including human disturbance such as vessel disturbance and anthropogenic sound, can result in negative consequences to the health and viability of an individual or population. Chronic stress can result in decreased reproductive success (Lordi et al. 2000; Beale and Monaghan 2004), decreased energy budget (Frid 2003), displacement from habitat (Southerland and Crockford 1993), and lower survival rates of offspring (Lordi et al. 2000). Although this study related to natural induced stressors, similar physiological changes may result from other types of stressors such as anthropogenic disturbance. At this time, it is unknown what the long-term implications of chronic stress may be on sea turtle species.

Sea turtles exposed to the general disturbance associated with a passing Navy vessel could exhibit a short-term behavioral response such as fleeing. In accordance with the NEPA, vessel movements in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from vessel movements in non-territorial waters would possible but unlikely. In accordance with the ESA, vessel disturbance under the No Action Alternative may affect leatherback turtles.

Vessel Collisions

Vessel collisions with sea turtles, or vessel strikes, have the potential to affect sea turtles in the Study Area. Turtles swimming or feeding at or just beneath the surface of the water are particularly vulnerable to a vessel strike. Sea turtles struck by vessels could be unharmed, injured, or killed.

As discussed for disturbance effects to sea turtles, above, collisions between vessels and sea turtles are possible, but have a low potential for occurrence. The low density rates for turtles, low number of annual steaming hours over a large area (122,241 nm^2 [419,287 km^2]), and Navy resource protection measures would combine to limit the likelihood of vessel-turtle collisions.

In accordance with the NEPA, vessel strikes in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from vessel movements in non-territorial waters would be possible but unlikely. In accordance with the ESA, vessel disturbance under the No Action Alternative may affect leatherback turtles.

Aircraft Overflights

Under the No Action alternative, 7,586 overflights would occur above the NWTRC annually. Of these, 96 would be helicopter flights, conducted primarily over land. Nearly 7,500 of the non-helicopter overflights would occur over the PACNW OPAREA, at elevations in excess of 3,000 feet (915 meters), and more than three nautical miles (5.5 km) from shore.

Aircraft overflights produce noise, and some of this sonic energy would be transmitted into the water. Sea turtles could be exposed to noise associated with fixed-wing aircraft overflights and helicopter activities while at the surface or while submerged. In addition, low-flying aircraft passing overhead could create a visual shadow effect that could induce a reaction in sea turtles.

It is difficult to differentiate between reactions that turtles may experience to the presence of aircraft and reactions to sound. Exposures to elevated noise levels that are associated with current activities are brief and infrequent, based on the transitory and dispersed nature of the overflights. Sound exposure levels are relatively low because sea turtles spend only 3 to 6 percent of the time at the sea surface and because most of the overflights would be above 3,000 feet (915 meters).

Little data regarding sea turtle reactions to aircraft overflights are available. Based on information on their sensory biology (Ridgway et al. 1969; Lenhardt 1994; Bartol et al. 1999; Bartol and Musick 2003; Ketten and Bartol 2006), sound from low-flying aircraft could be heard by a sea turtle at or near the surface. Hazel et al. (2007) suggested that green turtles rely more on visual cues than auditory cues when reacting to approaching water vessels. This suggests that sea turtles might not respond to aircraft overflights based on noise alone. Overflights do not generate underwater sound levels that result in harm to sea turtles (Eller and Cavanagh 2000; Laney and Cavanagh 2000).

Sea turtles exposed to aircraft overflights that occur under the No Action Alternative may exhibit no response, or may exhibit behavioral reactions such as quick diving. Any behavioral avoidance reaction would be short-term and would not permanently displace animals or result in physical harm. Overflights are not expected to result in chronic stress because it is extremely unlikely that individual animals would be repeatedly exposed to low-altitude overflights. In accordance with the NEPA, aircraft overflights in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from vessel movements in non-territorial waters would be possible but unlikely. In accordance with the ESA, aircraft overflights under the No Action Alternative may affect leatherback turtles.

Non-Explosive Ordnance Use

Current Navy training activities in the PACNW OPAREA include firing a variety of weapons that employ non-explosive training rounds, including inert bombs, missiles, naval gun shells, cannon shells, and small-caliber ammunition. These materials are used in the PACNW OPAREA located in the open ocean beyond three nautical miles (5.5 km) and represent potential stressors to sea turtles. Ordnance strikes have the potential to injure or kill sea turtles in the Study Area. Turtles swimming or feeding at or just beneath the water surface are particularly vulnerable to an ordnance strike.

Approximately 86,000 non-explosive ordnance rounds would be used in the PACNW OPAREA annually under the No Action Alternative. Although use may be concentrated in W-237, ordnance is used in all areas of the PACNW OPAREA beyond three nautical miles (5.5 km). The density of annual ordnance use would be approximately 0.7 items per nm^2 (3.4 km^2) over the 122,241 nm^2 (419,287 km^2) range. Using the turtle density estimate extrapolated from Southern California, 0.12 to 0.26 turtles could occur per nm^2 (3.4 km^2) within the Study Area. Given the relatively small size of the turtles (up to 70 inches [1.8 meters]) and the ordnance used (from less than one inch [2.5 centimeters] to 8 feet [2.4 meters]), the potential for turtles to be struck by ordnance is low. Consistent use of Navy protective measures would also help minimize the likelihood of ordnance strikes to sea turtles.

In accordance with the NEPA, non-explosive ordnance use in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from non-explosive ordnance use in non-territorial waters would be possible but unlikely. In accordance with the ESA, non-explosive ordnance strikes under the No Action Alternative may affect leatherback sea turtles.

Underwater Detonations and Explosive Ordnance

Explosions that would occur in the No Action Alternative in the Study Area would result from training exercises that use explosive ordnance, including bombs (BOMBEX), missiles (MISSILEX), and SINKEX. They also would result from underwater detonations associated with explosive ordnance detonation (EOD) training. Explosive ordnance use and underwater detonation would be limited to the training areas that were identified in Table 2-9.

Underwater explosions conducted under the No Action Alternative have the potential to adversely affect sea turtles in the Study Area by causing temporary behavioral effects, sub-lethal or lethal injuries, or direct mortality.

However, the same factors that would limit other adverse effects to sea turtles would result in a low potential for impacts from explosions. These include the relatively low potential for sea turtles to occur in the Study Area, the limited number of training activities using explosive ordnance over a large area (122,241 nm^2 [419,287 km^2]), and consistent implementation of Navy resource protection measures.

Under the No Action Alternative, approximately 27 bomb and missile explosions would occur each year during training activities in the PACNW OPAREA. In addition, 124 explosive sonobuoys would be used.

Although use of these explosive training components would be concentrated in W-237, their use may occur in all areas of the PACNW OPAREA beyond three nautical miles (5.5 km). The occurrence density of annual ordnance use would be approximately 0.0012 detonations per nm^2 (3.4 km^2) over the entire PACNW OPAREA.

Although the leatherback sea turtle generally occurs in the offshore areas of the PACNW OPAREA, they have been sited, on rare occasions, in the waters of Puget Sound. In the unusual event that a sea turtle were in the vicinity of underwater EOD activities, they could be exposed to noise and the pressure wave from the detonation. However, the monitoring and protective measures undertaken prior to any detonation of EOD would reduce the likelihood of sea turtles being injured or exposed to such explosions. With the low occurrence rate and protective measures employed, impacts from underwater EOD may affect leatherback sea turtles.

An explosive analysis was conducted to estimate the number of sea turtles that could be exposed to impacts from explosions. (See Section 3.8.2.1 for sea turtle-specific thresholds and Section 3.9, Marine Mammals, for a full description of the modeling and methods.) Each explosion or detonation generates a zone of influence, that is, the area where leatherback turtles would potentially be exposed to the resulting pressure wave. Under the No Action Alternative, the explosions and detonations that would take place in the Study Area would have the potential to affect two leatherback sea turtles – one would potentially be affected at the dual criteria (23 psi peak pressure from small explosives) level and one potentially affected at non-injurous behavior disruption level. No sea turtles mortalities would be expected under this alternative. The Navy is working with NMFS through the ESA Section 7 consultation process to ensure that unavoidable significant effects to sea turtles do not result from implementation of the proposed action.

In accordance with the NEPA, explosive ordnance use in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from explosive ordnance use in non-territorial waters would be possible but unlikely. In accordance with the ESA, use of explosive ordnance in the PACNW OPAREA under the No Action Alternative may affect leatherback sea turtles.

Expended Materials

The Navy expends a variety of materials during training exercises in the PACNW OPAREA. The types and quantities of materials expended and information regarding fate and transport of these materials within the marine environment are discussed in Section 3.1, Geology and Soils; Section 3.3, Hazardous Materials; and Section 3.4, Water Resources. The analyses in these sections determined that most expended materials rapidly sink to the sea floor where they become encrusted by natural processes or are incorporated into the sea floor, with no substantial accumulations in any particular area and no significant negative effects to water quality or marine benthic communities.

Sea turtles of all sizes and species are known to ingest a wide variety of marine debris, which they might mistake for prey. Plastic bags and plastic sheeting are most commonly swallowed by sea turtles, but balloons, Styrofoam beads, monofilament fishing line, and tar are also known to be ingested (NRC 1990;). Marine debris can pass through the digestive tract and be voided naturally without causing harm, or it can cause sublethal or lethal effects (Balazs 1985). Sublethal effects include nutrient dilution, which occurs when non-nutritive debris displaces nutritious food in the gut, leading to slow growth or reduced reproductive success (McCauley and Bjorndal 1999).

Lutz (1997) found that hungry sea turtles will actively seek and consume marine debris if other food is not available. In most cases, this debris passed through the gut within a few days, but latex was found to take up to four months to clear the intestinal system. While ingestion of marine debris has been linked to sea turtle mortalities, sublethal effects are more common (NRC 1990; McCauley and Bjorndal 1999).

Ordnance-Related Materials

Ordnance-related materials include non-explosive training rounds and shrapnel from explosive rounds. The solid materials of high metal content quickly sink through the water column to the sea floor where they could be available for ingestion by benthic foraging sea turtles. Ingestion of expended ordnance is not expected to occur in the water column because ordnance quickly sinks.

Leatherbacks feed throughout all zones of the water column (Davenport 1988; Eckert et al. 1989; Grant and Ferrell 1993; Salmon et al. 2004; James et al. 2005a). Prey is predominantly gelatinous zooplankton such as jellyfish and tunicates (NMFS and USFWS 1992; Grant and Ferrell 1993; Bjorndal 1997; James and Herman 2001; Salmon et al. 2004), and they typically do not feed in the benthic environment. Therefore, although leatherbacks could reach ordnance-related materials resting on the bottom at depths up to 1,000 meters, they are unlikely to ingest it.

Leatherbacks would not be expected to ingest ordnance expended under the No Action Alternative because they do not typically feed in the benthic environment. In accordance with the NEPA, expended materials in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from expended materials in non-territorial waters would be possible but unlikely. In accordance with the ESA, ordnance-related materials under the No Action Alternative would have no effect on leatherback sea turtles.

Target-Related Materials

At-sea targets used in the PACNW OPAREA range from high-technology, remotely operated airborne and surface targets (such as airborne drones) to low-technology, floating, at-sea targets (such as inflatable targets) and airborne, towed banners. Many of the targets are designed to be recovered for reuse and are not destroyed during training. The expendable targets used in the Study Area are the Expendable Mobile Antisubmarine Warfare Training Target (EMATT) and MK-58 Marine Marker. These units are two and three feet in length, respectively, and sink to the bottom intact. Because of these characteristics, they present no ingestion hazard to sea turtles.

MK-58 marine markers produce chemical flames and surface smoke. They are used in training exercises to mark a surface position to simulate divers, vessels, and points of contact on the surface of the ocean. The smoke dissipates in the air and has little effect on the marine environment. The marker burns similar to a flare, producing a flame until all burn components have been used. While the light generated from the marker is bright enough to be seen up to three miles (4.8 kilometers) away in ideal conditions, the light either reflects off the water's surface or enters the water and attenuates in brightness over depth. Because they spend only three to six percent of time on the sea surface, it would be extremely unlikely that sea turtles would be affected by the light from the marker.

In accordance with the NEPA, target use in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from target use in non-territorial waters would be possible but unlikely. In accordance with the ESA, use of target-related materials under the No Action Alternative would have no effect on leatherback turtles.

Entanglement

Entanglement in persistent marine debris threatens the survival of sea turtles in the eastern Pacific Ocean (NMFS and USFWS 1998a). Often, turtles that become entangled in debris, usually abandoned fishing gear, cannot submerge to feed or surface to breathe. Those that do not starve or drown may lose a limb or attract predators with their struggling. Turtles also can become entangled in plastics and other buoyant and persistent synthetic debris discarded into the ocean (Balazs 1995; Carr 1987).

Military-related debris such as parachutes may be encountered by sea turtles in the waters of the PACNW OPAREA. Although entanglement in military-related debris was not cited as a source of injury or mortality for any sea turtle in a large stranding database for Californian waters, there is a potential for sea turtles to become entangled in expended materials.

The greatest risk of entanglement occurs when debris, primarily parachutes, is on or near the surface. Aircraft-launched sonobuoys, flares, torpedoes, and EMATTs deploy nylon parachutes of varying sizes (e.g., the surface area is 1.5 square feet (0.1 square meter) to 3.5 square feet (0.3 square meter)). At water impact, the parachute assembly is expended and sinks because all of the material is negatively buoyant. Some components are metallic and will sink rapidly.

Entanglement and the eventual drowning of a sea turtle in a parachute assembly would be unlikely because such an event would require the parachute to land directly on an animal, or the animal would have to swim into it before it sinks.

The expended material accumulates on the ocean floor and is covered by sediments over time, reducing the potential for entanglement. If bottom currents are present, the canopy may billow (bulge) and pose an entanglement threat to sea turtles with bottom-feeding habits. However, the probability of a sea turtle encountering a submerged parachute assembly and the potential for accidental entanglement in the canopy or suspension lines is low.

Under the No Action Alternative, one torpedo would be potentially be used each year during SINKEX activities. With the low density of turtles and the use of one torpedo, impacts from guide wires may affect sea turtles.

Under the No Action Alternative, approximately 9,200 parachutes would be deployed and not recovered. These parachutes would deliver sonobuoys, targets, and markers during training exercises. Assuming an even distribution of parachutes over the PACNW OPAREA, the concentration of material presenting a short-term entanglement hazards would be 0.075 pieces per nm^2 ($3.4\ km^2$). Based on the potential occurrence of sea turtles (0.12 to 0.26 animals per nm^2 [$3.4\ km^2$]) the number of sea turtles potential affected would be 0.009 to 0.0195 animals per year. Thus, the potential for sea turtle entanglement in Navy debris would be low.

In accordance with the NEPA, entanglement from military-related debris in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from entanglement from military-related debris in non-territorial waters would be possible but unlikely. In accordance with the ESA, entanglement from military-related debris under the No Action Alternative may affect leatherback sea turtles.

3.8.2.3 Alternative 1

Under Alternative 1, the level of activities in the PACNW OPAREA would increase relative to the No Action Alternative. In addition to accommodating training activities currently conducted, Alternative 1 would support an increase in training activities to include force structure changes associated with the introduction of new weapon systems, vessels, and aircraft into the Fleet. Baseline-training activities would be increased. In addition, training activities associated with force structure changes would be implemented.

Vessel Movements

As described for the No Action Alternative, the number of Navy vessels operating during training exercises would vary, but would continue to include an average of one vessel per activity. Under Alternative 1, steaming hours would increase four percent from current conditions. During a year of training activities, 7,228 steaming hours would occur in the PACNW OPAREA. However, vessel movements would be widely dispersed throughout the area, with approximately 0.06 hours of steaming per nm^2 (3.4 km^2) annually.

The small increase in steaming hours would not measurably increase potential effects to sea turtles. Disturbance impacts to sea turtles from vessel movements and from general disturbance associated with passing Navy vessels under Alternative 1 would be the similar to those described for the No Action Alternative.

Sea turtles exposed to the general disturbance associated with a passing Navy vessel could exhibit a short-term behavioral response such as fleeing. In accordance with the NEPA, vessel movements in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from vessel movements in non-territorial waters would possible but unlikely. In accordance with the ESA, vessel disturbance under Alternative 1 may affect leatherback sea turtles.

Vessel Collisions

The types of vessel strike impacts to sea turtles under Alternative 1 would be the same as those described for the No Action Alternative. The four percent increase in steam hours would still produce approximately 0.06 hours of steaming per nm^2 (3.4 km^2) annually. The modest increase in steaming hours associated with this alternative would not measurably change effects on sea turtles relative to the No Action Alternative.

In accordance with the NEPA, vessel strikes in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from vessel movements in non-territorial waters would be possible but unlikely. In accordance with the ESA, vessel disturbance under Alternative 1 may affect leatherback sea turtles.

Aircraft Overflights

Under Alternative 1, 9,204 overflights would occur above the NWTRC annually. This would represent a 21 percent increase from No Action Alternative conditions. Of these overflights, 109 would be helicopter flights conducted primarily over land, a 13 percent increase from the No Action Alternative. Most of the remaining, non-helicopter overflights would occur over the PACNW OPAREA at elevations in excess of 3,000 feet (915 meters) and more than three nautical miles (5.5 km) from shore.

The 21 percent increase in potential exposure to visual and noise disturbance would result in similar effects to sea turtle behavior described for the No Action Alternative. Exposures to elevated noise levels associated with Alternative 1 would be brief and infrequent, based on the transitory, dispersed nature of the overflights. Sound exposure levels are relatively low because sea turtles spend only 3 to 6 percent of the time at the sea surface and most of the overflights would be above 3,000 feet (915 meters).

Sea turtles could exhibit no response, or may exhibit behavioral reactions such as quick diving. Any behavioral avoidance reaction would be short-term and would not permanently displace animals or result in physical harm. Overflights are not expected to result in chronic stress because it is extremely unlikely that individual animals would be repeatedly exposed to low-altitude overflights.

In accordance with the NEPA, aircraft overflights in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from vessel movements in non-territorial waters would be possible but unlikely. In accordance with the ESA, aircraft overflights under the Alternative 1 may affect leatherback sea turtles

Non-Explosive Ordnance Use

Approximately 100,000 non-explosive ordnance rounds would be used in the PACNW OPAREA annually under Alternative 1 – a 16 percent increase from current conditions. As described for the No Action Alternative, use may be concentrated in W-237, but ordnance is used in all areas of the PACNW OPAREA beyond three nautical miles (5.5 km). The density of annual ordnance use would be approximately 0.8 items per nm^2 (3.4 km^2) over the range. Using the existing turtle density estimate of 0.12 to 0.26 turtles per nm^2 (3.4 km^2), and given the relatively small sizes of both the turtles (up to 70 inches [1.8 meters]) and the ordnance used (from less than one inch [2.5 centimeters] to 8 feet [2.4 meters]), the potential for direct ordnance strike of turtles is low. Consistent use of Navy protective measures would also help minimize the likelihood of ordnance strikes.

In accordance with the NEPA, non-explosive ordnance use in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from non-explosive ordnance use in non-territorial waters would be possible but unlikely. In accordance with the ESA, non-explosive ordnance strikes under the Alternative 1 may affect leatherback sea turtles.

Underwater Detonations and Explosive Ordnance

Under the Alternative 1, approximately 73 bomb and missile explosions would occur each year during training activities in the PACNW OPAREA. In addition, 136 explosive sonobuoys would be used. As described for the No Action Alternative, use of these explosive training components would be concentrated in W-237, but they could be used in all areas of the PACNW OPAREA beyond three nautical miles (5.5 km). The occurrence density of annual ordnance use would be approximately 0.0017 detonations per nm^2 (3.4 km^2) over the entire PACNWOPAREA.

The leatherback sea turtle generally occurs in the offshore areas of the PACNW OPAREA, but they have been sited in Puget Sound. In the unusual event that a sea turtle were in the vicinity of underwater EOD activities, they could be exposed to the pressure wave from the detonation. With the low occurrence rate of leatherbacks in Puget Sound, the infrequency of EOD activities (four total detonations per year), and protective measures employed, impacts from underwater EOD may affect leatherbacks.

As described for the No Action Alternative, an explosive analysis was conducted to estimate the number of sea turtles that could be exposed to impacts from explosions (see Section 3.9 Marine Mammals for a full description of the modeling and methods and Section 3.8.2.1 for sea turtle-specific thresholds). The explosions and detonations that would take place under Alternative 1 would have the potential to affect four leatherback sea turtles – two would potentially be affected at the dual criteria level (23 psi peak pressure from small explosives) and two would potentially be affected at the non-injurous behavior disruption level. No sea turtle mortalities would be expected under Alternative 1. The Navy is working with NMFS through the ESA Section 7 consultation process to ensure that unavoidable significant effects to sea turtles do not result from implementation of the proposed action.

In accordance with the NEPA, explosive ordnance use in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from explosive ordnance use in non-territorial waters would be possible but unlikely. In accordance with the ESA, use of explosive ordnance in the PACNW OPAREA under Alternative 1 may affect leatherback turtles.

Expended Materials

Ordnance-Related Materials

As described for the No Action Alternative, leatherback sea turtles would not be expected to be at risk from ingesting ordnance-related materials because they feed in the water column, not in the benthic environment. Because these materials sink rapidly and are encrusted on the sea floor, the potential to affect the leatherback would be remote.

Under current conditions, one torpedo would be potentially be used each year during SINKEX activities. Torpedoes may be deployed using guide wires to direct them to their target. As the torpedo leaves the launch tube a thin wire spins out, electronically linking the vessel and torpedo. This enables an operator to initially guide the torpedo toward the target. The wire is severed prior to detonation as the torpedo's guidance system takes over during the final phases of the attack. The thin wires are made of metal and sink to the bottom. With the low density of turtles and the use of one torpedo, impacts from guide wires may affect leatherbacks.

Leatherbacks would not be expected to ingest ordnance expended under Alternative 1 because they do not typically feed in the benthic environment. In accordance with the NEPA, expended materials in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from expended materials in non-territorial waters would be possible but unlikely. In accordance with the ESA, ordnance-related materials under the No Action Alternative would have no effect on leatherback sea turtles.

Target-Related Materials

As described for the No Action Alternative, a variety of at-sea targets are used in the PACNW OPAREA. Many of the targets are designed to be recovered for reuse and are not destroyed during training. The expendable EMATT and MK-58 units are two and three feet in length (0.6 to 0.9 meter) and sink to the bottom intact. Because of these characteristics, they present no ingestion hazard to sea turtles.

The smoke and flames produced by the MK-58 dissipate in the air, having little effect on the marine environment. While the light generated from the marker is bright enough to be seen up to three miles (4.8 kilometers) away in ideal conditions, the light either reflects off the water’s surface or enters the water and attenuates in brightness over depth.

In accordance with the NEPA, target use in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from target use in non-territorial waters would be possible but unlikely. In accordance with the ESA, use of target-related materials Alternative 1 would have no effect on leatherback sea turtles.

Entanglement

Under Alternative 1, use of parachuted sonobuoys would increase by approximately three percent compared to the No Action Alternative. Changes in the use of targets and markers that are delivered using parachutes were provided under “Target-Related Materials.” As described for the No Action Alternative, the parachutes would not be recovered and would sink to the sea floor. The modest increase in the use of materials that could cause a short-term entanglement hazard would not measurably increase potential impacts to sea turtles above those described for the No Action Alternative.

Under Alternative 1, two torpedoes would be potentially be used each year during SINKEX activities. As described for the No Action Alternative, torpedoes may be guided by thin wires after initial deployment. These metal wires sever prior to detonation and sink to the bottom.

In accordance with the NEPA, entanglement from military-related debris in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from entanglement from military-related debris in non-territorial waters would be possible but unlikely. In accordance with the ESA, entanglement from military-related debris under Alternative 1 may affect leatherback turtles.

3.8.2.4 Alternative 2

Under Alternative 2, the level of activities in the PACNW OPAREA Study Area would increase relative to the No Action Alternative and Alternative 1. Implementation of this alternative would include all elements of Alternative 1 (accommodating training activities currently conducted, increasing training activities, and accommodating force structure changes). In addition, training activities of the types currently conducted would be increased and range enhancements would be implemented (as described in Section 2.5.2.). These range enhancements would lead to an increase in gunnery, missile, and electronic combat exercises.

Vessel Movements

As described for the other alternatives, the number of Navy vessels operating during training exercises would average one vessel per exercise. During a year of training activities, steaming hours would increase by 10 percent to 7,628 hours, relative to the No Action Alternative. Vessel movements would be widely dispersed throughout the PACNW OPAREA, with approximately 0.06 hours of steaming per nm^2 (3.4 km^2).

The modest increase in steaming hours would not measurably increase potential effects to sea turtles. Disturbance impacts to sea turtles from vessel movements under Alternative 2 would be similar to those described for the No Action Alternative and Alternative 1.

Sea turtles exposed to the general disturbance associated with a passing Navy vessel could exhibit a short-term behavioral response such as fleeing. In accordance with the NEPA, vessel movements in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from vessel movements in non-territorial waters would possible but unlikely. In accordance with the ESA, vessel disturbance under Alternative 2 may affect leatherback sea turtles.

Vessel Collisions

The types of vessel strikes effects to sea turtles under Alternative 2 would be the same as those described for the No Action Alternative. The 10 percent increase in steaming hours associated with this alternative would not measurably change effects on sea turtles relative to the No Action Alternative.

In accordance with the NEPA, vessel strikes in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from vessel movements in non-territorial waters would be possible but unlikely. In accordance with the ESA, vessel disturbance under Alternative 2 may affect leatherback sea turtles.

Aircraft Overflights

Under Alternative 2, 11,786 overflights would occur annually. This would be a 55 percent increase over the number of overflights in the No Action Alternative. As with the other alternatives, most overflights would occur over the PACNW OPAREA at elevations in excess of 3,000 feet (915 meters) and beyond three nautical miles (5.5 km).

The increase in potential exposure to visual and noise disturbance that would be associated with a 55 percent increase in overflights would not measurably increase effects to sea turtles. Sea turtles could exhibit no response, or may change their behavior to avoid the disturbance. Any behavioral avoidance reaction would be short-term and would not permanently displace animals or result in physical harm. Overflights are not expected to result in chronic stress because it is extremely unlikely that individual animals would be repeatedly exposed to low-altitude overflights.

In accordance with the NEPA, aircraft overflights in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from vessel movements in non-territorial waters would be possible but unlikely. In accordance with the ESA, aircraft overflights under Alternative 2 may affect leatherback sea turtles.

Non-Explosive Ordnance Use

Approximately 181,000 non-explosive ordnance rounds would be used in the PACNW OPAREA annually under Alternative 2. As described above, use could be concentrated in W-237, but ordnance would be used in all areas of the PACNW OPAREA beyond three nautical miles (5.5 km). The density of annual ordnance use would be approximately 1.5 items per nm^2 (3.4 km^2) over the entire PACNW OPAREA. Using the existing turtle density estimate, 0.12 to 0.26 turtles could occur per nm^2 (3.4 km^2) within the PACNW OPAREA. Given the relatively small sizes of both the turtles (up to 70 inches [1.8 meters]) and the ordnance used (from less than one inch [2.5 centimeters] to 8 feet [2.4 meters]), the potential for turtles to be struck by ordnance is low. Consistent use of Navy protective measures would also help minimize the likelihood of ordnance strikes to sea turtles.

In accordance with the NEPA, non-explosive ordnance use in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from non-explosive ordnance use in non-territorial waters would be possible but unlikely. In accordance with the ESA, non-explosive ordnance strikes under Alternative 2 may affect leatherback turtles.

Underwater Detonations and Explosive Ordnance

Under the No Action Alternative, approximately 93 bomb and missile explosions would occur each year during training activities in the PACNW OPAREA. In addition, 149 explosive sonobuoys would be used. Although use of these explosive training components would be concentrated in W-237, their use may occur in all areas of the PACNW OPAREA beyond three nautical miles (5.5 km). The occurrence density of annual ordnance use would be approximately 0.002 detonations per nm^2 (3.4 km^2) over the entire PACNW OPAREA.

Leatherbacks have been sited in Puget Sound, and could potentially be exposed to the pressure wave from the EOD detonations. As described for Alternative 1, in the unusual event that a sea turtle were in the vicinity of underwater EOD activities, they could be exposed to the pressure wave from the detonation. With the low occurrence rate of leatherbacks in Puget Sound, the infrequency of EOD activities (four total detonations per year), and protective measures employed, impacts from underwater EOD may affect leatherback sea turtles.

As described above, an analysis was conducted to estimate the number of sea turtles that could be exposed to impacts from explosions (see Section 3.9 Marine Mammals for a full description of the modeling and methods and Section 3.8.2.1 for sea turtle-specific thresholds). The explosions and detonations that would take place under Alternative 2 would have the potential to affect six leatherback sea turtles – three would potentially be affected at the dual criteria level (23 psi peak pressure from small explosives) and three would potentially be affected at the non-injurous behavior disruption level. No sea turtle mortalities would be expected under Alternative 2. The Navy is working with NMFS through the ESA Section 7 consultation process to ensure that unavoidable significant effects to sea turtles do not result from implementation of the proposed action.

In accordance with the NEPA, explosive ordnance use in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from explosive ordnance use in non-territorial waters would be possible but unlikely. In accordance with the ESA, use of explosive ordnance in the PACNW OPAREA under Alternative 2 may affect leatherback sea turtles.

Expended Materials

Ordnance-Related Materials

As described above, leatherback sea turtles would not be expected to be at risk from ingesting ordnance-related materials because they feed in the water column, not in the benthic environment. Because these materials sink rapidly and are encrusted on the sea floor, the potential to affect the leatherback would be remote. Leatherbacks would not be expected to ingest ordnance expended under Alternative 2 because they do not typically feed in the benthic environment. In addition, there is no difference in SINKEX activities between Alternative 1 and 2.

In accordance with the NEPA, expended materials in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from expended materials in non-territorial waters would be possible but unlikely. In accordance with the ESA, ordnance-related materials under Alternative 2 would have no effect on leatherback sea turtles.

Target-Related Materials

As described above, a variety of at-sea targets are used in the PACNW OPAREA. Many of the targets are recovered for reuse and are not destroyed during training. The expendable EMATT and MK-58 units sink to the bottom intact. Because of these characteristics, they present no ingestion hazard to sea turtles.

The smoke and flames produced by the MK-58 dissipate in the air, having little effect on the marine environment. The light generated from the marker is either reflects off the water's surface or enters the water and attenuates in brightness over depth.

In accordance with the NEPA, target use in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from target use in non-territorial waters would be possible but unlikely. In accordance with the ESA, use of target-related materials under Alternative 2 would have no effect on leatherback sea turtles.

Entanglement

Under Alternative 2, use of sonobuoys would increase by approximately 6 percent compared to the No Action Alternative. Changes in the use of targets and markers that are delivered using parachutes were provided under "Target-Related Materials." As described for the No Action Alternative, the parachutes would not be recovered and would sink to the sea floor. The modest increase in the use of materials that could cause a short-term entanglement hazard would not increase potential impacts to sea turtles above those described for the No Action Alternative.

Under Alternative 2, two torpedoes would be potentially be used each year during SINKEX activities. As described above, torpedoes may be guided by thin wires after initial deployment. These metal wires sever prior to detonation and sink to the bottom. The use of two guide wires each year would have a low probability of affecting sea turtles in the PACNW OPAREA.

In accordance with the NEPA, entanglement from military-related debris in territorial waters would have minimal impact on leatherback turtles. In accordance with EO 12114, harm to leatherback turtles from entanglement from military-related debris in non-territorial waters would be possible but unlikely. In accordance with the ESA, entanglement from military-related debris under Alternative 2 may affect leatherback sea turtles.

3.8.3 Mitigation Measures

As discussed in Section 3.8.4, impacts to the leatherback sea turtle resulting from the alternatives proposed in the EIS/OEIS would be below thresholds that could adversely affect the continued presence of this species in the NWTRC or their use of the Study Area. The current requirements and practices described in Chapter 5 would continue to be implemented, and no further mitigation measures would be needed to protect sea turtles in the NWTRC.

3.8.4 Summary of Effects by Alternative

There are no formal density studies for sea turtles in the PACNW OPAREA, but use of the area by sea turtles other than the leatherback is restricted by cold water temperatures. The low occurrence of turtles, limited number of stressors from Navy activities, and routine implementation by the Navy of protective measures combine to produce a low potential for effects to sea turtles under all the alternatives. Table 3.8-2 summarizes the effects of the alternatives.

Table 3.8-2: Summary Effects – Sea Turtles

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Activities would have temporary and spatially limited short-term impacts. • No long-term effects would occur. • No Action Alternative may affect Federally listed leatherback turtles.	• Activities would have temporary and spatially limited short-term impacts. • No long-term effects would occur. • No Action Alternative may affect Federally listed leatherback turtles.
Alternative 1	• Impacts generally the same as No Action Alternative. • Alternative 1 may affect Federally listed leatherback turtles.	• Impacts generally the same as No Action Alternative. • Alternative 1 may affect Federally listed leatherback turtles.
Alternative 2 (Preferred Alternative)	• Impacts generally the same as No Action Alternative. • Alternative 2 may affect Federally listed leatherback turtles.	• Impacts generally the same as No Action Alternative. • Alternative 2 may affect Federally listed leatherback turtles.

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3.9 Marine Mammals

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3.9 MARINE MAMMALS

This section summarizes the affected environment and environmental impacts analysis for marine mammals occurring in the NWTRC. Marine mammals addressed in this section include whales, dolphins, seals, sea lions, and the sea otter.

This section is organized to:

- Describe population characteristics of the species known to occur in the Study Area;
- Identify the regulatory conditions that apply to these species and that affect potential operational activities;
- Identify the methods used to analyze potential effects;
- Describe the substantial effects of each alternative on this group and to individual species as warranted; and
- Describe the proposed mitigation measures and their effectiveness at avoiding or reducing potential impacts from activities.

Information on federally-protected species is presented first, followed by non-listed species. Due to the numerous species of marine mammals included in this analysis, tables are used to summarize relevant information.

3.9.1 Affected Environment

This section provides information on the occurrence, distribution, habitat requirements, reproduction, feeding characteristics, and acoustic capabilities of marine mammals in the Study Area.

All marine mammals are protected under the Marine Mammal Protection Act (MMPA) of 1972, amended in 1994. The MMPA is administered by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS). Ten of the marine mammals found in the NWTRC Study Area receive additional protection under the Endangered Species Act (ESA). Section 7 of the ESA provides information on the preparation of biological evaluations to address potential impacts to these species and their critical habitats.

Marine mammals that occur within the Study Area belong to four taxonomic groups:

- *Mysticetes* (large whales with baleen) and *odontocetes* (toothed whales, porpoises, and dolphins) are known collectively as cetaceans. Cetaceans spend their lives entirely at sea.
- *Pinnipeds* (seals and sea lions) are divided into eared seals or *otariids* such as sea lions and fur seals, and earless seals or *phocids* such as harbor seals and elephant seals. Pinnipeds hunt and feed exclusively in the ocean, but certain species in the NWTRC Study Area come ashore to rest, molt, breed, and bear young.
- *Mustelids* (sea otter) are related to weasels, skunks, and wolverines. The sea otter (*Enhydra lutris*) rarely comes ashore and spends most of its life in the ocean where it swims, feeds, and rests.

Marine mammals inhabit most marine environments from deep ocean canyons to shallow estuarine waters. Their distribution is affected by demographic, evolutionary, ecological, habitat preference, and human-related factors (Bowen et al. 2002; Bjørge 2002; Forcada 2002; Stevick et al. 2002). The movements of marine mammals are often related to feeding or breeding activity (Stevick et al. 2002). For example, many populations of marine mammals migrate seasonally to exploit areas where favorable environmental conditions exist for feeding, breeding, and/or molting. Some baleen whale species, such as the humpback whale (*Megaptera novaeangliae*), annually migrate to low-latitude mating and calving grounds in winter and to high-latitude feeding grounds in summer (Corkeron and Connor 1999). Marine mammal movements can also be linked to the distribution and abundance of prey (Gaskin 1982; Payne et al. 1986; Kenney et al. 1996). Cetacean movements have also been linked to indirect indicators of prey such as temperature variations, sea-surface chlorophyll-*a* concentration, and bottom depth (Fiedler 2002). Upwelling zones, eddies, and turbulent mixing can locally enhance productivity and/or entrain prey.

There are 32 species of marine mammals known to occur in the NWTRC Study Area (Table 3.9-1). Life history and habitat information for these species is detailed in the *Marine Resources Assessment for the Pacific Northwest Operating Area* (DoN 2006). For some species, the Study Area constitutes a large portion of their total range. Other species, such as the gray whale (*Eschrichtius robustus*), primarily transit through the Study Area during annual migrations between northern feeding grounds and breeding lagoons in Mexico; however, some animals remain off the coasts of Washington, Oregon, and northern California during the fall and summer months (Calambokidis et al. 2002). The 32 species that occur in the NWTRC Study Area include 7 species of baleen whales (mysticetes), 19 species of toothed whales (odontocetes), 5 species of seals and sea lions (pinnipeds), and the sea otter (mustelid). Table 3.9-1 summarizes their density, ESA and MMPA status, population trends, and occurrence in the area. Information presented in Table 3.9-1 was compiled from numerous literature and technical sources, which are identified in each species profile description. The abundance of the species varies by species and seasonally for many (Table 3.9-1). Many species are listed as common, indicating that they occur routinely, either year-round or during annual migrations into or through the area. Some species are indicated as “rare” because of sporadic sightings or as “extralimital” animals documented once or twice as appearing outside their normal range. All of the species that occur in the NWTRC Study Area are either cosmopolitan (occur worldwide), or associated with the temperate and sub-Arctic oceans (Leatherwood et al. 1988).

Species occurrence within the OPAREA may be described as either primary or secondary occurrence. Primary occurrence means areas or habitats where a species is primarily found. Secondary occurrence indicates areas and habitats where a species may be found especially during seasonal migrations or anomalous environmental conditions (DoN 2006).

The beluga whale (*Delphinapterus leucas*) and pantropical spotted dolphin (*Stenella attenuata*) were excluded from Table 3.9-1 because they are considered very infrequent visitors of the Study Area. An individual beluga whale was sighted a few times during 1940 near Tacoma, Washington, but these were considered extralimital records (Scheffer and Slipp 1948). There are few records of the pantropical spotted dolphin north of the California-Mexico border, including strandings in central California (Worthy et al. 1993) and Alaska. However, this species prefers much warmer waters and is not expected in the Study Area. Since the NWTRC Study Area is well outside the normal range of both these species, they will not be discussed further in this analysis.

The distribution of some marine mammal species is based on the presence of salmon, an important prey source. Seals and sea lions congregate near areas where migrating salmon run. For example, in the San Juan Islands, harbor seals (*Phoca vitulina richardii*) congregate near a constricted channel where incoming tidal currents funnel migrating salmon (Zamon 2001). In Oregon, harbor seals wait for chum salmon (*Oncorhynchus keta*) runs during the incoming tide near a constriction in Netarts Bay (Brown and Mate 1983). During the summer, resident killer whales (*Orcinus orca*) congregate at locations associated with high densities of migrating salmon (Heimlich-Boran 1986; Nichol and Shackleton 1996; Olson 1998; NMFS 2005d). Their strong preference for Chinook salmon (*Oncorhynchus tshawytscha*) may influence the year-round distribution patterns of resident killer whales in the Study Area (Ford and Ellis 2005).

Table 3.9-1: Summary of Marine Mammal Species Found in the NWTRC Study Area

Common Name Species Name	Density (animals/km^2) [a]	Stock	ESA/ MMPA Status [b]	Population Trend	Occurrence	Designated Critical Habitat	Warm Season May-Oct	Cold Season Nov-Apr
ESA Listed Species								
Blue whale *Balaenoptera musculus*	0.0005	Eastern North Pacific	E, D, S	May be increasing	Rare, all year	None in North Pacific	Yes	No
Fin whale *Balaenoptera physalus*	0.0014	California, Oregon, and Washington	E, D, S	May be increasing	Rare, all year	None	Yes	Yes
Humpback whale *Megaptera novaeangliae*	0.0007	Eastern North Pacific	E, D, S	Increasing	Rare, warm season	None	Yes	No
North Pacific right whale *Eubalaena japonica*	--	Eastern North Pacific	E, D, S	Unknown	Very rare, warm season	None in Study Area	Yes	Yes
Sei whale *Balaenoptera borealis*	0.000115-0.000182	Eastern North Pacific	E, D, S	May be increasing	Very rare, all year	None	Yes	No
Sperm whale *Physeter macrocephalus*	0.0026	California, Oregon, and Washington	E, D, S	Unknown	Uncommon	None	Yes	Yes
Southern resident killer whale *Orcinus orca*	0.00055-0.00162 [c]	Eastern North Pacific Southern Resident	E, D	Increasing	Rare	Yes, Puget Sound and vicinity	Yes	Yes
Steller sea lion *Eumetopias jubatus*	0.000011-0.011	Eastern North Pacific	T, D	Increasing	Uncommon	Yes, rookeries in Oregon and California	Yes	Yes
Sea Otter *Enhydra lutris*	--	California Washington	T, D	Increasing Increasing	Common, all year	None	Yes	Yes
Non-ESA Listed Baleen Whales								
Gray whale *Eschrichtius robustus*	--	Eastern North Pacific		Increasing	Common, warm season	--	No	Yes
Minke whale *Balaenoptera acutorostrata*	0.000395-0.000655	California, Oregon, and Washington		No trends	Rare, all year	--	No	Yes
Non-ESA Species Toothed Whales								
Baird's beaked whale *Berardius bairdii*	0.000775-0.001614	California, Oregon, and Washington		Unknown	Very rare, warm season	--	Yes	Yes

Table 3.9-1: Summary of Marine Mammal Species Found in the NWTRC Study Area (cont'd)

Common Name Species Name	Density (Animals/km²) a/	Stock	ESA/ MMPA Status b/	Population Trend	Occurrence	Designated Critical Habitat	Warm Season May-Oct	Cold Season Nov-Apr
Bottlenose dolphin offshore *Tursiops truncatus*	0.000515	California/Oregon/Washington Offshore		Stable	Very rare/extralimital	--	Yes	Yes
Cuvier's beaked whale *Ziphius cavirostris*	0.003038	California, Oregon, and Washington		Unknown	Uncommon	--	Yes	Unknown
Dall's porpoise *Phocoenoides dalli*	0.0970	California, Oregon, and Washington		Unknown	Abundant	--	No	Yes
Dwarf sperm whale *Kogia sima*	0.000504-0.001232	California, Oregon, and Washington		Unknown	Uncommon, warm season	--	Unknown	Yes
False killer whale *Pseudorca crassidens*	--	Hawaiian		Unknown	Rare	--	Unknown	Unknown
Harbor porpoise *Phocoena phocoena*	1.51 1.12	N. California/S. Oregon Oregon/Washington Coast		Stable Stable	Common	--	Yes	Yes
Hubbs' beaked whale *Mesoplodon carlhubbsi*	0.001321-0.001350[d/]	Washington, Oregon, and California		Unknown	Rare	--	Unknown	Unknown
Killer whale offshore *Orcinus orca*	0.00055-0.00162[c/]	Eastern North Pacific Offshore		Unknown	Uncommon, all year	--	No	Yes
Killer whale transient *Orcinus orca*	0.00055-0.00162[c/]	West Coast Transient		Unknown	Uncommon, all year	--	No	Yes
Northern right whale dolphin *Lissodelphis borealis*	0.0113	California, Oregon, and Washington		No trend	Common	--	Yes	Yes
Pacific white-sided dolphin *Lagenorhynchus obliquidens*	0.016029-0.024823	California, Oregon, and Washington		No trend	Common, warm season	--	Yes	Yes
Pygmy sperm whale *Kogia breviceps*	0.000504-0.001232	California, Oregon, and Washington		Unknown	Uncommon, warm season	--	Unknown	Unknown
Risso's Dolphin *Grampus griseus*	0.004014-0.013222	California, Oregon, and Washington		No trend	Uncommon	--	Yes	Yes
Rough-toothed dolphin *Steno bredanensis*	--	Hawaiian		Unknown	Very rare/extralimital	--	Unknown	Unknown

Table 3.9-1: Summary of Marine Mammal Species Found in the NWTRC Study Area (cont'd)

Common Name Species Name	Density (Animals/km^2) a/	Stock	ESA/ MMPA Status b/	Population Trend	Occurrence	Designated Critical Habitat	Warm Season May-Oct	Cold Season Nov-Apr
Short-beaked common dolphin *Delphinus delphis*	0.014137-0.259357	California, Oregon, and Washington		Varies by oceanographic conditions	Uncommon, warm season	--	Yes	Yes
Short-finned pilot whale *Globicephala macrorhynchus*	0.000713	California, Oregon, and Washington		Unknown	Rare	--	Unknown	Unknown
Stejneger's beaked whale *Mesoplodon stejnegeri*	0.001321-0.001350[c/]	California, Oregon, and Washington		Unknown	Rare	--	Unknown	Unknown
Striped dolphin *Stenella coeruleoalba*	0.0000497-0.015653	California, Oregon, and Washington		No trend	Very Rare, warm season	--	No	Unknown
Non-ESA Species Pinnipeds								
California sea lion *Zalophus californianus*	0.00092-0.032	U.S. Stock		Increasing	Common, cold season	--	Yes	Yes
Harbor seal *Phoca vitulina*	--			Increasing Stable	Abundant, all year	--	Yes	Yes
Northern elephant seal *Mirounga angustirostris*	0.0022-0.0048	California Breeding		Increasing	Uncommon, warm season	--	Yes	Yes
Northern fur seal *Callorhinus ursinus*	0.40	Eastern Pacific		Increasing	Common, cold season; Uncommon, warm season	--	Yes	Yes

a/ Animals per square kilometer for total Study Area from DoN 2007;

b/ ESA = Endangered Species Act. MMPA = Marine Mammal Protection Act. E = endangered. D = depleted. S = strategic stock under the MMPA. T = threatened.

c/ Estimate for southern resident, transient, and offshore killer whales

d/ Includes six species of rare beaked whales; estimates for individual species are unavailable (Carretta et al. 2007a)

Density and abundance estimates for cetaceans were obtained from the *Marine Mammal and Sea Turtle Density Estimates for the Pacific Northwest Study Area* (DoN 2007). The abundance of most cetaceans was derived from shipboard surveys conducted by the Southwest Fisheries Science Center in 1991, 1993, 1996, 2001, and 2005 (Barlow 1995; Barlow 2003; Barlow and Forney 2007). The most recent estimates are used to develop NMFS Stock Assessment Reports; interpret the impacts of human-caused mortality associated with fishery bycatch, ship strikes, and other sources; evaluate current status of the stock, and evaluate the ecological role of cetaceans in the eastern North Pacific (Carretta et al. 2007a; Carretta et al. 2007b; Angliss and Outlaw 2008).

In the marine mammal density study (DoN 2007), predictive species-habitat models were built for species with sufficient numbers of sightings to estimate densities for the NWTRC Study Area. For species with insufficient numbers of sightings, density estimates were obtained from Barlow and Forney (2007). Density estimates are for the summer season (late July to early December) (DoN 2007).

There is concern about the effects of noise from some naval activities on marine mammals. Therefore, information on acoustics and hearing abilities of the marine mammals occurring in the NWTRC Study Area is summarized in Table 3.9-2 and is discussed in separate species profiles. Information presented in Table 3.9-2 was compiled from numerous literature and technical sources, which are identified in each species profile.

3.9.1.1 Threatened and Endangered Marine Mammal Species

There are nine marine mammal species listed as either endangered or threatened under the ESA with confirmed or possible occurrence in the NWTRC Study Area. These include the blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus),* humpback whale, North Pacific right whale (*Eubalaena japonica)*, sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*), southern resident killer whale, Steller sea lion (*Eumetopias jubatus*), and sea otter. Except for the sea otter and the southern resident killer whale (which could be considered locally more common), these species are uncommon to very rare in the NWTRC Study Area. The sea otter is a common inhabitant in some locations and the southern resident killer whale is seasonally common in the Puget Sound and Strait of Juan de Fuca areas. Key aspects of the life history of each marine mammal species are summarized below. Detailed descriptions are presented in the Marine Resources Assessment for the PACNW OPAREA (DoN 2006).

Factors contributing to the endangered or threatened status of these species include historic whaling, mortality incidental to commercial gillnet fisheries, entanglement with longline sets, ship strikes, and incidental injuries. After the 1997 implementation of a take reduction plan, which included skipper education workshops and required the use of pingers and minimum 6-fathom extenders, overall cetacean entanglement rates in the drift gillnet fishery dropped considerably (Barlow and Cameron 2003). Currently, these effects are typically very small at the species level (generally on the order of one to two individuals per species per year or less). Although marine mammal mortality from ship strikes has been documented, the incidence numbers are presently very low (generally on the order of zero to five documented records depending on the species) and infrequent.

Table 3.9-2: Sound Production and Hearing Capabilities of Marine Mammals in the Pacific Northwest OPAREA and Puget Sound

Common Name	Sound Production		Hearing Ability
	Frequency Range (kHz)	Source Level Sound (dB re 1 μPa-m)	Frequency Range (kHz)
Baleen whales			
North Pacific right whale	0.050 - 0.6	137 - 192	0.010 - 22 (predicted)
Humpback whale	0.020 - 10	144 - 192	0.7 - 10 (predicted)
Minke whale	0.060 - 20	150 - 175	Not Available
Sei whale	0.433 (+/- 0.192) - 3.5	156 +/- 3.6	Not Available
Fin whale	0.010 - 0.75	155 - 186	Not Available
Blue whale	0.012 - 0.4	188 (maximum)	Not Available
Gray whale	0.020 - 20	142 - 185	<2
Toothed whales			
Sperm whale	0.1 - 30	140 - 236	5 - 20 (measured from 1 neonatal sperm whale)
Pygmy sperm whale	60 - 200	Not Available	90 - 150
Dwarf sperm whale	13-33	Not Available	Not Available
Cuvier's beaked whale	0.3 - 135	214 (maximum)	Not Available
Hubbs' beaked whale	0.3 - 80	Not Available	Not Available
Stejneger's beaked whale	Not Available	Not Available	Not Available
Baird's beaked whale	4 - 42	Not Available	Not Available
Rough-toothed dolphin	0.1 - 200	Not Available	Not Available
Bottlenose dolphin	0.8 - 130	125 - 228	0.01 - 150
Striped dolphin	6 - 24+	Not Available	29 - 123
Short-beaked common dolphin	0.2 - 150	180 (maximum)	5 - 150
Pacific white-sided dolphin	0.002 - 80	170 (peak amplitude)	0.075 - 150
Risso's dolphin	0.1 - 65	222 (maximum)	1.6 - 150
Northern right whale dolphin	1 - 16+	170 (maximum)	Not Available
False killer whale	4 - 130	220 - 228	16 - 64
Killer whale	0.1 - 35	137 - 224	<0.5 - 105
Short-finned pilot whale	0.5 - >20	180 (maximum)	Not Available
Harbor porpoise	0.04 - 160	135 - 177	16 - 140
Dall's porpoise	0.04 - 160	120 - 175	Not Available
Pinnipeds			
Harbor seal	0.1 - 150	Not Available	1 - 180
Northern elephant seal	0.2 - 1	Not Available	0.075 - 45
Northern fur seal	Not Available	Not Available	0.5 - 60
Steller sea lion	0.03 - 3 (female calls only)	Not Available	1 - 25
California sea lion	0.25 - 6	Not Available	1 - 40
Mustelids			
Sea otter	0.2-12.8 (in-air)	Not Available	Not Available

Blue Whale (Balaenoptera musculus)

Listing Status

The blue whale was classified as endangered in 1970 under the ESA. The Eastern North Pacific stock is considered a depleted and strategic stock under the MMPA. The blue whale was severely depleted by commercial whaling in the 20th century (NMFS 1998b). A final species recovery plan has been prepared (NMFS 1998b).

Critical Habitat

There is no designated critical habitat for this species in the North Pacific.

Population Status

The most recent NMFS population estimate for this stock of blue whales is 1,186 (CV = 0.19) individuals (Carretta et al. 2007b). However, the best estimate for the California/Oregon/Washington stock, which incorporates five survey years (1991, 1993, 1996, 2001, and 2005), is 1,548 (CV = 0.16) individuals (Barlow and Forney 2007). The abundance of blue whales along the California coast has been increasing during the past two decades (Calambokidis et al. 1990; Barlow 1994; Calambokidis 1995).

Distribution

Blue whales are distributed from the ice edges to the tropics in both hemispheres (Jefferson et al. 1993). Most animals summer in high latitudes and move into the subtropics and tropics during the winter (Yochem and Leatherwood 1985). However, some individuals may remain year-round in low latitude areas with adequate food supplies (Wade and Friedrichsen 1979; Reilly and Thayer 1990).

In the Pacific, blue whales may be found as far north as the Gulf of Alaska, Aleutian Islands, Kuril Islands, and the Kamchatka Peninsula during the spring and summer months (Yochem and Leatherwood 1985) and as far south as the coast of Guatemala in the fall and winter months. Photographic identification has established matches between individual blue whales in the Queen Charlotte Islands in British Columbia and the Santa Barbara Channel in California (COSEWIC 2002), and in the Gulf of Alaska and southern California (Calambokidis personal communication 2005). A blue whale tagged in the Okhotsk Sea under the "Discovery" tagging program was reported as having been killed in waters east of Kodiak Island (Ivashin and Rovnin 1967).

Satellite telemetry studies conducted by the Oregon State University in 2004 with tagged blue whales traced blue whale movements from off the coast of Oregon south through Mexican waters to a previously unknown possible winter breeding and calving area 500 mi (805 km) off the coast of Costa Rica. Within two months of tagging, blue whales tagged off central California ranged from the north end of Vancouver Island, Canada to Magdalena Bay, Mexico, a distance of over 2,000 mi (3,219 km). Of the 12 blue whales carrying location tags, four were briefly clustered in a 5-mi (8-km) area of water off Coos Bay, Oregon. Overall, the blue whales showed a strong affinity for the outer edge of cold, upwelled water (also known as salmon water), where they fed on krill (http://mmi.oregonstate.edu/wtg/research/blue-whale accessed on August 286, 2008).

Although blue whales are found singly or in groups of two or three (Yochem and Leatherwood 1985), apparently solitary whales are likely part of a large dispersed group (Wade and Friedrichsen 1979).

Feeding/Reproduction

Blue whales forage in coastal and oceanic waters and feed almost exclusively on krill (Nemoto and Kawamura 1977). Krill include eight invertebrate species. Important foraging areas include edges of continental shelves and upwelling regions that form close to regions of steep topographic relief off the continental shelf break (Reilly and Thayer 1990; Schoenherr 1991; Croll et al. 1999). The Eastern North

Pacific stock feeds in waters from California to Alaska in summer and fall, and migrates south to the waters of Mexico to Costa Rica in winter (NMFS 2006e) for breeding and to give birth (Mate et al.1999). Female blue whales reach sexual maturity at 5 to 15 years of age (Yochem and Leatherwood 1985). There is usually a two-year interval between calves. Calving occurs primarily during the winter (Yochem and Leatherwood 1985).

Acoustics

Blue whales produce calls with the lowest frequency and highest source levels of all cetaceans. The frequency range of their long, patterned, low-frequency "songs" is 0.012 to 0.4 kHz, with dominant energy in the infrasonic range at 0.012 to 0.025 kHz (Ketten 1998; Mellinger and Clark 2003). Their short-duration sounds are transient, with a higher frequency range that often sweeps down (Di Iorio et al. 2005; Rankin et al. 2005). These short-duration sounds are less than 5 sec in duration and are high-intensity, broadband (0.858±0.148 kHz) pulses (Di Iorio et al. 2005; Rankin et al. 2005). Source levels of blue whale vocalizations have been reported at up to 188 decibels (dB) re 1 µPa-m (Ketten 1998; McDonald et al. 2001) and at 195 dB re 1 µPa-m at 0.017 kHz (Aburto et al. 1997). Stafford et al. (2005) recorded the highest calling rates when blue whale prey was closest to the surface during its vertical migration.

No data on hearing ability for this species are available. However, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing.

Information Specific to the Northwest Training Range Complex Study Area

Blue whales are known to feed in the southern part of the NWTRC Study Area. During the spring and early summer, the primary occurrence for the blue whale is south of 44°N, from the shore to seaward of the OPAREA boundary. There is an additional area of primary occurrence north of 48°N, based on whaling records off British Columbia. An area of secondary occurrence is located between 44°N and 48°N. Waters within the Study Area presumably are used as a feeding area. Year-round, the Puget Sound is an area of rare occurrence for the blue whale.

From late summer into autumn, the coast of the NWTRC Study Area is an area of primary occurrence for the blue whale. Blue whales are feeding in the area as late as October, although fewer individuals are seen because the majority of the population migrates south. Acoustic data collected by Sound Surveillance System hydrophones reveal that males are calling at this time of the year in this area (Stafford et al. 2001).

Based on predictive spatial habitat models (see Appendix D), density estimates of blue whales in the NWTRC Study Area ranged from 0 to 0.144 individuals per square kilometer (km^2), with an overall Study Area density estimate of 0.0005 individuals per km^2 (DoN 2007).

Fin Whale (*Balaenoptera physalus*)

Listing Status

The fin whale was listed in 1970 as endangered under the ESA. The California/Oregon/Washington stock is considered depleted and strategic under the MMPA. A draft species recovery plan has been prepared (NMFS 2006a).

Critical Habitat

Critical habitat has not been designated for the fin whale.

Population Status

The NMFS population estimate for the California/Oregon/Washington stock of the fin whale is 3,454 (CV = 0.27) individuals (Carretta et al. 2007b). However, this assessment only incorporates surveys performed in 2001 and 2005. Currently, the best estimate for the California/Oregon/Washington Stock, which incorporates five survey years (1991, 1993, 1996, 2001, and 2005), is 2,099 (CV = 0.18) individuals (Barlow and Forney 2007). The population trend for this species is thought to be potentially increasing (refer to Table 3.9-1).

Distribution

Fin whales are broadly distributed throughout the world's oceans, usually in temperate to polar latitudes and less commonly in the tropics (Reeves et al. 2002). During the summer in the Pacific, fin whales are distributed from the southern Chukchi Sea (69°N) south to 30°N in the California Current (Mizroch et al. 1999). They have been observed during the summer in the central Bering Sea (Moore et al. 2000). During the winter, fin whales are sparsely distributed from 60°N, south to the northern edge of the tropics, near which it is assumed that they mate and calve (Mizroch et al. 1999).

Feeding/Reproduction

In the North Pacific, fin whales appear to prefer krill and large copepods, but also eat schooling fish such as herring (*Clupea pallasii*), walleye pollock *(Theragra chalcogramma),* and capelin (*Mallotus villosus*), (Nemoto and Kawamura 1977). Single fin whales are most common, but they gather in groups, especially when good sources of prey are aggregated. Female fin whales in the North Pacific mature at eight to 12 years of age (Boyd et al. 1999) and calve once every two to three years (Agler et al. 1993). Reproductive activities for fin whales occur primarily in low latitude areas in the winter (Reeves 1998; Carretta et al. 2007b). Peak calving is in October through January (Hain et al. 1992).

Acoustics

Although the frequency can range up to 0.750 kHz, the most typical fin whale sound is a 0.02-kHz, infrasonic pulse with a duration of about 1 sec. Source levels are 184 to 186 dB re 1 µPa-m (maximum up to 200); (Thomson and Richardson 1995; Charif et al. 2002). There also is a long, patterned 0.015- to 0.030-kHz vocal sequence of males that might function as male breeding displays, much like the male humpback whale song (Croll et al. 2002). The depth of calling fin whales is about 164 ft (50 m) (Watkins et al. 1987).

While no data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing.

Information Specific to the Northwest Training Range Complex Study Area

Fin whales occur throughout the OPAREA and, prior to commercial whaling off British Columbia, fin whales were occasional visitors to the inland waters (Osborne et al. 1988). However, fin whales are now extremely rare within the Puget Sound (Wade personal communication 2005). Strandings reported within the Puget Sound have all been individuals struck by ships, and they presumably were carried on the bow into the sound (Norman et al. 2004).

Based on predictive spatial habitat models (see Appendix D), density estimates of fin whales in the NWTRC Study Area ranged from 0 to 0.0245 individuals per km^2, with an overall Study Area density estimate of 0.0014 individuals per km^2 (DoN 2007).

Humpback Whale (*Megaptera novaeangliae*)

Listing Status

The humpback whale was listed as endangered in 1970 under the ESA. This species is classified as depleted and strategic stock under the MMPA. A final species recovery plan has been prepared (NMFS 1991).

Critical Habitat

Critical habitat has not been designated for this species in waters off California, Oregon, and Washington.

Population Status

The population trend for this species is thought to be increasing (refer to Table 3.9-1). There are three recognized stocks or populations in the North Pacific, including the eastern (which includes most whales off California, Oregon, Washington, and Mexico), central, and western stocks (Baker et al. 1998; Calambokidis et al. 2001; Carretta et al. 2006), and up to six subpopulations of humpback whales in the North Pacific might be recognized (Calambokidis et al. 2001). The Eastern North Pacific humpback whale stock is the one most likely to be encountered within the NWTRC. The most recent NMFS estimate of population size for the Eastern North Pacific stock is 1,391 (CV = 0.22; Carretta et al. 2007a). However, the best estimate for the California/Oregon/Washington Stock, which incorporates five survey years (1991, 1993, 1996, 2001, and 2005), is 942 (CV = 0.26) individuals (Barlow and Forney 2007).

Distribution

Humpback whales are globally distributed in all major oceans and most seas. They are generally found during the summer on high-latitude feeding grounds and during the winter in the tropics and subtropics, although some individuals are seen in high latitude areas during all months of the year (Straley 1990). During the summer, humpback whales occur from southern California to the Aleutian Islands, Kamchatka Peninsula, and Bering and Chukchi Seas (Calambokidis et al. 2001). Shallow banks or ledges with high sea-floor relief characterize feeding grounds (Payne et al. 1990; Hamazaki 2002).

Feeding/Reproduction

Humpback whales feed on krill and small schooling fish, including herring, mackerel, sand lance, sardines, anchovies, and capelin (Clapham and Mead 1999). Although humpback whales do not typically feed on the breeding grounds, some feeding behavior has been observed there (Salden 1989; Gendron and Urbán R. 1993). Feeding typically occurs over deep, oceanic waters during migration while feeding and breeding habitats are mostly in shallow coastal waters over continental shelves (Clapham and Meade 1999). Female humpbacks become sexually mature at 4 to 9 years of age and usually calve at intervals of two to three years (Clapham 1996).

Acoustics

The best-known of the humpback's vocalizations are the "songs" of males in the late fall, winter, and spring. These are thought to be breeding displays used only by adult males (Helweg et al. 1992). Singing is most common on breeding grounds, but is occasionally heard outside breeding areas and out of season (Mattila et al. 1987; Gabriele et al. 2001; Gabriele and Frankel 2002; Clark and Clapham 2004). There is geographical variation in humpback whale song (Payne et al. 1983).

Components of the male song range from under 0.02 kHz to 8 kHz, with source levels of 144 to 174 dB re 1 µPa-m. Au et al. (2001) recorded high-frequency harmonics (up to 13.5 kHz) and source levels between 171 and 189 dB re 1 µPa-m. Songs have also been recorded on feeding grounds (Mattila et al. 1987; Clark and Clapham 2004). The main energy lies between 0.2 and 3.0 kHz, with frequency peaks at 4.7 kHz.

Humpback vocalizations also include sounds made within groups on the wintering (calving) grounds and social sounds made on the feeding grounds (Thomson and Richardson 1995). Social calls are from 0.05 kHz to over 10 kHz, with dominant frequencies below 3 kHz (Silber 1986). "Feeding" calls, unlike song and social sounds, are highly stereotyped series of narrow-band trumpeting calls. They are 0.02 kHz to 2 kHz, less than 1 sec in duration, and have source levels of 162 to 192 dB re 1 µPa-m. The fundamental frequency of feeding calls is approximately 0.5 kHz (D'Vincent et al. 1985; Thompson et al. 1986).

While no tests on humpback whale hearing have been made, Houser et al. (2001) constructed a humpback audiogram using a mathematical model based on the internal structure of the ear and estimated sensitivity to frequencies from 0.7 kHz to 10 kHz, with maximum relative sensitivity between 2 and 6 kHz.

Information Specific to the Northwest Training Range Complex Study Area

Humpback whales feed in the OPAREA during the non-breeding season. They are present off the northern California coast between April and December and may be found off the Oregon and Washington coasts from May through November (Dohl et al. 1983; Green et al. 1992; Forney and Barlow 1998). Between January and March, most whales are south on their breeding grounds and not in the OPAREA.

Humpback whales primarily feed along the shelf break and continental slope (Green et al. 1992; Tynan et al. 2005). Off Washington, they concentrate between Juan de Fuca Canyon and the outer edge of the shelf break in a region called “the Prairie,” near Barkley and Nitnat Canyons, and near Swiftsure Bank (Calambokidis et al. 2004b). Off the coast of Oregon, humpbacks congregate near Heceta Bank (Green et al. 1992). These locations represent important feeding areas for humpback whales in the OPAREA.

The area of primary occurrence is along the outer coast from the shore to a depth of about 9,842 ft (3,000 m). Primary occurrence branches off somewhat near the Strait of Juan de Fuca to account for nearby feeding aggregations. The area of secondary occurrence is an additional 100 nm (185 km) buffer that accounts for encountering some individuals that might migrate farther offshore. Occurrence seaward of this secondary buffer is rare.

Although humpback whales were common in inland Washington waters prior to the whaling period, only a few sightings have been made in this area until 2001 (Scheffer and Slipp 1948; Calambokidis and Steiger 1990; Pinnell and Sandilands 2004, Falcone et al. 2005). Today, with creation of the Orca Network online forum to compile whale sighting reports and more public interest in reporting whale sightings, the number of humpback whales sightings in inland waters increased to 30 reports in 2004 (Falcone et al. 2005). Based on historical whaling records, an area of secondary occurrence was located in the Strait of Juan de Fuca, in the central part of the Puget Sound (around San Juan Island and west side of Whidbey Island), and near Nanaimo (west coast of the Strait of Georgia)**.** Occurrences were rare beyond this area.

Based on predictive spatial habitat models (see Appendix D), density estimates of humpback whales in the NWTRC Study Area ranged from 0 to 0.062 individuals per km^2, with an overall Study Area density estimate of 0.0007 individuals per km^2 (DoN 2007).

North Pacific right whale (*Eubalaena japonica*)

Listing Status

Once abundant, the North Pacific right whale is the most endangered whale species in the world. The North Pacific right whale was classified as endangered in 2008 under the ESA. In December 1991, NMFS approved the Final Recovery Plan for the Northern right whale (including both the North Atlantic and North Pacific right whales). It identified known and potential factors affecting the northern right whale and recommended actions to reduce or eliminate impacts to the species. NMFS revised the plan in 2005 for the North Atlantic right whale. A separate recovery plan is being developed for the North Pacific right whale population (NMFS, Office of Protected Resources accessed on May 27, 2008 at http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/rightwhale_northpacific.htm#more).

Critical Habitat

Although there is designated critical habitat for this species in the western Gulf of Alaska and an area in the southeastern Bering Sea (NMFS 2006d), there is no designated critical habitat for this species within the OPAREA or Study Area.

Population Status

Three species of right whales, the North Pacific right whale (*Eubalaena japonica*), the North Atlantic right whale (*Eubalaena glacialis*), and the southern right whale (*Eubalaena australis*), are currently recognized by scientists. Census data are too limited to suggest a population trend for the North Pacific right whale species. North-south migratory movements indicate that two largely discrete populations of right whales may occur in the eastern and western North Pacific (Clapham et al. 2004). Although reliable population estimates are not available for this species (Angliss and Outlaw 2005), the eastern North Pacific population may include only a few tens to less than a hundred animals (Clapham et al. 2004; NMFS 2005b; Angliss and Outlaw 2008). In the western North Pacific, the population may number in the low hundreds (Brownell et al. 2001; Clapham et al. 2004).

Distribution

Right whales were probably never common along the west coast of North America (Scarff 1986; Brownell et al. 2001). Historical whaling records provide virtually the only information on North Pacific right whale distribution. Presently, sightings are extremely rare, occurring primarily in the Okhotsk Sea and the eastern Bering Sea (Brownell et al. 2001; Shelden et al. 2005; Shelden and Clapham 2006; Wade et al. 2006). The area of densest concentration in the Gulf of Alaska is east from 170°W to 150°W and south to 52°N (Shelden and Clapham 2006). Right whales occur in subpolar to temperate waters. They are generally migratory, with at least a portion of the population moving between summer feeding grounds in temperate or high latitudes and winter calving areas in warmer waters (Kraus et al. 1986; Clapham et al. 2004).

Feeding/Reproduction

Right whales feed primarily on calanoid copepods *(Calanus marshallae),* a type of zooplankton, in addition to krill and other species of calanoid copepods (Reeves and Kenney 2003). Climate change may be causing calanoid copepods to occur more commonly in relatively shallow water (bottom depth of 164 ft [50 m] to 262 ft [80 m]; Tynan et al. 2001), resulting in more shallow-water sightings of right whales. However, sightings along the middle and outer portions of the continental shelf and in even deeper waters continue to occur (Wade et al. 2006; Carretta et al. 1994).

There is an absence of evidence for coastal calving for the North Pacific right whale. Scarff (1986) hypothesized that right whales that summer in the eastern North Pacific mate, calve, and overwinter in the mid- or western North Pacific. Mid-ocean whaling records of right whales in the winter suggest that right whales historically may have wintered and calved far offshore in the Pacific (Scarff 1986, 1991; Clapham et al. 2004). In contrast, right whales in the North Atlantic and Southern Hemisphere have calving grounds in shallow bays, lagoons, or waters over the continental shelf (IWC 2001).

Right whales in the North Pacific probably reach sexual maturity at about 10 years (Omura et al. 1969). Calves are born during December through March. There is usually a three-year calving interval in the North Atlantic (Kraus et al. 2001).

Acoustics

There is limited information on North Pacific right whale calls. Given the paucity of data with regard to North Pacific right whale acoustics, the North Atlantic right whale is a valid analog for potential sound types produced by the North Pacific right whale. Sounds include an “up” call that sweeps from about 0.09 to 0.15 kHz in 0.7 sec (McDonald and Moore 2002; Wiggins et al. 2004). Baumgartner et al. (2005) noted downsweep calls by North Atlantic right whales in the 0.016 to 0.16 kHz frequency band that corresponded strongly to the daily vertical migration of zooplankton. For other groups of right whales, vocalizations are usually between 0.2 and 0.6 kHz (Matthews et al. 2001; Laurinolli et al. 2003; Vanderlaan et al. 2003). Source levels have been estimated for pulsive calls of North Atlantic right whales, which are 172 to 187 dB re 1 µPa-m (Thomson and Richardson 1995; Parks and Tyack 2005). Other sound types produced by North Atlantic right whales have source levels ranging from 137 to 162 dB re 1 µPa-m for tonal calls and 174 to 192 dB re 1 µPa-m for broadband gunshot sounds produced by males (Parks et al. 2005; Parks and Tyack 2005).

Morphometric analyses of the inner ear of right whales resulted in an estimated hearing frequency range of 0.01 to 22 kHz (Parks et al. 2004; Parks personal communication 2006). Research by Nowacek et al. (2004) on North Atlantic right whales suggests that received sound levels of 133 to 148 dB re 1 µPa-m for the duration of the sound exposure are likely to disrupt feeding behavior, but they noted that a return to normal behavior would be expected within minutes of when the source was turned off.

Information Specific to the Northwest Training Range Complex Study Area

There were no sightings of North Pacific right whales during ship surveys conducted off California, Oregon, and Washington from 1991 through 2005 (Barlow and Forney 2007). However, throughout the year, there is a constant, low probability of encountering this species anywhere in the coastal and offshore waters in the NWTRC Study Area. Because of the low population numbers in the North Pacific, few individuals are observed (Brownell et al. 2001). Occurrences within the Puget Sound are rare. There was a May 1992 sighting over Quinault submarine canyon (Green et al. 1992; Rowlett et al. 1994).

Sei Whale (*Balaenoptera borealis*)

Listing Status

The sei whale was classified in 1970 as endangered under the ESA. A draft species recovery plan was prepared and submitted for agency review; however, a final recovery plan has not been released. The Eastern North Pacific stock is considered a "depleted" and "strategic" stock under the MMPA.

Critical Habitat

There is no designated critical habitat for this species.

Population Status

Census data suggest an increasing population trend. Currently, the best estimate for the Eastern North Pacific stock, which incorporates five survey years (1991, 1993, 1996, 2001, and 2005), is 98 (CV = 0.57) individuals (Barlow and Forney 2007). The NMFS estimate for the Eastern North Pacific stock of the sei whale is 43 individuals (Carretta et al. 2007a).

Distribution

Sei whales have a worldwide distribution, but are found primarily in cold temperate to subpolar latitudes, (Horwood 1987). Sei whales spend the summer months feeding in the subpolar higher latitudes and return to the lower latitudes to calve in the winter. In the North Pacific, sei whales are thought to occur mainly south of the Aleutian Islands. They are present across the temperate Pacific north of 40°N (NMFS 1998a) and are seen at least as far south as 20°N (Horwood 1987). Sei whales are most often found in deep, oceanic waters of the cool temperate zone. They appear to prefer regions of steep relief, such as the continental shelf break, canyons, or basins between banks and ledges (Kenney and Winn 1987; Schilling et al. 1992; Gregr and Trites 2001; Best and Lockyer 2002). These areas often concentrate zooplankton, especially copepods.

Feeding/Reproduction

In the North Pacific, sei whales particularly feed along the cold eastern currents (Perry et al. 1999). In the North Pacific, prey includes calanoid copepods, krill, fish, and squid (Nemoto and Kawamura 1977). The dominant food for sei whales off California during June through August is the northern anchovy (*Engraulis mordax*), while in September and October they eat mainly krill (Rice 1977). The location of winter breeding areas and characteristics of preferred breeding grounds are unknown (Rice 1998; Perry et al. 1999). Their reproductive cycle is about two years (Gambell 1985).

Acoustics

Sei whale vocalizations have been recorded only on a few occasions. Recordings from the North Atlantic consisted of paired sequences (0.5 to 0.8 sec, separated by 0.4 to 1.0 sec) of 10 to 20 short (4 milliseconds) FM sweeps between 1.5 and 3.5 kHz; source level was not known (Thomson and Richardson 1995). These mid-frequency calls are distinctly different from low-frequency tonal and frequency swept calls recently recorded in the Antarctic; the average duration of the tonal calls was 0.45±0.3 sec, with an average frequency of 0.433±0.192 kHz and a maximum source level of 156±3.6 dB re 1 µPa-m (McDonald et al. 2005).

No data on hearing ability for this species are available. Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing.

Information Specific to the Northwest Training Range Complex Study Area

Sei whales are known for occasional irruptive occurrences in areas, followed by disappearances for sometimes decades. Therefore, there is a secondary occurrence in the NWTRC Study Area, despite few recent observations. Many British Columbia whaling catches were made in the early to mid 1900s, providing evidence that sei whales have used this area in the past (Pike and MacAskie 1969; Gregr et al. 2000). There is a rare occurrence in the Puget Sound, because sei whales are not expected to occur there. However, a sei whale washed ashore west of Port Angeles during September 2003 (Preston 2003).

Barlow and Forney (2007) estimated sei whale densities for Washington and Oregon of 0.000115 individuals per km^2. Off the northern California coast, their density estimate was 0.000182 individuals per km^2.

Sperm Whale (*Physeter macrocephalus*)

Listing Status

The sperm whale was classified as endangered in 1970 under the ESA. A draft species recovery plan has been prepared (NMFS 2006b). The California/Oregon/Washington stock is considered as a "depleted" and "strategic" stock under the MMPA.

Critical Habitat

There is no designated critical habitat for this species.

Population Status

Census data are too limited to suggest a population trend for this species. Currently, sperm whale numbers in the eastern temperate North Pacific are estimated to be 32,100 individuals and 26,300 individuals by acoustic and visual detection methods, respectively (Barlow and Taylor 2005). The most recent NMFS population estimate for sperm whales in the California/Oregon/Washington stock is 1,233 (CV = 0.41) individuals (Carretta et al. 2007a). However, a recent paper which utilizes five survey years (1991, 1993, 1996, 2001, and 2005) estimates the sperm whale population to be 1,934 (CV = 0.31) for the California/Oregon/Washington stock (Barlow and Forney 2007).

Distribution

The sperm whale occurs throughout offshore and coastal waters from Washington to California (Carretta et al. 2007b). Male sperm whales are found from tropical to polar waters in all oceans of the world, between approximately 70°N and 70°S (Rice 1998). The female distribution is more limited and corresponds approximately to the 40° parallels but extends to 50° in the North Pacific (Whitehead 2003). Sperm whales show a strong preference for deep waters (Rice 1989), especially areas with high sea floor relief. Globally, sperm whale distribution is associated with waters over the continental shelf break, over the continental slope, and into deeper waters (Hain et al. 1985). Worldwide, females rarely enter the shallow waters over the continental shelf (Whitehead 2003).

Feeding/Reproduction

Sperm whales have a highly diverse diet. Prey includes large mesopelagic squid and other cephalopods, fish, and occasionally benthic invertebrates (Fiscus and Rice 1974; Rice 1989; Clarke 1996). Calving generally occurs in the summer at lower latitudes and the tropics (DoN 2005). Female and immature sperm whales form groups of 20 to 30 individuals that move together in a coordinated fashion over periods of days (Whitehead 2003). Mating is observed from winter through summer and calving occurs during spring through fall. This species has an inter-birth interval of four to seven years.

Acoustics

Sperm whales produce short-duration (generally less than 3 sec), broadband clicks from 0.1 kHz to 30 kHz, with dominant energy in two bands (2 to 4 kHz and 10 to 16 kHz). Most of the acoustic energy is at frequencies below 4 kHz, although diffuse energy past 20 kHz has been reported (Thode et al. 2002). The source levels can be up to 236 dB re 1 µPa-m (Møhl et al. 2003). Clicks are heard most often when sperm whales are diving and foraging (Whitehead and Weilgart 1991; Miller et al. 2004; Zimmer et al. 2005b). These may be echolocation clicks used in feeding, contact calls for communication, and orientation during dives.

The anatomy of the sperm whale’s ear indicates that it hears high-frequency sounds (Ketten 1992). The sperm whale also may have some ultrasonic hearing but at a lower maximum frequency than many other odontocetes (Ketten 1992). The sperm whale may also possess better low-frequency hearing than some other odontocetes, although not as low as many baleen whales (Ketten 1992). Auditory brainstem response in a neonatal sperm whale indicated highest sensitivity to frequencies between 5 and 20 kHz (Ridgway and Carder 2001).

Information Specific to the Northwest Training Range Complex Study Area

Two noteworthy sperm whale stranding events occurred in the NWTRC Study Area. During November 1970, there was an incident that was well-publicized by the media of attempts to dispose of a decomposed sperm whale carcass on an Oregon beach by using explosives. A mass stranding of 47 sperm whales occurred in Oregon during June 1979 (Rice et al. 1986; Norman et al. 2004).

The primary area of occurrence for the sperm whale is seaward of the 3,281-foot (1,000-m) isobath in the OPAREA. An area of secondary occurrence is located between depths of 656 ft (200 m) and 3,281ft (1,000 m), to account for the possibility of sightings in more shallow waters. Sperm whale occurrences in waters between the shore and the 656-foot (200-m) depth are expected to be rare. Sperm whales would have a rare occurrence within the Puget Sound.

Based on predictive spatial habitat models (see Appendix D), density estimates of sperm whales in the NWTRC Study Area ranged from 0 to 0.049 individuals per km^2, with an overall Study Area density estimate of 0.0026 individuals per km^2 (DoN 2007).

Southern Resident Killer Whale (*Orcinus orca*)

Listing Status

The southern resident killer whale was listed as endangered in 2005 under the ESA. This stock is considered a depleted stock under the MMPA. A final species recovery plan has been prepared (NMFS 2008b).

Critical Habitat

There is designated critical habitat in the Puget Sound and Strait of Juan de Fuca areas of Washington (NMFS 2006e). The critical habitat designation encompasses parts of Haro Strait and the waters around the San Juan Islands, the Strait of Juan de Fuca and all of Puget Sound, a total of just over 2,500 mi^2 (6,475 km^2) The agency is excluding from the designation 18 military sites covering nearly 112 mi^2 (290 km^2) of habitat. Federal agencies will now be required to consult with NMFS to ensure their actions will not destroy or adversely modify the killer whales' designated habitat. Critical habitat designation means a more focused analysis on how the action would alter the habitat, and how that will affect the ability of the habitat to support the population's conservation. Critical habitat boundaries are presented in Figure 3.9-1.

Population Status

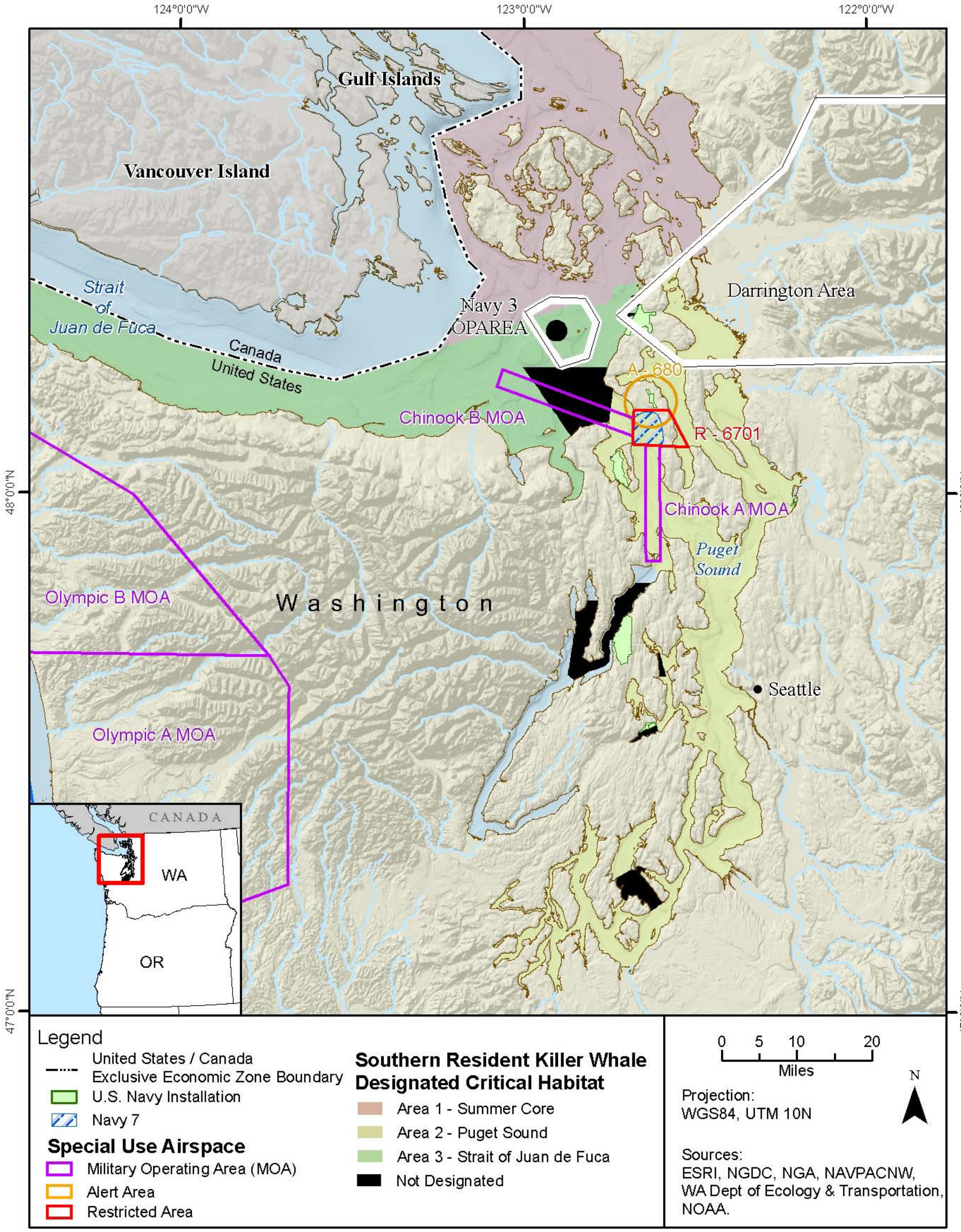
Census data indicated a peak number for this stock of 96 individuals in 1993, which then declined to 79 individuals in 2002 (Carretta et al. 2007b). The current population has increased from that low point and was estimated to be 87 animals in 2007 (NMFS 2008b).

Distribution

Killer whales have been observed in virtually every marine habitat from the tropics to the poles and from shallow, inshore waters (and even rivers) to deep, oceanic regions (Dahlheim and Heyning 1999). In the eastern North Pacific, killer whales range from protected inshore waters to waters off the outer coast (Wiles 2004). An excellent summary of the seasonal movements of the three pods (J, K, and L) that comprise the southern resident killer whale stock is provided by NMFS (2008b). Southern resident killer whales spend a significant portion of the year in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound, particularly during the spring, summer, and fall (May through November). While in inland waters during warmer months, all of the pods concentrate their activity from the south side of the San Juan Islands through Haro Strait northward to North and South Pender Islands and Boundary Passage (Hauser 2006). Less time is generally spent elsewhere, including other sections of the Georgia Strait, Strait of Juan de Fuca, and San Juan Islands and the Southern Gulf Islands, Rosario Strait, Admiralty Inlet west of Whidbey Island, and Puget Sound. Individual pods are generally similar in their preferred areas of use (Olson 1998). Reasons for seasonal and annual variations in pod distribution are not well understood, but some research suggests that southern resident killer whale movements are linked to distribution of several salmon species, a primary forage species (NMFS 2008b). Southern resident killer whales occur in coastal waters of Washington, Oregon, and Vancouver Island and are known to travel as far south as central California. Killer whales in the eastern North Pacific occasionally enter the lower reaches of rivers in Washington and Oregon while feeding (Wiles 2004). To date, there is no evidence that the southern resident killer whales travel more than 31 mi (50 km) offshore (NMFS 2008b).

Feeding/Reproduction

Southern residents feed heavily in areas characterized by high-relief underwater topography, such as subsurface canyons seamounts, ridges, and steep slopes (Heimlich-Boran 1988; Felleman et al. 1991). Salmon are the principle prey for resident killer whales during spring, summer, and fall (Heimlich-Boran 1986; Felleman et al. 1991; Ford et al. 1998; Baird and Hanson 2004; Ford and Ellis 2005; Hanson et al. 2005). Chinook salmon (*Oncorhynchus tshawytscha*) the area's largest salmonid, are the most commonly targeted species. Other salmonids appear to be eaten less frequently, as are rockfish, halibut (*Hippoglossus stenolepis*), lingcod (*Opiodon elongatus*), and herring.



Source: NMFS Website Updated June 3, 2007 at (http://www.nwr.noaa.gov/Publications/FR-Notices/2006/upload/71FR69054.pdf)

Figure 3.9-1: Critical Habitat for Southern Resident Killer Whale

Killer whales have the most stable social system known among cetaceans. This includes long-term associations between individuals and limited dispersal from maternal pods (Bigg et al. 1990; Baird 2000). Among resident killer whales in the northeastern Pacific, births occur largely from October to March, although births can occur year-round (Olesiuk et al. 1990; Stacey and Baird 1997). Females typically give birth for the first time at 11 to 15 years of age (Ford and Ellis 1999). Maximum life span is estimated to be 80 to 90 years for females and 50 to 60 years for males (Olesiuk et al. 1990).

Acoustics

Killer whales produce a wide-variety of clicks and whistles, but most social sounds are pulsed, with frequencies ranging from 0.5 to 25 kHz (dominant frequency range: 1 to 6 kHz) (Thomson and Richardson 1995). Echolocation clicks indicate source levels ranging from 195 to 224 dB re 1 µPa-m peak-to-peak, dominant frequencies ranging from 20 to 60 kHz, and durations of about 0.1 sec (Au et al. 2004). Source levels associated with social sounds have been calculated to range from 131 to 168 dB re 1 µPa-m and vary with vocalization type (Veirs 2004).

Resident killer whales are very vocal, making calls during all types of behavioral states. Acoustic studies of resident killer whales in the Pacific Northwest have found that there are dialects in their highly stereotyped, repetitive discrete calls, which are group-specific and shared by all group members (Ford 1991, 2002b). These dialects likely are used to maintain group identity and cohesion, and may serve as indicators of relatedness that help prevent inbreeding between closely related whales (Ford 1991, 2002b). Dialects have been documented in northern Norway (Ford 2002a) and southern Alaska killer whales populations (Yurk et al. 2002) and likely occur in other regions.

Both behavioral and auditory brainstem response techniques indicate killer whales can hear a frequency range of 1 to 100 kHz and are most sensitive at 20 kHz. This is one the lowest maximum-sensitivity frequencies known among toothed whales (Szymanski et al. 1999).

Information Specific to the Northwest Training Range Complex Study Area

The 2007 southern resident killer whale population is estimated to be 87 individuals (NMFS 2008b). This estimate is a direct count of individually identifiable animals. The southern resident killer whale stock experienced an almost 20 percent decline from 1996 to 2001 (NMFS 2005d). The pods designated J and K have generally maintained their numbers, and most of the decline has occurred in the L pod, which comprises about half of the southern resident population. This pod's decline is especially worrisome because it involves both increased mortality of members and a reduction in birth rates.

The southern resident population resides from May through October in the protected inshore waters of the Strait of Georgia and Puget Sound, especially in the vicinity of Haro Strait, west of San Juan Island, along Boundary Passage, and off the southern tip of Vancouver Island (Heimlich-Boran 1988; Ford et al. 1994; Olson 1998; Krahn et al. 2004; Wiles 2004). During the peak summer feeding time, the pods tend to make a circuit between the mouth of the Fraser River and the Strait of Juan de Fuca, traveling up to 99 mi (160 km) a day to feed on migrating salmon. The southern resident population congregates at coastal locations at this time of year in association with high densities of the fish (Heimlich-Boran 1986; Nichol and Shackleton 1996; Olson 1998; NMFS 2005d). During September and October, they can often be found off the mouth of the Fraser River in the Strait of Georgia, intercepting salmon before the fish can enter the river.

Little is known of where the southern resident population goes when they leave the Puget Sound, particularly from November to May, although there are occasional winter sightings within this area. Pods have visited coastal sites off Washington and Vancouver Island (Ford et al. 1994), and are known to travel as far north as the Queen Charlotte Islands. During the winter, J pod commonly is seen in inshore waters far south in Puget Sound as Olympia, while K and L pods apparently spend more time in offshore waters. In January 2000, whales from K and L pods were sighted in Monterey Bay; this was the first sighting of the southern resident population in waters south of Washington. Members of L pod were again sighted in Monterey Bay during March 2003. Other unusual sightings occurred in late October 1997, when 19 animals spent 30 days in Dyes Inlet near Bremerton, Washington, where they likely followed a chum salmon run to Chico Creek, and on 13 March 2004 when L pod was sighted in outer coast waters, about 12 mi (18 km) off Westport, Washington (Hanson Personal Communication 2005).

The area of primary occurrence for the southern resident population is north of 47° and inshore of the continental shelf break, including all of the Puget Sound**.** The area of secondary occurrence north of 47° is between the shelf break and the 3,281-ft (1,000-m) isobath. South of 47°, the area of secondary occurrence consists of waters shallower than the 3,281-foot (1,000-m) isobath. There is a rare occurrence in waters seaward of the 3,281-foot (1,000-m) isobath.

Steller Sea Lion (*Eumetopias jubatus*)

Listing Status

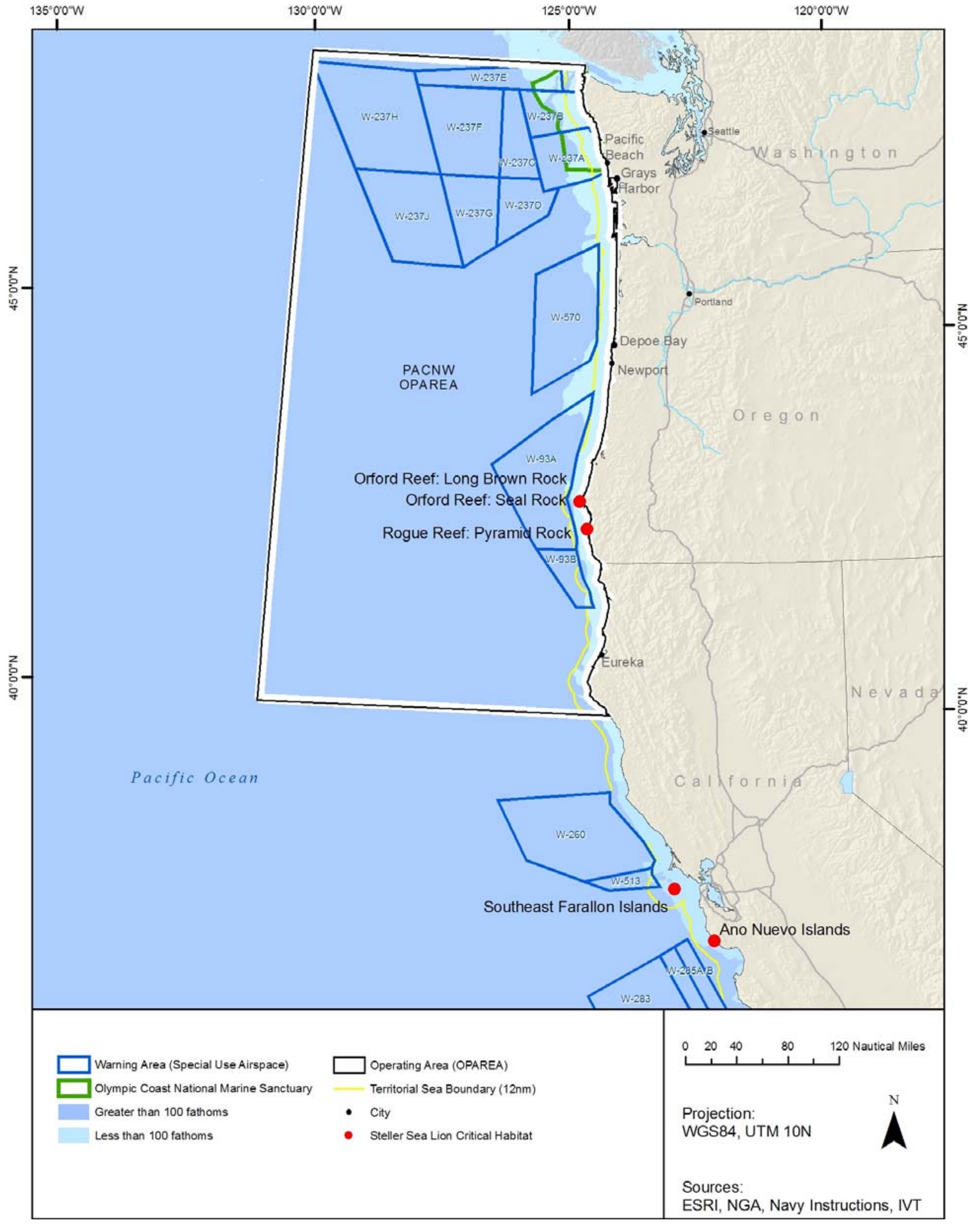
The Steller sea lion was originally listed as threatened under the ESA in 1990. In 1997, the NMFS reclassified Steller sea lions as two subpopulations, listing the Western stock as endangered under the ESA, and maintaining threatened status for the Eastern stock (NMFS 1997b). The Western stock occupies Alaskan waters, while the Eastern stock occurs in southeastern Alaska, Canada, and the NWTRC Study Area. Rookeries of the Eastern stock occur along the coasts of Oregon and California (NMFS 2008c). There is a final revised species recovery plan that addresses both the Eastern and Western stocks (NMFS 2008c).

Critical Habitat

Critical habitat has been designated for the Steller sea lion (NMFS 1993b). Critical habitat includes so called “aquatic zones” that extend 3,000 ft (1 km) seaward in State and Federally managed waters from the baseline or basepoint of each major rookery in Oregon and California (NMFS 2008c). Three major rookery sites in Oregon (Rogue Reef, Pyramid Rock; and Long Brown Rock and Seal Rock on Orford Reef at Cape Blanco) and three rookery sites in California (Ano Nuevo I; Southeast Farallon I; and Sugarloaf Island and Cape Mendocino) are designated critical habitat (NMFS 1993b). Critical habitat locations in Oregon and California are shown in Figure 3.9-2.

Population Status

There are two distinct populations, based on genetics and population trends (Loughlin 1997; Angliss and Outlaw 2005). The western U.S. stock includes animals at and west of Cape Suckling, Alaska (144°W). The Eastern U.S. stock includes the animals east of Cape Suckling (NMFS 1997b; Loughlin 2002; Angliss and Outlaw 2005). The most recent population estimate for the Eastern North Pacific stock of the Steller sea lion, which occurs in the OPAREA and Puget Sound, is 48,519 individuals (Angliss and Outlaw 2008). The Eastern stock was estimated to number between 46,000 and 58,000 animals in 2002, and has been increasing at approximately 3 percent per year since the late 1970s (NMFS 2008c; Pitcher et al. 2007).



Source: NMFS Final Revised Steller Sea Lion Recovery Plan 2008 at:
http://www.fakr.noaa.gov/protectedresources/stellers/recovery/sslrpfinalrev030408.pdf

Figure 3.9-2: Steller Sea Lion Critical Habitat for Eastern Stock

Distribution

Steller sea lions are found along the coasts of Washington, Oregon, and northern California where they occur at breeding rookeries and numerous haulout locations along the coastline (Jeffries et al. 2000; Scordino 2006) From breeding rookeries in northern California (St. George Reef) and southern Oregon (Rogue Reef), male Steller sea lions often disperse widely outside of the breeding season (Scordino 2006). Based on mark and sighting studies, males migrate back to into these Oregon and California locations from winter feeding areas in Washington, British Columbia, and Alaska (Scordino 2006). In Washington, Steller sea lions use haulout sites primarily along the outer coast from the Columbia River to Cape Flattery, as well as along the Vancouver Island side of the Strait of Juan de Fuca (Jeffries et al. 2000). Numbers vary seasonally in Washington with peak numbers present during the fall and winter months (Jeffries et al. 2000). Steller sea lions are gregarious animals that often travel or haul out in large groups of up to 45 individuals (Keple 2002). At sea, groups usually consist of females and subadult males; adult males are usually solitary while at sea (Loughlin 2002).

Feeding/Reproduction

Foraging habitat is primarily shallow, nearshore and continental shelf waters, and some Steller sea lions feed in freshwater rivers (Reeves et al. 1992; Robson 2002). They also are known to feed in deep waters past the continental shelf break (Jefferson personal communication 2005). Haulout and rookery sites are located on isolated islands, rocky shorelines, and jetties. Steller sea lions also haul out on buoys, rafts, floats, and Navy submarines in the Puget Sound (Jeffries et al. 2000; DoN 2001a). Steller sea lions are opportunistic predators, feeding primarily on fish and cephalopods, and their diet varies geographically and seasonally (Merrick et al. 1997). In the Pacific Northwest, breeding rookeries are located in British Columbia, Oregon, and northern California. There are no rookeries in Washington (NMFS 1992b; Angliss and Outlaw 2005). Steller sea lions form large rookeries during late spring when adult males arrive and establish territories (Pitcher and Calkins 1981). Large males aggressively defend territories while non-breeding males remain at peripheral sites or haulouts (Pitcher and Calkins 1981). The female sea lions arrive soon after and give birth (Pitcher and Calkins 1981). Most births occur from mid-May through mid-July, and breeding takes place shortly thereafter (Pitcher and Calkins 1981). Most pups are weaned within a year (Pitcher and Calkins 1981). Females reach sexual maturity at 4 to 5 years of age (Pitcher and Calkins 1981).

Acoustics

On land, territorial male Steller sea lions usually produce low-frequency roars (Schusterman et al. 1970; Loughlin et al. 1987). The calls of females range from 0.03 to 3 kHz, with peak frequencies from 0.15 to 1 kHz; typical duration is 1.0 to 1.5 sec (Campbell et al. 2002). Pups produce bleating sounds. Underwater sounds are similar to those produced on land (Loughlin et al. 1987).

When the underwater hearing sensitivity of two Steller sea lions was tested, the hearing threshold of the male was significantly different from than that of the female. The range of best hearing for the male was from 1 to 16 kHz, with maximum sensitivity (77 dB re 1 µPa-m) at 1 kHz. The range of best hearing for the female was from 16 to above 25 kHz, with maximum sensitivity (73 dB re 1 µPa-m) at 25 kHz. However, because of the small number of animals tested, the findings could not be attributed to individual differences in sensitivity or sexual dimorphism (Kastelein et al. 2005).

Information Specific to the Northwest Training Range Complex Study Area

The Steller sea lion is a common species in the NWTRC Study Area because several thousand animals are year-round residents in coastal Washington and Oregon . Peak abundance occurs on islands during the spring breeding season and at sea in the fall (Bonnell et al. 1992).

- In Washington, Steller sea lions primarily haul out along the coast from the Columbia River to Cape Flattery (Jeffries et al. 2000). They are widely distributed throughout inland waters and are frequently observed over deep water in the Strait of Georgia (Keple 2002).
- Primary rookery sites in Oregon are located along the southern coast at Orford and Rogue Reefs, while main haulout sites include Sea Lion Caves, Three Arch Rocks, Ecola Point, and the Columbia River jetty (Bonnell et al. 1992; Brown 1997; Scordino 2006). During the summer, Steller sea lions are common in cold, upwelled waters off southern Oregon; they tend to remain near rookeries (<19 mi [<30 km]), Heceta and Stonewall Banks, and the mouth of the Umpqua River (Bonnell et al. 1992).
- Rogue Reef in southern Oregon is a primary breeding rookery for Steller sea lions (Scordino 2006).
- St. George Reef is the primary haulout and rookery site in the northern California part of the OPAREA (Loughlin et al. 1992).
- Steller sea lions also haul out along the southern coast of Vancouver Island near the Strait of Juan de Fuca (Jeffries et al. 2000).

An area of primary occurrence extends into the Strait of Juan de Fuca, around San Juan and Whidbey Islands, and through the Strait of Georgia. Another area of primary occurrence extends from the shore to the 1,640-foot (500-m) isobath along the outer coast of the OPAREA. The southern part of the Puget Sound is an area of secondary occurrence. Secondary occurrence also includes the area between the 1,640-foot (500-m) and 3,281-foot (1,000-m) isobaths. Steller sea lions are rare seaward of this secondary occurrence area.

The current population of 47,885 in the eastern North Pacific includes part of the population found in the NWTRC Study Area. The marine mammal density study estimated a density of 0.000011 individuals per km^2 during the warm season, and 0.011 individuals per km^2 during the cold season.

Sea Otter (*Enhydra lutris*)

Listing Status

The USFWS recognizes five stocks in U.S. waters under MMPA guidelines (USFWS 2005c). These include single stocks each in California (i.e., the southern sea otter [*Enhydra lutris nereis*]) and Washington (i.e., the northern sea otter [*Enhydra lutris kenyoni*]) and three stocks in Alaska that are designated southeast, southcentral, and southwest stocks of the northern sea otter. Only the southwest Alaska stock of the northern sea otter is listed as threatened under the ESA (USFWS 2005c). The southwest Alaska stock of the northern sea otter does not occur in the NWTRC Study Area. Sea otters that occur along the coast of Washington (which have no formal federal designation) are the results of reintroduction efforts of the northern sea otter in the late 1960s and early 1970s (Jameson et al. 1982). A federal species recovery plan for the northern sea otter population has not been developed; however, the State of Washington developed a recovery plan to address the northern sea otter population in its waters (Lance et al. 2004). The southern sea otter (California stock) is listed as threatened under the ESA and has a final recovery plan (U.S. Fish and Wildlife Service 2003).

Critical Habitat

There is no critical habitat designated for this species.

Population Status

Census data suggest an increasing population trend. Harvesting for pelts during the 1700s and 1800s severely reduced sea otter numbers throughout their range (Kenyon 1975). Until 1969 when reintroduction efforts began, sea otters were absent from Washington. Since then, recovery has been occurring in Washington, Canada, and parts of southeast Alaska. The most recent survey in Washington counted 360 sea otters and 2,359 sea otters in California (Jameson and Jeffries 2004; Lance et al. 2004).

Distribution

Sea otters occupy nearly all coastal marine habitats, from bays and estuaries to rocky shores exposed to oceanic swells (Riedman and Estes 1990; Bodkin 2003; USFWS 2003b and 2005c). Although sea otters prefer rocky shoreline with kelp beds, this is not an essential habitat requirement, and some individuals use soft-sediment areas where kelp is absent (Riedman and Estes 1990; USFWS 2003b). Sea otters seldom range more than 1 mi (2 km) from shore, although some individuals, particularly juvenile males, travel farther offshore (Riedman and Estes 1990; Ralls et al. 1995 and 1996; USFWS 2003b; Lance et al. 2004). Sea otters move seasonally to areas where there is food or where sheltered water offers protection from storms and rough seas (Kenyon 1975; Riedman and Estes 1990). Individual sea otters in Washington show such shifts (Lance et al. 2004), but the population as a whole does not migrate, and otters range along the Washington coast year-round. The current Washington population primarily occupies rocky habitats (Lance et al. 2004). Sea otters in Washington occasionally haul out at low tide on offshore rocks and islands.

Feeding/Reproduction

Sea otters feed on or near the bottom in shallow water. The diet varies with physical and biological habitat characteristics (Riedman and Estes 1990; Estes and Bodkin 2002). Large sea urchins (*Allocentrotus sp.*) are the preferred prey, to the extent that urchin density and large size classes can be depleted and the otters are forced to a more diverse diet (Kvitek et al. 1989; Kvitek et al. 1998; Kvitek et al. 2001; VanBlaricom and Chambers 2003; Laidre et al. 2004). Along the Washington coast, their diverse diet includes crustaceans, bivalves, urchins, and sea cucumbers (Bowlby et al. 1988; Lance et al. 2004; Jeffries et al. 2005). They also prey on cephalopods, fish, and seabirds (Riedman and Estes 1990). Sea otters occupying new habitat in the Strait of Juan de Fuca have a diet dominated by red urchins (Jeffries et al. 2005).

Sea otters may be sighted alone or in groups, called “rafts” (Riedman and Estes 1990). Adult males establish territories, and females move freely among males’ territories (Jameson 1989). Females and males attain sexual maturity at three and five years of age, respectively (USFWS 2003b). Breeding and pupping occur throughout the year, with a breeding peak in late autumn in Washington and most births occurring from late February to early April (USFWS 2003b; Lance et al. 2004). Most adult female sea otters give birth to a single pup each year (Jameson and Johnson 1993).

Acoustics

Underwater sounds of the sea otter have not been studied. Their airborne sounds include screams, whines, whistles, hisses, deep-throated snarls or growls, soft cooing sounds, grunts, and barks (Kenyon 1975; McShane et al. 1995). Sounds typically range in frequency from 0.2 to 12.8 kHz with various harmonics and a dominant frequency of 0.2 to 4.9 kHz (McShane et al. 1995). The screams of pups and their mothers (dominant frequency range of 3 to 5 kHz) can travel more than 0.6 mi (1.0 km), and may vary enough to provide individual recognition between mother and pup (Sandegren et al. 1973; McShane et al. 1995).

There are no hearing data available for this species.

Information Specific to the Northwest Training Range Complex Study Area

Based on known habitat use, there is an area of primary occurrence for the sea otter between the shore and bottom depth of 131 ft (40 m) from Neah Bay, around the Olympic Peninsula, to Grays Harbor. A secondary occurrence is located in this same area between the 131-foot (40-m) and 328-foot (100-m) isobaths. All of the Puget Sound is an area of secondary occurrence (Lynch personal communication

2005). The Oregon coast from the shore to the 328-foot (100-m) isobath is an area of secondary occurrence, based on the historical range of the species and recent sightings that indicate that the species may be expanding its range. There is a rare occurrence offshore from, and south of, the coastal areas of secondary occurrence.

The pre-exploitation range of the sea otter included the entire Washington coast, with a major concentration off Point Grenville (Lance et al. 2004). The current population of 743 occurs along 114 mi (185 km) of coastline from Destruction Island in the south to Pillar Point (Neah Bay) in the north, with concentrations at Duk Point, Cape Alava, Sand Point, Cape Johnson, Perkins Reef, and Destruction Island (Lance et al. 2004). Almost half the Washington population occurs at Destruction Island (Lance et al. 2004). Recent sightings have been made as far south as Cape Elizabeth (Calambokidis et al. 2004b; Doughton 2004).

Although the sea otter is not usually seen in the Puget Sound (Osborne et al. 1988), there are confirmed sightings and movements of tagged individuals in the eastern Strait of Juan de Fuca, around the San Juan Islands, and within the Puget Sound near Olympia (Calambokidis et al. 1987; Lance et al. 2004). Prior to recent sightings, the Strait of Juan de Fuca had not been occupied by sea otters for over 100 years (Jeffries et al. 2005). One sea otter was sighted about 6 mi (9 km) inland up McAllister Creek (Jeffries and Allen 2001).

Most of Oregon's historical sea otter habitat occurs in the southern half of the state in the extensive nearshore rocky reef systems. However, the population was extirpated by hunting and, for unknown reasons, reintroduction efforts were not successful (Jameson et al. 1982). However, confirmed sightings of sea otters along the Oregon coast have increased over the past decade and include sightings at Cape Blanco, Yachats, Yaquina Bay, and Simpson Reef at Cape Arago (Lynch personal communication 2005).

In the last 10 years, there have been only two confirmed sightings of sea otters in northern California. Because these were on consecutive days in August 2005 (Hatfield personal communication 2005), they probably involved a single animal.

There are no density calculations for this species in the NWTRC Study Area.

3.9.1.2 Non-Listed Marine Mammals

All of the baleen whale species that could occur in and near the NWTRC Study Area have extensive ranges in the North Pacific that extend from summer high-latitude feeding areas to winter sub-tropical calving grounds (Bonnell and Dailey 1993; Ferguson and Barlow 2001 and 2003). Non-listed species of baleen whales that occur in the NWTRC Study Area include the minke whale and gray whale.

In contrast, toothed whale species do not undertake the long-distance migrations that are typical of baleen whales. However, some species, such as common and Pacific white-sided dolphins, have a southward shift in distribution during the winter (Green et al. 1992; Barlow 1995; Forney et al. 1995). Other species, such as coastal bottlenose dolphins, move in association with tidal intrusion fronts, possibly because prey accumulates in the frontal regions (Mendes et al. 2002; Moreno 2006).

Minke Whale (*Balaenoptera acutorostrata*)

Population Status

Census data suggest a stable population trend. NMFS recognizes three stocks of minke whales off the U.S. coast. These include a California/Oregon/Washington stock, an Alaskan stock, and a Hawaiian stock (Carretta et al. 2006). The current NMFS population estimate for the California/Oregon/Washington stock of the minke whale is 898 (CV = 0.65) individuals (Carretta et al. 2007a). In addition, a recent paper which utilizes five survey years (1991, 1993, 1996, 2001, and 2005) estimates the minke whale population to be 823 (CV = 0.56) for the California/Oregon/Washington stock (Barlow and Forney 2007).

Distribution

The minke whale occupies waters over the continental shelf, including inshore bays and some estuaries (Murphy 1995; Mignucci-Giannoni 1998; Calambokidis et al. 2004a). The minke whales found in waters off California, Oregon, and Washington appear to be resident in that area, and to have home ranges, whereas those farther north are migratory.

Feeding/Reproduction

In the North Pacific, major food items include krill, Japanese anchovy *(Engraulis japonicus)*, Pacific saury *(Cololabis saira)*, herring, sand lance *(Ammodytes* sp.*)*, and walleye pollock (Perrin and Brownell 2002; Stern personal communication 2006). Although minke whales are distributed in polar, temperate, and tropical waters (Jefferson et al. 1993), there is no obvious migration from low-latitude, winter breeding grounds to high-latitude, summer feeding locations in the western North Pacific (Horwood 1990). Stewart and Leatherwood (1985) suggested that mating occurs in winter or early spring although it had never been observed.

Acoustics

Minke whales produce both high- and low-frequency sounds (range: 0.06 to 20 kHz) with a dominant frequency range of 0.06 to greater than 12 kHz, depending on sound type (Thomson and Richardson 1995). Source levels for this species variously have been estimated to range from 151 to 175 dB re 1 µPa-m (Ketten 1998) and from 150 to 165 dB re 1 µPa-m (Gedamke et al. 2001). A sound that may be a breeding display includes a brief pulse at 1.3 kHz followed by an amplitude-modulated call with greatest energy at 1.4 kHz, with slight frequency modulation duration of 2.5 sec (Rankin and Barlow 2005).

While no empirical data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes are most adapted to hear low to infrasonic frequencies.

Information Specific to the Northwest Training Range Complex Study Area

Minke whales appear to establish home ranges in the inland waters of Washington and along central California (Dorsey 1983; Dorsey et al. 1990), and exhibit site fidelity to these areas between years (Dorsey et al. 1990). They are observed year-round in the Puget Sound, with a peak in abundance between July and September (Everitt et al. 1979; Osborne et al. 1988; Dorsey et al. 1990). There is an area of rare occurrence seaward of these areas.

Dorsey et al. (1990) noted minke whales feeding in locations of strong tidal currents in inland waters of the Puget Sound. Hoelzel et al. (1989) reported that 80 percent of feeding observations in the San Juan Islands were over submarine slopes of moderate incline at a depth of about 66 ft (20 m) to 328 ft (100 m). Prey taken in the San Juans included juvenile herring (*Clupea harengus*) and probably sand lance (Hoelzel et al. 1989). Off the California outer coast, they foraged along the edge of kelp beds and out to the shelf break (Dorsey et al. 1990) in contrast to other locales where minkes forage from closer to shore to the edge of the shelf break (Stern personal communication 2005).

Within the Puget Sound, there is an area of primary occurrence around the San Juan Islands and in the Strait of Juan de Fuca. Primary occurrence extends into Admiralty Inlet on the west side of Whidbey Island. Within this area, individuals move within and between specific feeding areas around submarine banks (Stern personal communication 2005). Three feeding grounds were identified: the Strait of Juan de Fuca, including all of the submarine banks; San Juan Channel and the Waldron Island area, including Cowlitz Bay, President's Channel, and Rosario Strait; and between Sucia, Patos, and Waldron Islands (Osborne et al. 1988; Hoelzel et al. 1989; Dorsey et al. 1990; Stern personal communication 2005). There are probably other feeding areas in the Puget Sound, and there is year-to-year variation in the use of some of these areas (Osborne et al. 1988; Dorsey et al. 1990).

There are areas of secondary and rare occurrence along the outer coast; the dividing line between these areas is based on available sighting records. The inland waters of the Puget Sound also are identified as an area of secondary occurrence. The frequency of sightings of minke whales in inland waters is very low in winter months (Everitt et al. 1979; Dorsey et al. 1990).

Barlow and Forney (2007) estimated the density of minke whales off the coast of Washington and Oregon to be 0.000655 individuals per km^2. Off the California coast, their estimate was 0.000395 individuals per km^2.

Gray Whale (*Eschrichtius robustus*)

Population Status

Census data suggest an increasing population trend. Gray whales are found only in the North Pacific. The western Pacific population is critically endangered and shows no apparent signs of recovery (Weller et al. 2002). The Eastern North Pacific stock, which occurs in the Study Area, was removed from the endangered species list in 1994 because of an increase in the population numbers to near historical levels (Carretta et al. 2005). This eastern population ranges from the south tip of Baja California to the Chukchi and Beaufort Seas (Jefferson et al. 1993).

The eastern population is not classified as a strategic stock by NMFS. The population estimate for the Eastern North Pacific stock is 18,178 individuals (Angliss and Outlaw 2008). The population still appears to be increasing, despite a 1999 mortality event in which large numbers of gray whales stranded along the coast from Mexico to Alaska (Gulland et al. 2005).

Distribution

Most of the Eastern Pacific stock summers in the shallow waters of the northern Bering Sea, Chukchi Sea, and western Beaufort Sea (Rice and Wolman 1971), but some individuals spend the summer feeding along the Pacific coast from southeastern Alaska to central California (Sumich 1984; Calambokidis et al. 1987 and 2002). Beginning in October, the whales migrate south to calving and breeding grounds on the west coast of Baja California and the southeastern Gulf of California (Braham 1984; Rugh 1984), a distance of 4,660 mi (7,500 km) to 6,214 mi (10,000 km) (Rugh et al. 2001; Jones and Swartz 2002).

Feeding/Reproduction

Breeding grounds consist of subtropical lagoons that are protected from the open ocean (Jones and Swartz 2002). Although some calves are born along the coast of California, most are born in the shallow, protected waters on the Pacific coast of Baja California (Urban et al. 2003).

Acoustics

Gray whales produce broadband signals ranging from 0.1 kHz to 12 kHz (Dahlheim et al. 1984; Jones and Swartz 2002). The most common sounds on breeding and feeding grounds are knocks from about 0.1 kHz to 2 kHz, with a dominant frequency range of 0.3 to 0.8 kHz (Thomson and Richardson 1995). The source level for knocks is approximately 142 dB re 1 uPa-m (Cummings et al. 1968). During migration, sounds most often are low-frequency, predominantly below 1.5 kHz (Crane and Lashkari 1996).

The structure of the gray whale ear is evolved for low-frequency hearing (Ketten 1992). The ability of gray whales to hear frequencies as low as 0.8 kHz has been demonstrated in playback studies (Cummings and Thompson 1971; Dahlheim and Ljungblad 1990; Moore and Clarke 2002) and by their responses to underwater noise from oil and gas activities (Malme et al. 1986; Moore and Clarke 2002). The threshold for inducing feeding interruptions from air gun noise was a received level of 173 dB re 1 µPa-m. For continuous industrial noise, the threshold for inducing avoidance was a received level of 120 dB re 1 µPa-m (Malme et al. 1986).

Information Specific to the Northwest Training Range Complex Study Area

Gray whales occur in the NWTRC Study Area throughout the year. In addition, larger numbers of migratory animals transit along the coast of Washington, Oregon, and California during migrations between breeding and feeding grounds. Peak sightings in the Study Area during the southbound migration occur in January (Rugh et al. 2001). There are two phases of the northbound migration, including an early phase from mid-February through April and a later phase, which consists of mostly cows and calves, from late April through May (Herzing and Mate 1984).

Some whales enter Willapa Bay, Grays Harbor, the Strait of Juan de Fuca, and the Puget Sound during migration (Richardson 1997; Calambokidis et al. 2004b). In recent years, gray whales have been sighted in the southern part of Puget Sound, particularly in Elliott Bay. Gray whales are known to enter the Puget Sound in spring and remain there through the early summer months; some are present in the region as early as January (Calambokidis et al. 1994). Most sightings in the Puget Sound occur between March and May (Calambokidis et al. 1994; DoN 2002a).

A group of a few hundred gray whales known as the Pacific Coast Feeding Aggregation (PCFA) feeds along the Pacific coast between southeastern Alaska and southern California throughout the summer and fall (NMFS 2001; Calambokidis et al. 2002). Gray whales that summer in Washington waters feed on benthic invertebrates, including dense aggregations of ghost shrimp in the Puget Sound (Weitkamp et al. 1992; Richardson 1997).

There is concern that the resumption of whaling by the Makah Indian Tribe of Washington may negatively impact the PCFA (Calambokidis et al. 2002). Based on the 1855 Treaty of Neah Bay, the Makah Indian Tribe has the right to hunt gray whales at usual and accustomed grounds off the coast of Washington (NMFS 2005c). The Makah hunted gray whales until the 1920s when the eastern population was drastically reduced. After the eastern population was delisted from the ESA in 1994, the Makah hunted one gray whale in 1999 but have since been prevented from whaling (NMFS 2005c). The Makah recently submitted a request to hunt 20 gray whales within a 5-year period. The Makah’s proposal includes time and area restrictions to avoid intentional harvest of PCFA whales and management measures to ensure that any incidental harvest of PCFA whales remains at or below the annual strike limit (NMFS 2005c).

An area of primary occurrence in the NWTRC Study Area is from the shore to a water depth of 656 ft (200 m). The area of secondary occurrence is an additional 10 nm (18 km) buffer that accounts for the possibility of encountering some individuals that might migrate farther offshore. There is a rare occurrence seaward of this secondary buffer.

Within the Puget Sound, the area of primary occurrence extends from the outer coast into the Strait of Juan de Fuca to north of the Kitsap Peninsula (about 47°N), including the area around Whidbey Island. Primary occurrence also includes Boundary Bay, which is often occupied by gray whales from March to June (Ford personal communication 2006). An area of secondary occurrence south of the Kitsap Peninsula accounts for possible sightings of this species in southern Puget Sound. An area of secondary occurrence north of the San Juan Islands is based on historic whaling catches in the Strait of Georgia.

There are currently no density estimates for gray whales in the NWTRC Study Area.

Pygmy Sperm Whale (*Kogia breviceps*) and Dwarf Sperm Whale *(Kogia sima)*

Population Status

Census data are too limited to suggest a population trend for these species. The NMFS population estimate for the California/Oregon/Washington stock of the pygmy sperm whale is 247 individuals (Carretta et al. 2007a). Census data are too limited to support a population estimate for the dwarf sperm whale (Carretta et al. 2007a). Currently, the best estimate for *Kogia* spp., which incorporates five survey years (1991, 1993, 1996, 2001, and 2005), is 1,237 (CV = 0.45) individuals (Barlow and Forney 2007). There are no confirmed and documented sightings of the dwarf sperm whale in this region (Carretta et al. 2006).

Distribution

Both species of *Kogia* occur along the continental shelf break and over the continental slope (McAlpine 2002). Both species apparently have a worldwide distribution in tropical and temperate waters (Jefferson et al. 1993). *Kogia* is known to occur in eastern North Pacific waters around Washington (Scheffer and Slipp 1948; Hubbs 1951; Roest 1970; Everitt et al. 1979) and, possibly, British Columbia (Baird et al. 1996).

Feeding/Reproduction

Both species probably feed on fish and invertebrates that feed on the zooplankton in tropical and temperate waters. There is no information on the breeding behavior of pygmy or dwarf sperm whales.

Acoustics

The only sound recordings for the pygmy sperm whale are from a stranded individual that produced echolocation clicks ranging from 60 to 200 kHz, with a dominant frequency of 120 to 130 kHz (Marten 2000). Recently, a dwarf sperm whale was recorded producing clicks at 13 to 33 kHz with durations of 0.3 to 0.5 sec (Jérémie et al. 2006).

An auditory brainstem response study completed on a stranded pygmy sperm whale indicated a hearing range of 90 to 150 kHz (Ridgway and Carder 2001). No information on hearing is available for the dwarf sperm whale.

Information Specific to the Northwest Training Range Complex Study Area

All eight confirmed stranding records of *Kogia* from Oregon and Washington are of the pygmy sperm whale (Norman et al. 2004). There is one stranding record of the dwarf sperm whale from British Columbia (Nagorsen and Stewart 1983; Willis and Baird 1998a), but this was considered an extralimital stray. Most reports of *Kogia* from the Study Area probably are pygmy sperm whales.

Based on the preference of *Kogia* for deep waters, the area of primary occurrence includes waters deeper than 3,280.8 ft (1,000 m). The area of secondary occurrence is between the 656-ft (200 m) and 3,281-ft (1,000 m) water depths. A rare occurrence for *Kogia* is expected in waters shallower than 656 ft (200 m) on the outer coast, and in all the waters of the Puget Sound, based in part on a *Kogia* sighting over the Juan de Fuca Canyon (Green et al. 1992).

Barlow and Forney (2007) estimated *Kogia* densities for Washington and Oregon of 0.001232 individuals per km^2. Off the northern California coast, their density estimate was 0.000504 individuals per km^2.

Cuvier's Beaked Whale (*Ziphius cavirostris*)

Population Status

The most recent NMFS population estimate for the California/Oregon/Washington stock is 1,884 (CV = 0.68) individuals. Currently, the best estimate for the California/Oregon/Washington stock, which incorporates five survey years (1991, 1993, 1996, 2001, and 2005), is 4,342 (CV = 0.58) individuals (Barlow and Forney 2007).

Distribution

The Cuvier's beaked whale is the most widely distributed of all beaked whale species, occurring in all three major oceans and most seas (Heyning 1989). This species occupies almost all temperate, subtropical, and tropical waters, as well as some subpolar and polar waters (MacLeod et al. 2006). Cuvier's beaked whales generally are sighted in waters with a bottom depth greater than 656 ft (200 m) and are frequently recorded in areas with depths of 3,281 ft (1,000 m) or more (Gannier 2000; MacLeod et al. 2004). Occurrence has been linked to physical features such as the continental slope, canyons, escarpments, and oceanic islands (MacLeod and D'Amico 2006). Beaked whales only rarely stray over the continental shelf (Pitman 2002).

Feeding/Reproduction

They may be mid-water and bottom feeders (Baird et al. 2005b) on cephalopods and, rarely, fish (MacLeod et al. 2003).

Acoustics

Sounds recorded from beaked whales include whistles and pulsed sounds (clicks) (Johnson et al. 2004; Madsen et al. 2005; MacLeod and D'Amico 2006). Whistle frequencies are about 2 to 12 kHz, while pulsed sounds range in frequency from 0.3 kHz to 135 kHz. However, higher frequencies may not be recorded due to equipment limitations. Frantzis et al. (2002) recorded pulsed sounds with a narrow peak frequency of 13 to 17 kHz, lasting 15 to 44 sec in duration. An acoustic recording tag attached to two Cuvier's beaked whales in the Ligurian Sea recorded echolocation clicks with center frequencies at around 42 kHz and source levels up to 214 dB re 1 µPa-m peak-to-peak (Zimmer et al. 2005a).

There are no hearing data available for the Cuvier's beaked whale. A stranded juvenile Gervais' beaked whale *(Mesoplodon europaeus)* was found to be most sensitive to high-frequency signals between 40 and 80 kHz but produced smaller evoked potentials to 5 kHz (Cook et al. 2006).

Information Specific to the Northwest Training Range Complex Study Area

Willis and Baird (1998b) reported an incidental catch record for a Cuvier's beaked whale just north of the NWTRC Study Area in offshore waters with a bottom depth of approximately 10,827 ft (3,300 m). They also reported a Cuvier's beaked whale sighting in waters with a bottom depth of less than 295 ft (90 m) in British Columbia. Tynan et al. (2005) reported an association of beaked whales with strong turbulence caused by rough topography along the slope near Heceta Bank off Oregon.

Waters deeper than 3,281 ft (1,000 m) are the area of primary occurrence for the Cuvier's beaked whale in the NWTRC Study Area. The area of secondary occurrence is between 1,640 ft (500 m) and 3,281 ft (1,000 m) in depth. Occurrence in waters shallower than 1,640 ft (500 m) is rare. The majority of the Puget Sound is an area of rare occurrence for this species, except for the deeper waters of the Strait of Juan de Fuca where there is an area of secondary occurrence.

Barlow and Forney (2007) estimated Cuvier's beaked whale densities for northern California of 0.003038 individuals per km^2 which would suggest approximately 324 beaked whales in the Study Area, mostly located off the coast of northern California.

Mesoplodont Beaked Whales (*Mesoplodon* spp.)

Population Status

Mesoplodont beaked whales are distributed throughout deep waters and along the continental slopes of the North Pacific. At least six species in this genus have been recorded off the U.S. west coast, but due to the rarity of records and the difficulty in identifying these animals in the field, virtually no species-specific information is available (Mead 1989). The six species known to occur in this region are: Blainville's beaked whale (*Mesoplodont densirostris*), Perrin's beaked whale (*M. perrini*), Lesser beaked whale (*M. peruvianus*), Stejneger's beaked whale (*M. stejnegeri*), Gingko-toothed beaked whale (*M. gingkodens*), and Hubbs' beaked whale (*M. carlhubbsi*). Insufficient sighting records exist off the coasts of Washington, Oregon, and California to determine spatial or seasonal patterns in the distribution of mesoplodont beaked whales.

Until better methods are developed for distinguishing the different mesoplodont species from one another, the management unit is defined to include all mesoplodont populations. Currently, a population estimate of 1,177 (CV = 0.18) individuals for all mesoplodont species was calculated by Barlow and Forney (2007) for the California/Oregon/Washington stock which incorporated five survey years (1991, 1993, 1996, 2001, and 2005). The most recent NMFS estimate for the California/Oregon/Washington stock based on 1996-2001 weighted average abundance estimates is 1,247 (CV = 0.92) individuals (Carretta et al. 2007a).

Distribution

World-wide, beaked whales normally inhabit continental slope and oceanic waters that are deeper than 656 ft (200 m) (Waring et al. 2001; Cañadas et al. 2002; Pitman 2002; MacLeod et al. 2004; Ferguson et al. 2006; MacLeod and Mitchell 2006). Occurrence often has been linked to the continental slope, canyons, escarpments, and oceanic islands (MacLeod and D'Amico 2006). For example, Tynan et al. (2005) reported an association of beaked whales with strong turbulence caused by rough topography along the slope near Heceta Bank off the Oregon coast. Beaked whales are only occasionally reported in waters over the continental shelf (Pitman 2002).

The Hubbs' beaked whale appears to be restricted to the North Pacific (Mead et al. 1982; Houston 1990; MacLeod et al. 2006). Nearly all records have involved strandings along the west coast of North America and in Japan, with one live sighting made in La Jolla, California (Hubbs 1946; Mead et al. 1982). There have also been several sightings in relatively nearshore waters of the Pacific Northwest, and MacLeod et al. (2006) speculated that the distribution might actually be continuous across the North Pacific between about 30° and 45°N. The Stejneger's beaked whale species appears to prefer cold-temperate and sub-polar waters (Loughlin and Perez 1985; MacLeod et al. 2006). It is found in the North Pacific from southern California to the Bering Sea and, on the west side of the Pacific basin, as far south as the Miyagi Prefecture, Japan (Loughlin and Perez 1985; MacLeod et al. 2006).

Feeding/Reproduction

This species may be both a mid-water and bottom feeder (Baird et al. 2005b) on squid and fish (Mead et al. 1982). They occur alone or in groups of up to 15 (MacLeod and D'Amico 2006), and probably calve in the summer (Mead et al. 1982; Willis and Baird 1998b).

Acoustics

Sounds recorded from beaked whales include whistles and pulsed sounds (clicks) (Johnson et al. 2004; Madsen et al. 2005; MacLeod and D'Amico 2006). Whistle frequencies are about 2 to 12 kHz, while pulsed sounds range in frequency from 0.3 kHz to 135 kHz, although higher frequencies might not have been recorded because of equipment limitations (MacLeod and D'Amico 2006). Vocalizations recorded from two juvenile Hubbs' beaked whales consisted of low and high-frequency click trains ranging in frequency from 0.3 kHz to 80 kHz and whistles with a frequency range of 2.6 to 10.7 kHz and duration of less than half a second (Lynn and Reiss 1992; Marten 2000).

There are no hearing data available for the beaked whale. A stranded juvenile Gervais' beaked whale *(Mesoplodon europaeus)* was found to be most sensitive to high-frequency signals between 40 and 80 kHz but produced smaller evoked potentials to 5 kHz (Cook et al. 2006). Beaked whale ears are predominantly adapted to hear ultrasonic frequencies and, based on the anatomy of the ears, may be more sensitive than other cetaceans to low-frequency sounds (MacLeod 1999).

Information Specific to the Northwest Training Range Complex Study Area

The area of primary occurrence for Hubbs or Stejneger's beaked whales is in waters deeper than 1,640 ft (500 m) in the NWTRC Study Area. An area of secondary occurrence is between the 656-ft (200 m) and 1,640-ft (500 m) water depths, and there is a rare occurrence for mesoplodont whales in waters shallower than 656 ft (200 m). The majority of the Puget Sound is an area of rare occurrence for this species except for the deeper waters of the Strait of Juan de Fuca where there is an area of secondary occurrence.

Until better methods are developed for distinguishing the different *Mesoplodon* species, the management unit is defined to include all *Mesoplodon* stocks. However, Barlow and Forney (2007) estimated mesoplodont whale densities for Washington and Oregon of 0.00135 individuals per km^2. Off the northern California coast, their density estimate was 0.001321 individuals per km^2.

Baird's Beaked Whale (*Berardius bairdii*)

Population Status

Population size for the California/Oregon/Washington stock is estimated to be 1,005 (CV = 0.37) individuals (Barlow and Forney 2007) and 228 (CV = 0.51) individuals by Carretta et al. (2007a).

Distribution

Baird's beaked whale is found only in the North Pacific and adjacent seas (Bering Sea, Okhotsk Sea, Sea of Japan, and Gulf of California), mainly north of 34°N in the west and 28°N in the east (Reeves et al. 2003). Baird's beaked whales appear mainly in deep waters over the continental slope, oceanic seamounts, and areas with submarine escarpments (Reeves and Mitchell 1993; Willis and Baird 1998b; Kasuya 2002; Tynan et al. 2005). Off Washington and British Columbia, Baird's beaked whales have been sighted in offshore waters with a bottom depth of 2,297 ft (700 m) to 5,495 ft (1,675 m) (Wahl 1977; Willis and Baird 1998b). Tynan et al. (2005) reported an association of beaked whales with strong turbulence caused by rough topography along the slope near Heceta Bank off the Oregon coast.

Feeding/Reproduction

Baird's beaked whales occur in relatively large groups of 6 to 30, and groups of 50 or more sometimes are seen (Balcomb 1989). Sexual maturity occurs at about 8 to 10 years, and the calving peak is in March and April (Balcomb 1989). They feed mainly on benthic fish and cephalopods, but prey also includes pelagic fish such as mackerel (*Scomber japonicus*), sardine, and saury (Kasuya 2002; Walker et al. 2002; Ohizumi et al. 2003). Baird's beaked whales in Japan prey primarily on deepwater gadiform fishes and cephalopods, indicating that they feed primarily at depths ranging from 2,625 ft (800 m) to 3,937 ft (1,200 m) (Walker et al. 2002; Ohizumi et al. 2003).

Acoustics

Sounds recorded from beaked whales were described previously. Both whistles and clicks have been recorded from Baird's beaked whales in the eastern North Pacific. Whistles had fundamental frequencies between 4 and 8 kHz, with two to three strong harmonics within the recording bandwidth. Clicks had a dominant frequency around 23 kHz, with a second frequency peak at around 42 kHz and, unlike species that echolocate, were most often emitted in irregular series of very few clicks (Dawson et al. 1998).

Information is not available for Baird's beaked whale hearing abilities. It may be similar to that described elsewhere in this section for other beaked whales.

Information Specific to the Northwest Training Range Complex Study Area

The Baird's beaked whale probably is a slope-associated species. As a result, the area of primary occurrence for this whale in the OPAREA is in waters deeper than 1,640 ft (500 m). The area of secondary occurrence is between 656-ft (200-m) to 1,640-ft (500-m) water depth. There is a rare occurrence in waters shallower than 656 ft (200 m). The majority of the Puget Sound is an area of rare occurrence for this species, except the deeper waters of the Strait of Juan de Fuca where there is an area of secondary occurrence.

Population size for the California/Oregon/Washington stock is estimated to be 1,005 (CV = 0.37) individuals. Barlow and Forney (2007) estimated Baird's beaked whale densities for Washington and Oregon of 0.001614 individuals per km^2. Off the northern California coast, their density estimate was 0.000775 individuals per km^2.

Rough-toothed Dolphin (*Steno bredanensis*)

Population Status

There are no abundance estimates available for this species in the NMFS stock assessment report (Caretta et al. 2007a) for this area of the Pacific. The most recent population estimate for the Hawaiian stock is 19,904 (CV = 0.52) individuals (Carretta et al. 2007a). Census data are too limited to suggest a population trend for this species. Small groups of 10 to 20 rough-toothed dolphins are common, and groups can range up to 50 animals (Miyazaki and Perrin 1994; Reeves et al. 1999). They also often associate with other cetacean species (Miyazaki and Perrin 1994; Nekoba-Dutertre et al. 1999; Ritter 2002; Wedekin et al. 2004).

Distribution

Although the rough-toothed dolphin is generally regarded as an offshore species that prefers deep waters, it can occur in waters with variable depths (e.g., Gannier and West 2005). Outside the North Pacific, this species may frequent coastal waters, shallow waters, and even lagoon systems (Flores and Ximenez 1997; Mignucci-Giannoni 1998; Lodi and Hetzel 1999; Ritter 2002; Banick and Borger 2005). They are found in tropical to warm-temperate waters globally, rarely ranging north of 40°N or south of 35°S (Miyazaki and Perrin 1994).

Feeding/Reproduction

Cephalopods and fish, including large fish such as dorado (*Coryphaena hippurus*), are prey (Miyazaki and Perrin 1994; Reeves et al. 1999; Pitman and Stinchcomb 2002). There is no information on the breeding behavior in this area.

Acoustics

The rough-toothed dolphin produces a variety of sounds, including broadband echolocation clicks and whistles. Echolocation clicks typically have a frequency range of 0.1 to 200 kHz, with a dominant frequency of 25 kHz (Miyazaki and Perrin 1994; Yu et al. 2003; Chou personal communication 2005). Whistles have a wide frequency range of 0.3 to greater than 24 kHz but dominate in the 2 to 14 kHz range (Miyazaki and Perrin 1994; Yu et al. 2003). There has been no data collected on rough-toothed dolphin hearing ability.

Information Specific to the Northwest Training Range Complex Study Area

Although there are a few rough-toothed dolphin strandings recorded in Oregon and Washington (Ferrero et al. 1994), this species prefers warm-temperate and tropical waters and the records are considered to be extralimital. This species is not expected to occur in the OPAREA or Puget Sound. There are no abundance or density estimates available for this species in the NMFS stock assessment report (Carretta et al. 2007a) for this area of the Pacific.

Bottlenose Dolphin (*Tursiops truncatus*)

Population Status

Census data suggest a stable population trend. The bottlenose dolphin ranges beyond the tropics and subtropics into temperate waters (Reeves et al. 2002). Bottlenose dolphins within the Pacific waters under U.S. jurisdiction are divided into three stocks: the California coastal stock; California/Oregon/Washington offshore stock; and Hawaiian stock (Carretta et al. 2006). Bottlenose dolphins found in the OPAREA and Puget Sound could be from the California coastal stock or the California/Oregon/Washington offshore stock. The most recent NMFS population estimate for the California/Oregon/Washington offshore stock is 5,065 individuals (CV = 0.66) (Carretta et al. 2007a).

Distribution

These dolphins live in coastal areas of all continents, around many oceanic islands and atolls, and over shallow offshore banks and shoals. There are also pelagic populations that range far from land (Miyashita 1993; Reeves et al. 2002). In the eastern North Pacific, the distribution of coastal bottlenose dolphins extends from at least Ensenada, Baja California, Mexico to Monterey Bay, California, with occasional sightings at San Francisco (Orr 1963; Ferrero and Tsunoda 1989; Bonnell and Dailey 1993; Maldini-Feinholz 1996). The northernmost record in the eastern North Pacific is a stranding that occurred in March 1988 near Colony Creek, 62 mi (100 km) north of Seattle (Osborne and Ransom 1988; Ferrero and Tsunoda 1989). Individuals have been documented in offshore waters as far north as about 41°N; they may range into Oregon and Washington waters during warm-water periods (Carretta et al. 2007b).

Feeding/Reproduction

Bottlenose dolphins are opportunistic feeders on fish, cephalopods, and shrimp (Wells and Scott 1999). Sound is important to feeding strategies, and includes both active echolocation to find food and passive listening to detect and orient to fish prey (Barros and Myrberg 1987; Gannon et al. 2005). Bottlenose dolphins are gregarious, typically occurring in groups of 2 to 15, although groups can include 100 or more animals (Shane et al. 1986). Bottlenose dolphins reach physical maturity at about 13 years (Mead and Potter 1990). Newborn calves are seen through out the year and reproduction may be influenced by productivity and food abundance (Urian et al. 1996) though calving peaks have not been determined (Weller personal communication 2005).

Acoustics

Sounds emitted by bottlenose dolphins include pulsed sounds (clicks and burst-pulses) and narrow-band continuous sounds (whistles) that usually are frequency-modulated. Ketten (1998) found that clicks and whistles have a dominant frequency range of 110 to 130 kHz and a source level of 218 to 228 dB re 1 µPa-m (Au 1993) and 3.5 to 14.5 kHz and 125 to 173 dB re 1 µPa-m, respectively. Thomson and Richardson (1995) reported the frequency of whistles from 0.8 to 24 kHz.

Inner ear anatomy of this species was described by Ketten (1992). The bottlenose dolphin can typically hear within a broad frequency range of 0.04 kHz to 160 kHz (Au 1993; Turl 1993). The range of highest sensitivity is between 25 and 70 kHz, with peaks in sensitivity occurring at 25 and 50 kHz at threshold levels of 47 and 46 dB re 1 µPa-m, respectively (Nachtigall et al. 2000).

Information Specific to the Northwest Training Range Complex Study Area

There is an area of rare occurrence for the bottlenose dolphin throughout the OPAREA and Puget Sound. The best estimate for the California/Oregon/Washington offshore stock is 2,026 individuals. Barlow and Forney (2007) estimated offshore bottlenose densities off the northern California coast as 0.000515 individuals per km^2, which would suggest approximately 55 bottlenose in the Study Area, mostly in the southern portion of the Study Area.

Striped Dolphin (*Stenella coeruleoalba*)

Population Status

The best estimate of the size of the California/Oregon/Washington stock is 18,976 (CV = 0.28) individuals (Barlow and Forney 2007). The most recent NMFS abundance estimate is 13,943 (CV = 0.53) individuals (Carretta et al. 2007a).

Distribution

Striped dolphins occur worldwide in cool-temperate to tropical waters. They are usually found beyond the continental shelf, typically over the continental slope out to oceanic waters. In the eastern Pacific, striped dolphins inhabit areas with large seasonal changes in surface temperature and thermocline depth, as well as seasonal upwelling (Au and Perryman 1985; Reilly 1990). This species appears to avoid waters colder than 20°C (Van Waerebeek et al. 1998). The northern limits are the Sea of Japan, Washington, and along roughly 40°N across the western and central Pacific (Reeves et al. 2002). Although striped dolphins typically do not occur north of California, there are a few sighting records off Oregon and Washington (Wahl 1977; Von Saunder and Barlow 1999; Barlow 2003). Strandings are documented along the coasts of Oregon, Washington, and British Columbia (Kellogg and Scheffer 1947; Kenyon and Scheffer 1949; Cowan and Guiguet 1952; Scheffer 1960). Occurrences north of California may be related to incidents of warm water moving northward (Baird et al. 1993; Norman et al. 2004).

Feeding/Reproduction

Striped dolphins feed on fish and squid (Perrin et al. 1994) in pelagic or benthopelagic zones along the continental slope or just beyond in oceanic waters. A majority of their prey possesses luminescent organs, suggesting that striped dolphins feed at great depths, diving to 656 ft (200 m) to 2,297 ft (700 m) to reach potential prey (DoN 2006). Striped dolphins are typically found in groups of 100 and 500, although they sometimes gather in the thousands. Sexual maturity occurs between 5 and 15 years of age (Archer II and Perrin 1999). Off Japan, where their biology has been best studied, there are summer and winter calving peaks (Perrin et al. 1994).

Acoustics

Striped dolphin whistles range from 6 kHz to more than 24 kHz, with dominant frequencies ranging from 8 to 12.5 kHz (Thomson and Richardson 1995). A single striped dolphin's hearing range, determined using standard psycho-acoustic techniques, was from 0.5 to 160 kHz with best sensitivity at 64 kHz (Kastelein et al. 2003).

Information Specific to the Northwest Training Range Complex Study Area

The area of primary occurrence for the striped dolphin in the NWTRC Study Area is in coast waters warmer than 15.5°C and deeper than 328 ft (100 m). There is a secondary occurrence between temperatures of 15°C and 15.5°C. The area of rare occurrence is in waters cooler than 15°C on the outer coast and throughout the Puget Sound.

Barlow and Forney (2007) estimated striped dolphin densities for Washington and Oregon of 0.0000497 individuals per km^2 and 0.015653 individuals per km^2 off the northern California coast. These estimated densities suggest approximately 1683 striped dolphins in the Study Area, with the majority anticipated to be in the southern portion of the NWTRC.

Short-beaked Common Dolphin (*Delphinus delphis*)

Population Status

The single current management unit for the short-beaked common dolphin in this area is a California/Oregon/Washington stock with a population estimate of 352,069 (CV = 0.18) individuals (Barlow and Forney 2007). The most recent NMFS abundance estimate is 449,846 (CV = 0.25) individuals (Carretta et al. 2007a).

Distribution

Common dolphins occupy a wide range of habitats, including waters over the continental shelf, along the continental shelf break, and over prominent underwater topography, such as seamounts (Hui 1979; Evans 1994; Bearzi 2003). This species prefers areas with large seasonal changes in surface temperature and thermocline depth (Au and Perryman 1985).

Feeding/Reproduction

The diet primarily is fish and cephalopods. Group size ranges from several dozen to more than 10,000 individuals (Jefferson et al. 1993). Peak calving is in spring and early summer (Forney 1994).

Acoustics

Recorded vocalizations include whistles, chirps, barks, and clicks (Ketten 1998). Clicks and whistles have dominant frequency ranges of 23 to 67 kHz and 0.5 to 18 kHz, respectively (Ketten 1998). Maximum source levels were approximately 180 dB 1 µPa-m (Fish and Turl 1976). Oswald et al. (2003) found that short-beaked common dolphins have whistles with a mean frequency range of 6.3 kHz, mean maximum frequency of 13.6 kHz, and mean duration of 0.8 sec.

Popov and Klishin (1998) recorded auditory brainstem responses from a short-beaked common dolphin. The audiogram was U-shaped, with a steeper high-frequency branch. This species' hearing range extended from 10 to 150 kHz and was most sensitive from 60 to 70 kHz.

Information Specific to the Northwest Training Range Complex Study Area

During summer and fall, the primary Study Area occurrence of the short-beaked common dolphin is along the outer coast in waters deeper than 656 ft (200 m), south of 42°N. The area of secondary occurrence is between the 328-ft (100-m) and 656-ft (200-m) isobath south of 42°N, and seaward of the 656-ft (200-m) isobath north of 42°N. There is a rare occurrence for this species in waters shallower than 656 ft (200 m) and in the Puget Sound.

In winter and spring, the primary occurrence in the OPAREA is south of the 13°C isotherm. The area of secondary occurrence is between the 12°C and 13°C isotherms. There is a rare occurrence for this species in waters cooler than 12°C and within the Puget Sound.

The single current management unit for the short-beaked common dolphin in this area is a California/Oregon/Washington stock with a population estimate of 352,069 (CV = 0.18) individuals (Barlow and Forney 2007). Barlow and Forney (2007) estimated short-beaked common dolphin densities for Washington and Oregon of 0.014137 individuals per km^2 and 0.259357 individuals per km^2 off the northern California coast. Based on predictive spatial habitat models (see Appendix D), the overall density estimate of short-beaked common dolphins in the NWTRC Study Area is 0.1570 individuals per km^2 (DoN 2007).

Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*)

Population Status

No population trends have been observed in California or adjacent waters. Size of the California/Oregon/Washington stock was estimated to be 23,817 (CV = 0.36) individuals (Barlow and Forney 2007). The most recent NMFS abundance estimate is 59,274 (CV = 0.50) individuals (Carretta et al. 2007a).

Habitat

The Pacific white-sided dolphin occurs in temperate North Pacific waters over the outer continental shelf and slope, and in the open ocean (Leatherwood et al. 1984). Distribution is from latitude 38°N or lower to the Bering Sea and coastal southern Alaska (Leatherwood et al. 1984). Seasonal north-south movement may occur, with animals found primarily off California in winter and moving into Oregon and Washington waters as temperatures increase (Green et al. 1992; Forney 1994; Carretta et al. 2007b). Peak abundance off Oregon and Washington typically is in May (Green et al. 1993).

Feeding/Reproduction

The diet in the eastern North Pacific includes cephalopods and fish (Schwartz et al. 1992; Black 1994; Heise 1997a; Brownell et al. 1999; Morton 2000), and includes salmonids off Washington (Stroud et al. 1981). In this gregarious species, group sizes range from tens to thousands of dolphins (Leatherwood et al. 1984). They frequently aggregate with Risso's and northern right whale dolphins (Brownell et al. 1999). Calving peaks from June through August (Heise 1997b).

Acoustics

Vocalizations produced by Pacific white-sided dolphins include whistles and echolocation clicks. Whistles are in the frequency range of 0.002 to 0.020 kHz (Thomson and Richardson 1995). Echolocation clicks range in frequency from 50 to 80 kHz; the peak amplitude is 170 dB re 1uPa-m (Fahner et al. 2004).

Tremel et al. (1998) measured the underwater hearing sensitivity of the Pacific white-sided dolphin from 0.075 kHz through 150 kHz. The greatest sensitivities were from 2 to 128 kHz, while the lowest measurable sensitivities were 145 dB at 100 Hz and 131 dB at 140 kHz. Below 0.008 kHz and above 100 kHz, this dolphin's hearing was similar to that of other toothed whales.

Information Specific to the Northwest Training Range Complex Study Area

The area of primary occurrence in the Study Area is in water depths between 328 ft (100 m) and 6,562 ft (2,000 m). Areas of secondary occurrence include a 50 nm (93 km) buffer seaward the area of primary occurrence, plus the Strait of Juan de Fuca and Strait of Georgia within the Puget Sound. The areas of rare occurrence are waters seaward of the 50 nm (93 km) buffer, waters inshore of the 328-foot (100-m) depth, and the southern Puget Sound, where there are no known sightings (Laake personal communication 2005).

The most current NMFS stock assessment for the Pacific white-sided dolphin off California, Oregon, and Washington is 23,817 (CV = 0.36) individuals (Barlow and Forney, 2007). Barlow and Forney (2007) estimated Pacific white-sided dolphin densities for Washington and Oregon of 0.024823 individuals per km^2 and 0.016029 individuals per km^2 off the northern California coast. Based on predictive spatial habitat models (see Appendix D), the overall Study Area density estimates of Pacific white-sided dolphins in the NWTRC Study Area was calculated at 0.0441 individuals per km^2 (DoN 2007).

Northern Right Whale Dolphin (*Lissodelphis borealis*)

Population Status

Population size of the California/Oregon/Washington stock was estimated to be 11,097 (CV = 0.26) individuals (Barlow and Forney 2007). The most recent NMFS abundance estimate is 20,362 (CV = 0.26) individuals (Carretta et al. 2007a).

Distribution

This species occurs in oceanic waters and along the outer continental shelf and slope, normally in waters colder than 20°C (Leatherwood and Walker 1979). These dolphins generally move nearshore only in areas where the continental shelf is narrow or where productivity on the shelf is especially high, including the California Current System (Smith et al. 1986). Leatherwood and Walker (1979) reported sighting this species frequently around prominent banks and sea mounts. Northern right whale dolphins are found primarily off California during the colder water months, and shift northward into Oregon and Washington as water temperatures increase (Leatherwood and Walker 1979; Forney 1994; Barlow 1995; Forney et al. 1995; Forney and Barlow 1998).

Feeding/Reproduction

The diet primarily includes squid and mesopelagic fish (Leatherwood and Walker 1979; Jefferson et al. 1994). In the cool temperate to subarctic waters of the North Pacific Ocean, distribution usually is from 30°N to 55°N and 145°W to 118°E. (Leatherwood and Walker 1979). Seasonal inshore-offshore and north-south movements are presumably related to prey availability, including in abundance of market squid, *Loligo opalescens,* a major prey item (Leatherwood and Walker 1979).

Sexual maturity occurs at about 10 years (Ferrero and Walker 1993). Although calving seasonality is unknown, small calves are seen in winter and early spring (Jefferson et al. 1994).

Acoustics

Clicks with high repetition rates and frequencies extending beyond 40 kHz (frequency limit of sonobuoy) have been recorded from northern right whale dolphins at sea (Fish and Turl 1976; Leatherwood and Walker 1979). Maximum source levels were approximately 170 dB 1 µPa-m (Fish and Turl 1976). Information is absent on detailed physical structures of their sound production or their hearing abilities.

Information Specific to the Northwest Training Range Complex Study Area

Northern right whale dolphins occur in the NWTRC Study Area year-round, but their abundance and distribution vary seasonally. They occur off Oregon and Washington except in winter; peak abundance off these coasts occurs along the continental slope in fall (Green et al. 1992). This species is most abundant off central and northern California in nearshore waters in winter (Dohl et al. 1983). Barlow and Forney (2007) estimated northern right whale dolphin densities for Washington and Oregon of 0.019373 individuals per km^2 and 0.006401 individuals per km^2 off the northern California coast. Based on predictive spatial habitat models (see Appendix D), the overall density estimate of the northern right whale dolphin in the NWTRC Study Area is 0.0113 individuals per km^2 (DoN 2007).

The area of primary occurrence for the northern right whale dolphin in the NWTRC Study Area is in waters cooler than the 15°C isotherm and/or deeper than 328 ft (100 m). The area of secondary occurrence is between the 15°C and 16°C isotherms. There is a rare occurrence in waters warmer than 16°C and shallower than 328 ft (100 m), as well as within the Puget Sound.

Risso's Dolphin (*Grampus griseus*)

Population Status

The Risso's dolphin is relatively common in most Pacific coast nearshore waters along the U.S. The population estimate of the California/Oregon/Washington stock is 11,910 (CV = 0.24) individuals (Barlow and Forney 2007). The most recent NMFS abundance estimate is 16,066 (CV = 0.28) individuals (Carretta et al. 2007a).

Distribution

The Risso's dolphin is distributed worldwide in tropical to warm-temperate waters, roughly between 60°N and 60°S, where surface water temperature is usually greater than 10°C (Kruse et al. 1999). In the eastern North Pacific, the Risso's dolphin extends north into Canadian waters (Reimchen 1980; Baird and Stacey 1991). They are most often found along the continental slope (CETAP 1982; Green et al. 1992; Baumgartner 1997; Davis et al. 1998; Mignucci-Giannoni 1998; Kruse et al. 1999), and Baumgartner (1997) hypothesized that this distribution strongly correlates with cephalopod distribution in the same area. Water temperature appears to affect the distribution of Risso's dolphins in the Pacific (Leatherwood et al. 1980; Kruse et al. 1999). Changes in distribution and abundance off California are probably in response to unseasonal warm-water events, such as El Niño events (Shane 1994, 1995).

Feeding/Reproduction

Cephalopods are the primary prey (Clarke 1996). In this social species, groups usually are about 30 individuals, but can include several hundred (Kruse et al. 1999) or several thousand animals (Jefferson personal communication 2005), including Pacific white-sided dolphins and northern right whale dolphins (Kruse et al. 1999). There is no information on the breeding behavior in this area.

Acoustics

Vocalizations include broadband clicks, barks, buzzes, grunts, chirps, whistles, and combined whistle and burst-pulse sounds that range in frequency from 0.4 to 22 kHz and in duration from less than a second to multiple seconds (Corkeron and Van Parijs 2001). The combined whistle and burst pulse sound (2 to 22 kHz, mean duration 8 seconds) may be unique to the Risso's dolphin (Corkeron and Van Parijs 2001). Echolocation clicks (40 to 70 µs duration) have a dominant frequency range of 50 to 65 kHz and estimated source levels up to 222 dB re 1 µPa-m peak-to-peak (Thomson and Richardson 1995; Philips et al. 2003; Madsen et al. 2004).

The hearing ability of one older individual was studied by Nachtigall et al. (1995) using behavioral methods in a natural setting that included natural background noise. This individual could hear frequencies from 1.6 to 100 kHz and was most sensitive between 8 and 64 kHz. Using the auditory brainstem response technique to measure hearing in a stranded infant, Nachtigall et al. (1995) found that this individual could hear frequencies ranging from 4 to 150 kHz, with best sensitivity at 90 kHz.

Information Specific to the Northwest Training Range Complex Study Area

Inland water stranding records for this species are from March 1975 in Discovery Bay in the eastern Strait of Juan de Fuca (Everitt et al. 1979) and near Port Angeles in October 1987 (Osborne et al. 1988).

The population estimate of the California/Oregon/Washington stock is 11,910 (CV = 0.24) individuals (Barlow and Forney 2007). The area of primary occurrence for the Risso's dolphin in the OPAREA is between water depths of 328 ft (100 m) and 6,562 ft (2,000 m) to 9,842 ft (3,000 m). There is a 50 nm (93 km) buffer of secondary occurrence offshore of the area of primary occurrence. Rare occurrence areas are seaward of the area of secondary occurrence, inshore of the 328 ft (100 m) water depth, and within the Puget Sound. Barlow and Forney (2007) estimated Risso's dolphin densities for Washington and Oregon of 0.013222 individuals per km^2 and 0.004014 individuals per km^2 off the northern California coast. These estimated densities suggest approximately 4,764 Risso's dolphins in the Study Area.

False Killer Whale (*Pseudorca crassidens*)

Population Status

There are no abundance estimates available for this species in the NMFS stock assessment report for this area of the Pacific. The most recent NMFS population estimate for the Hawaiian stock is 268 (CV = 1.08) individuals (Carretta et al. 2007a).

False killer whales are found in tropical and temperate waters, generally between 50°S and 50°N latitude (Baird et al. 1989; Odell and McClune 1999). Although they can occur as far north as the Study Area, false killer whales are uncommon north of the U.S./Mexico border. Norman et al. (2004) observed that most strandings for this species in Washington and Oregon occurred during or within a year of an El Niño.

Distribution

This species is found primarily in oceanic and offshore areas, although they are known to closely approach the inshore waters of Washington and British Columbia (Baird et al. 1989). Inshore movements are occasionally associated with movements of prey and shoreward flooding of warm ocean currents (Stacey et al. 1994). Seasonal movements in the North Pacific also may be related to prey distribution (Odell and McClune 1999).

Feeding/Reproduction

The diet primarily includes deep-sea cephalopods and fish (Odell and McClune 1999), but false killer whales have been known to attack other cetaceans, including dolphins (Perryman and Foster 1980; Stacey and Baird 1991a), sperm whales (Palacios and Mate 1996), and baleen whales (Jefferson personal communication 2005). Stomach contents of an individual that stranded in Puget Sound contained a few salmon vertebrae (Scheffer and Slipp 1948).

No seasonality in reproduction is known (Jefferson et al. 1993).

Acoustics

Dominant frequencies of false killer whale whistles are from 4 to 9.5 kHz and their echolocation clicks are from either 20 to 60 kHz or 100 to 130 kHz depending on ambient noise and target distance (Thomson and Richardson 1995). Click source levels typically range from 200 to 228 dB re 1 µPa-m (Ketten 1998). False killer whales recorded in the Indian Ocean produced echolocation clicks with dominant frequencies of about 40 kHz and estimated source levels of 201 to 225 dB re 1 µPa-m (Madsen et al. 2004).

False killer whales can hear frequencies ranging from approximately 2 to 115 kHz, with best hearing sensitivity from 16 to 64 kHz (Thomas et al. 1988). Behavioral audiograms of false killer whales support a range of best hearing sensitivity between 16 and 24 kHz, with peak sensitivity at 20 kHz (Yuen et al. 2005). The same study also measured audiograms using the auditory brainstem response technique, which came to similar results, with a range of best hearing sensitivity between 16 and 22.5 kHz, peaking at 22.5 kHz. Behavioral audiograms in this study consistently resulted in lower thresholds than those obtained by auditory brainstem response.

Information Specific to the Northwest Training Range Complex Study Area

There is a rare occurrence for the false killer whale throughout the entire NWTRC Study Area. Individuals and small groups are on occasion documented to spend extended periods of time within the area (Osborne et al. 1988; Barry et al. 1989; Stacey and Baird 1991a; Shore 1999; Douglas and Calambokidis 2002; Sandilands 2003).

Killer Whale (*Orcinus orca*), Transient

Population Status

Among the genetically distinct assemblages of transient killer whales in the northeastern Pacific, only the West Coast Transient stock, which occur from southern California to southeastern Alaska, are expected to occur in the NWTRC Study Area. They consist of about 314 individuals California (Carretta et al. 2007a). The number in Washington waters at any one time is probably fewer than 20 individuals (Wiles 2004).

Distribution

Transient killer whales in the eastern North Pacific spend most of their time along the outer coast, but visit Hood Canal and Puget Sound in search of harbor seals, sea lions, and other prey. Transient occurrence in inland waters appears to peak during August and September (Morton 1990; Baird and Dill 1995; Ford and Ellis 1999) which is the peak time for harbor seal pupping, weaning, and post-weaning (Baird and Dill 1995).

Feeding/Reproduction

Transient killer whales show greater variability in habitat use, with some groups spending most of their time foraging in shallow waters close to shore while others hunt almost entirely in open water (Heimlich-Boran 1988; Felleman et al. 1991; Baird and Dill 1995; Matkin and Saulitis 1997). Transient killer whales feed on marine mammals and some seabirds, but apparently no fish (Morton 1990; Baird and Dill 1996; Ford et al. 1998; Ford and Ellis 1999; Ford et al. 2005). Transient killer whales travel in small, matrilineal groups, but they typically contain fewer than 10 animals and their social organization generally is more flexible than the resident killer whale (Morton 1990; Ford and Ellis 1999). These differences in social organization probably relate to differences in foraging (Baird and Whitehead 2000). There is no information the reproductive behavior of killer whales in this area.

Acoustics

General information on dives, vocalizations, and hearing ability for killer whales is presented in Section 3.9.1.1. In contrast to resident whales, transient killer whales appear to use passive listening as a primary means of locating prey, call less often, and use high-amplitude vocalizations only when socializing, communicating over long distances, or after a successful attack. This probably results from the ability of other marine mammal species (their prey) to “eavesdrop” on killer whale sounds (Barrett-Lennard et al. 1996; Deecke et al. 2005; Saulitis et al. 2005).

Information Specific to the Northwest Training Range Complex Study Area

Transients usually use inland waters, particularly on the southern end of Vancouver Island near Race Rocks and Victoria, only from August to October, which is the peak time for harbor seal pupping (Baird and Dill 1995; Olson 1998). However, in two recent events, transient killer whales stayed for extended times in Hood Canal to feed on harbor seals. One event involved 11 transient killer whales that stayed in Hood Canal for 60 days, from 2 January to 3 March 2003, and consumed about half of the harbor seal population (1,400) in Hood Canal. The second event took place in 2005, when six transient killer whales took an estimated 835 seals over 150 days. Despite these events, aerial surveys and land-based counts have not indicated a noticeable decline in harbor seal abundance (London et al. 2005).

Killer whales tend to show up along the Oregon coast during late April and May and may target gray whale females and calves migrating north. Based on food type, these probably are transients. When observed offshore, the determination of a particular whale to either a transient, offshore, or a resident is often difficult. For this reason, all killer whales are considered to part of the be southern resident stock for analysis of effect. There is a primary occurrence for the killer whale throughout the OPAREA and Puget Sound.

Killer Whale (*Orcinus orca*), Offshore

Population Status

The NMFS population estimate for the Eastern North Pacific Offshore stock of killer whales is 446 (CV = 31) individuals (Carretta et al. 2007a).

Distribution

Offshore killer whales usually occur 9 mi (15 km) or more offshore but also visit coastal waters and occasionally enter protected inshore waters (Wiles 2004). Most encounters with offshore killer whales in the NWTRC Study Area have taken place near the Queen Charlotte Islands (Haida Gwaii) and off the west coast of Vancouver Island (NMFS 2005d). Groups of offshore killer whales are encountered as far south as Los Angeles, mostly during winter (Ford et al. 1994).

Feeding/Reproduction

Diet in the eastern North Pacific is specific to the type of killer whale. The offshore ecotype appears to eat mostly fish (Bigg 1982; Morton 1990; Heise et al. 2003; Herman et al. 2005). Few details are known about the biology of offshore killer whales, but they commonly occur in groups of 20 to 75 individuals (Wiles 2004).There is no information the reproductive behavior of killer whales in this area.

Acoustics

General information on dives, vocalizations, and hearing ability for killer whales is presented in Section 3.9.1.1. The acoustic abilities presented there are assumed to be similar for offshore killer whales.

Information Specific to the Northwest Training Range Complex Study Area

Killer whales tend to be seen along the Oregon coast during late April and May and may target gray whale females and calves migrating north. However, based on food type, these probably are transients. When observed offshore, the determination of a particular whale to either a transient, offshore, or a resident is often difficult. For this reason, all killer whales are considered to part of the southern resident stock for analysis of effect. There is a primary occurrence for the killer whale throughout the OPAREA and Puget Sound.

Short-finned Pilot Whale (*Globicephala macrorhynchus*)

Population Status

The short-finned pilot whale is not listed under the ESA, however, the California/Oregon/Washington stock is considered strategic under the MMPA because the average human-caused mortality may not be sustainable (Barlow et al. 1997). Population size for the California/Oregon/Washington stock is 350 (CV = 0.48) individuals (Barlow and Forney 2007). The NMFS population estimate for the California/Oregon/Washington stock is 304 (CV = 1.02) individuals (Carretta et al. 2007a).

Distribution

Worldwide, pilot whales usually are found over the continental shelf break, in slope waters, and in areas of high topographic relief, but movements over the continental shelf and close to shore at oceanic islands can occur (Mignucci-Giannoni 1998; Gannier 2000; Olson and Reilly 2002). The short-finned pilot whale is found in tropical to warm-temperate seas. It usually does not range north of 50°N or south of 40°S (Jefferson et al. 1993). The range of the short-finned pilot whale appears to be expanding to fill the former range of the long-finned pilot whale (Bernard and Reilly 1999), which apparently has been extirpated from the North Pacific (Kasuya 1975).

Feeding/Reproduction

Distribution and seasonal inshore/offshore movements probably coincide closely with the abundance of squid, their preferred prey (Hui 1985; Waring et al. 1990; Waring and Finn 1995; Bernard and Reilly

1999). Pilot whales are very social and may travel in groups of several to hundreds of animals, often with other cetaceans (Bernard and Reilly 1999; Gannier 2000). They appear to live in relatively stable, female-based groups (Jefferson et al. 1993). Sexual maturity occurs at 9 years for females and 17 years for males (Bernard and Reilly 1999). The mean calving interval is 4 to 6 years (Bernard and Reilly 1999). Calving peaks in the northern hemisphere vary by stock (Jefferson et al. 1993).

Acoustics

Short-finned pilot whale whistles and clicks have a dominant frequency range of 2 to 14 kHz and 30 to 60 kHz, respectively, at an estimated source level of 180 dB re 1 µPa-m (Fish and Turl 1976; Ketten 1998). There are no published hearing data for this species.

Information Specific to the Northwest Training Range Complex Study Area

Stock structure of short-finned pilot whales has not been adequately studied in the eastern North Pacific. Population size for the California/Oregon/Washington stock is estimated at 350 (CV = 0.48) individuals and an estimated short-finned pilot whale density for northern California of 0.000713 individuals per km^2 (Barlow and Forney 2007).

Along the west coast of North America, sightings of short-finned pilot whales north of Point Conception are uncommon (Everitt et al. 1979; Osborne et al. 1988; Forney 1994). Baird and Stacey (1993) and Stacey and Baird (1993) reviewed occurrence records in British Columbia waters and recommended that it be considered rare there, occurring in most years, but with only a few records per year. Norman et al. (2004) found that most stranding events for this species occurred during or within a year of an El Niño. Occurrence records for the OPAREA are primarily during the warmer months (Fiscus and Niggol 1965; Pike and MacAskie 1969; Everitt et al. 1979; Baird and Stacey 1993).

There is a rare occurrence for the short-finned pilot whale throughout the entire OPAREA and Puget Sound.

Harbor Porpoise (*Phocoena phocoena*)

Population Status

Census data suggest a stable population trend. The latest NMFS stock estimates for the three stocks located in the NWTRC Study Area (Northern CA/Southern OR, Oregon/Washington Coast, and Washington Inland water) are 17,763; 37,745; and 10,682 individuals, respectively (Carretta et al. 2007a).

Distribution

Harbor porpoise are generally found in cool temperate to subarctic waters over the continental shelf in both the North Atlantic and North Pacific (Read 1999). This species is seldom found in waters warmer than 17°C (Read 1999) or south of Point Conception (Hubbs 1960; Barlow and Hanan 1995).

Feeding/Reproduction

Along the coast of Washington, harbor porpoise primarily feed on Pacific herring (*Clupea pallasii*), market squid, and smelts (Gearin et al. 1994). In most areas, harbor porpoises occur in small groups consisting of just a few individuals. They mature at an earlier age, reproduce more frequently, and live for shorter periods than other toothed whales (Read and Hohn 1995). Calves are born in late spring (Read 1990b; Read and Hohn 1995). Dall's and harbor porpoises appear to hybridize relatively frequently in the Puget Sound area (Willis et al. 2004).

Acoustics

Harbor porpoise vocalizations include clicks and pulses (Ketten 1998), as well as whistle-like signals (Verboom and Kastelein 1995). The dominant frequency range is 110 to 150 kHz, with source levels of

135 to 177 dB re 1 µPa-m (Ketten 1998). Echolocation signals include one or two low-frequency components in the 1.4 to 2.5 kHz range (Verboom and Kastelein 1995).

A behavioral audiogram of a harbor porpoise indicated the range of best sensitivity is 8 to 32 kHz at levels between 45 and 50 dB re 1 µPa-m (Andersen 1970); however, auditory-evoked potential studies showed a much higher frequency of approximately 125 to 130 kHz with two frequency ranges of best sensitivity (Bibikov 1992). More recent psycho-acoustic studies found the range of best hearing to be 16 to 140 kHz, with a reduced sensitivity around 64 kHz and maximum sensitivity between 100 and 140 kHz (Kastelein et al. 2002).

Information Specific to the Northwest Training Range Complex Study Area

Harbor porpoise stocks in the NWTRC Study Area, including their boundaries and population estimates, are as follows (Carretta et al. 2007a):

- Northern California/Southern Oregon stock: Point Arena, California, to Cape Blanco, Oregon with a population estimate of 17,763 (CV = 0.39) individuals.
- Oregon/Washington coast stock: Cape Blanco, Oregon, to Cape Flattery, Washington with a population estimate of 37,745 (CV = 0.38) individuals.
- Inland Washington stock: includes Puget Sound with a population estimate of 10,682 (CV = 0.38) individuals.

The harbor porpoise is a common species in the NWTRC Study Area year-round. Peak abundance is in the fall off northern California (Dohl et al. 1983) and in fall and winter off Oregon and Washington (Green et al. 1992). They occur year-round and breed in the inland waters between Washington and British Columbia (Osborne et al. 1988). Harbor porpoise strandings in Puget Sound and surrounding waters occur most frequently during May, with 70 percent of strandings between March and June (Osborne 2003; NMFS 2005a).

The harbor porpoise used to be common throughout the Puget Sound (Scheffer and Slipp 1948; Flaherty and Stark 1982). However, most recent sightings within the Puget Sound have been limited to the central portion (Calambokidis et al. 1992; Raum-Suryan and Harvey 1998). There are high harbor porpoise densities north of Orcas Island (Laake personal communication 2005).

The area of primary occurrence for the harbor porpoise in the NWTRC Study Area includes waters shallower than 328 ft (100 m) and the area north of Whidbey Island (DoN 2006). There is a secondary occurrence between the 328 ft (100 m) and 984 ft (300 m) water depths and in the area south of Whidbey Island (DoN 2006). There is a rare occurrence in waters deeper than 984 ft (300 m).

Dall's Porpoise (*Phocoenoides dalli*)

Population Status

Population size for the Washington/Oregon/California Dall's porpoise stock is estimated to be 85,955 (CV = 0.45) individuals (Barlow and Forney 2007). The NMFS population estimate for the California/Oregon/Washington stock is 99,517 (CV = 0.33) individuals (Carretta et al. 2007a). No specific data are available regarding trends in population size in California or adjacent waters.

Distribution

The Dall's porpoise is found from northern Baja California, Mexico, north to the northern Bering Sea and south to southern Japan (Jefferson et al. 1993). The species is only common between 32°N and 62°N in the eastern North Pacific (Morejohn 1979; Houck and Jefferson 1999). North-south movements in California, Oregon, and Washington have been suggested. Dall's porpoises shift their distribution southward during cooler-water periods (Forney and Barlow 1998). Norris and Prescott (1961) reported finding Dall's porpoise in southern California waters only in the winter, generally when the water temperature was less than 15°C. Inshore/offshore movements off southern California have also been reported, with individuals remaining inshore in fall and moving offshore in the late spring (Norris and Prescott 1961; Houck and Jefferson 1999; Lagomarsino and Price 2001). Seasonal movements have also been noted off Oregon and Washington, where higher densities of Dall's porpoises were sighted offshore in winter and spring and inshore in summer and fall (Green et al. 1992).

Feeding/Reproduction

Dall's porpoises feed primarily on small fish and squid (Houck and Jefferson 1999). Groups of Dall's porpoises generally include fewer than 10 individuals and are fluid, probably aggregating for feeding (Jefferson 1990 and 1991; Houck and Jefferson 1999). There is a strong summer calving peak from June through August, and a smaller peak in March (Jefferson 1989). Animals reach sexual maturity at 3.5 to 8 years (Houck and Jefferson 1999).

Acoustics

Only short-duration pulsed sounds have been recorded from Dall's porpoise (Houck and Jefferson 1999); this species apparently does not whistle often (Thomson and Richardson 1995). Dall's porpoises produce short-duration (50 to 1,500 µs), high-frequency, narrow-band clicks, with peak energies between 120 and 160 kHz (Jefferson 1988). There are no published data on hearing abilities of this species. However, based on the morphology of the cochlea, it is estimated that the upper hearing threshold is about 170 to 200 kHz (Awbrey et al. 1979).

Information Specific to the Northwest Training Range Complex Study Area

The Dall's porpoise is an abundant species that occurs year-round throughout the OPAREA and Study Area. It is the most common cetacean in northern Puget Sound and the Strait of Juan de Fuca (Osborne et al. 1988). They are also found in Haro Strait between San Juan Island and Vancouver Island, where tagging studies suggest that Dall's porpoises seasonally move between the Haro Strait area and the Strait of Juan de Fuca or farther west (Hanson et al. 1998). Barlow and Forney (2007) estimated Dall's porpoise densities for Washington and Oregon of 0.151924 individuals per km^2 and 0.106199 individuals per km^2 off the northern California coast. Based on predictive spatial habitat models (see Appendix D), an overall density estimate of harbor porpoises in the NWTRC Study Area was calculated at 0.0970 individuals per km^2 (DoN 2007).

Along the coast of the NWTRC Study Area, the area of primary occurrence for Dall's porpoise is in waters cooler than 15.5°C and deeper than 328 ft (100 m). Within the Puget Sound, there is a primary occurrence in the Strait of Juan de Fuca and approximately north of Whidbey Island and into the Strait of Georgia. Secondary occurrence areas include coastal waters between the 15.5° and 16°C isotherms and deeper than 328 ft (100 m) (Barlow personal communication 2005) and the Puget Sound south of approximately Whidbey Island (Laake personal communication 2005). There is a rare occurrence in waters shallower than 328 ft (100 m) along the outer coast and in the western portion of southern Puget Sound.

Harbor Seal (*Phoca vitulina richardsi*)

Population Status

Census data suggest an increasing population trend in California and stable populations in Washington and Oregon. The three harbor seal stocks that are recognized along the west coast of the continental United States, with estimated population numbers, are as follows (Carretta et al. 2007a):

- Inland waters of Washington (including Hood Canal, Puget Sound, and the Strait of Juan de Fuca out to Cape Flattery), with an estimate of 14,612 (CV = 0.15) individuals.
- Outer coast of Oregon and Washington, with a stock estimate of 24,732 (CV = 0.12) individuals.
- California, with a stock estimate of 34,233 individuals.

Distribution

Harbor seals are a coastal species, rarely found more than 12 mi (20 km) from shore, and frequently occupy bays, estuaries, and inlets (Baird 2001). Individual seals have been observed several miles (kilometers) upstream in coastal rivers (Baird 2001). Ideal harbor seal habitat includes haulout sites, shelter during the breeding periods, and sufficient food (Bjørge 2002). Haulout areas can include intertidal and subtidal rock outcrops, sandbars, sandy beaches, peat banks in salt marshes, and manmade structures such as log booms, docks, and recreational floats (Wilson 1978; Prescott 1982; Schneider and Payne 1983; Gilbert and Guldager 1998; Jeffries et al. 2000). Human disturbance can affect haulout choice (Harris et al. 2003).

Feeding/Reproduction

Harbor seals are opportunistic feeders that adjust their patterns to take advantage of locally and seasonally abundant prey (Payne and Selzer 1989; Baird 2001; Bjørge 2002). Diet consists of fish and invertebrates (Bigg 1981; Roffe and Mate 1984; Orr et al. 2004). Although harbor seals in the Pacific Northwest are common in inshore and estuarine waters, they primarily feed at sea (Orr et al. 2004) during high tide.

On land, harbor seals congregate in groups of about 30 to 80 individuals, although groups of several thousand are found in areas where food is plentiful (Jeffries et al. 2000; Ronald and Gots 2003). In coastal and inland regions of Washington, pups are born from April through January. Pups are generally born earlier in the coastal areas and later in the Puget Sound/Hood Canal region (Calambokidis and Jeffries 1991; Jeffries et al. 2000). Suckling harbor seal pups spend as much as 40 percent of their time in the water (Bowen et al. 1999).

Acoustics

In the air, harbor seal males produce a variety of low-frequency (<4 kHz) vocalizations, including snorts, grunts, and growls. Pups make individually unique calls for mother recognition that contain multiple harmonics with main energy below 0.35 kHz (Bigg 1981; Thomson and Richardson 1995). Adult males also produce underwater sounds during the breeding season that typically range from 0.025 to 4 kHz (duration range: 0.1 s to multiple seconds; Hanggi and Schusterman 1994). Hanggi and Schusteman (1994) found that there is individual variation in the dominant frequency range of sounds between different males, and Van Parijs et al. (2003) reported oceanic, regional, population, and site-specific variation that could be vocal dialects.

Harbor seals hear nearly as well in air as underwater (Kastak and Schusterman 1998). In water, they hear frequencies from 1 to 180 kHz and are most sensitive at frequencies below 50 kHz; above 60 kHz sensitivity rapidly decreases. In air, they hear frequencies from 0.25 kHz to 30 kHz and are most sensitive from 6 to 16 kHz (Richardson 1995; Terhune and Turnbull 1995; Wolski et al. 2003).

Information Specific to the Northwest Training Range Complex Study Area

The harbor seal is an abundant species in the OPAREA and Study Area that occurs year-round. There are about 50 haulout sites along the coasts of Oregon and Washington, particularly in coastal estuaries and along the Olympic Peninsula (Bonnell et al. 1992; Jeffries et al. 2003). Main haulout sites in Washington inland waters include the Strait of Juan de Fuca, San Juan Islands, Eastern Bays, Puget Sound, and Hood Canal (DoN 2001a; Jeffries et al. 2003). Woodard Bay and Gertrude Island are the two most important rookery sites in the Puget Sound (Calambokidis and Jeffries 1991). In Washington and Oregon, harbor seals tend to use some estuaries and bays for breeding and others primarily for feeding (Boveng 1988). Harbor seals can haul out on recreational floats, log rafts and booms, oyster rafts, fish net pens, marina floats, and breakwaters in the Puget Sound (Calambokidis and Jeffries 1991). They also haul out on submarines at Naval Base Kitsap (NBK)-Bangor (DoN 2001a).

Aerial surveys off Oregon and Washington recorded most harbor seals within 12 mi (20 km) of shore in areas where water depths are less than 656 ft (200 m) (Bonnell et al. 1992; Calambokidis et al. 2004b). Sightings farther offshore and in deeper waters also occur (Wahl 1977; Bonnell et al. 1992). Peak abundance occurs during the pupping season and the annual molt (Jeffries et al. 2000).

Primary occurrence is the area between the shore and a water depth of 1,640 ft (500 m) along the outer coast, and throughout the entire Puget Sound. An area of secondary occurrence is in water depths between 1,640 ft (500 m) and 6,562 ft (2,000 m). Rare occurrence extends seaward in water deeper than 6,562 ft (2,000 m). The population of harbor seals along the Washington and Oregon coasts is estimated to be approximately 24,732 individuals and the estimated inland population is 14,612 (Carretta et al. 2007b).

Northern Elephant Seal (*Mirounga angustirostris*)

Population Status

Census data suggest an increasing population trend. The northern elephant seal population has recovered dramatically after being reduced to several dozen, or perhaps no more than a few, animals in the 1890s (Bartholomew and Hubbs 1960; Stewart et al. 1994). There are now at least 101,000 elephant seals in the California stock (Carretta et al. 2007a), which extends into the NWTRC Study Area. Numbers in this stock are increasing by around 6 percent annually (Stewart et al. 1994; Carretta et al. 2007a).

Distribution

The northern elephant seal occurs almost exclusively in the eastern and central North Pacific. Rookeries are located from central Baja California, Mexico, to northern California (Stewart and Huber 1993). In California, they include the Channel Islands, Piedras Blancas, Cape San Martin, Año Nuevo Island and Peninsula, the Farallon Islands, and Point Reyes (Stewart et al. 1994; Carretta et al. 2006). Large rookeries, such as those on Año Nuevo Island and Peninsula and the Channel Islands, may contain thousands of seals. Elephant seals may be expanding their pupping range northward, possibly in response to the continued population growth (Hodder et al. 1998). Bonnell et al. (1992) and Hodder et al. (1998) noted a possible incipient breeding colony at Shell Island off Cape Arago in southern Oregon.

The foraging range extends thousands of miles (kilometers) offshore into the central North Pacific. Adults tend to stay offshore, but juveniles and subadults are often seen along the coasts of Oregon, Washington, and British Columbia (Condit and Le Boeuf 1984; Stewart and Huber 1993). During foraging, females may cover more than 11,185 mi (18,000 km) and males can travel more than 13,049 mi (21,000 km) (Stewart and DeLong 1995).

Feeding/Reproduction

Primarily prey include cephalopods, fish, and crustaceans, such as pelagic red crabs (*Pleuroncodes planipes*) (Condit and Le Boeuf 1984; DeLong and Stewart 1991; Stewart and Huber 1993; Antonelis et al. 1994). Feeding habitat is mostly in deep, offshore waters of warm temperate to subpolar zones far removed from the breeding rookeries (Stewart and DeLong 1995; Stewart 1997; Le Boeuf et al. 2000). Adult seals migrate to feeding areas in the Subarctic Current between 40° and 50° N and the Alaska Stream, which flows northward through the Gulf of Alaska. Juvenile seals forage in the California Current. While adults use the California Current primarily as a migration corridor, they also feed there while in transit (Stewart and Delong 1993).

Northern elephant seals use sandy beaches for breeding and molting. Most sites are on offshore islands, but some are on the coastal mainland (Stewart et al. 1994). Seals also use small coves and sand dunes behind and adjacent to breeding beaches (Stewart personal communication 2005). They haul out on land to give birth and mate, and after spending time at sea to feed (post-breeding migration), they generally return to the same general areas (sometimes using different beaches) to molt (Stewart and Yochem 1984; Stewart and DeLong 1995).

Acoustics

Evidence for underwater sound production by this species is scant (Kastak and Schusterman 1999). However, the northern elephant seal produces loud, low-frequency vocalizations in the air which differ between the sex and age of elephant seals. Mean frequencies are in the range of 0.1 to 0.3 kHz for adult males (Le Boeuf and Petrinovich 1974). Adult females typically produce calls between 0.5 and 1 kHz determined by call function (Bartholomew and Collias 1962). Pups also produce vocalizations and use a <1.4 kHz call to maintain contact with the mother (Bartholomew and Collias 1962).

The audiogram of the northern elephant seal indicates that this species is well-adapted for underwater hearing. Sensitivity is best between 3.2 and 45 kHz, with greatest sensitivity at 6.4 kHz and an upper frequency cutoff of approximately 55 kHz (Kastak and Schusterman 1999). In-air hearing is generally poor, but is best for frequencies between 3.2 and 15 kHz, with greatest sensitivity at 6.3 kHz (Kastak and Schusterman 1999). Elephant seals are relatively good at detecting tonal signals over masking noise (Southall et al. 2000).

Information Specific to the Northwest Training Range Complex Study Area

The northern elephant seal is a common species during the cold season and an uncommon species during the warm season in the OPAREA (Stewart and DeLong 1994). They occasionally haul out along the coasts of northern California, Oregon, Washington, and British Columbia, and regularly haul out on Shell Island off Cape Arago in southern Oregon. This island may be an incipient breeding colony (Hodder et al. 1998). Pups have been sighted there and at Protection and Minor Islands in the Puget Sound (Hodder et al. 1998; Jeffries et al. 2000).

Primary occurrence is seaward of a water depth of 656 ft (200 m) along the outer coast. An area of secondary occurrence is in waters between the 328 ft (100 m) and 656 ft (200 m) deep. Northern elephant seals also have a secondary occurrence in the Strait of Juan de Fuca and around the San Juan Islands that accounts for individuals moving into Puget Sound. Rare occurrence areas are from the shore to a water depth of 328 ft (100 m), the southern part of Puget Sound, and the Strait of Georgia. Bonnell et al. (1992) estimated northern elephant seal densities of 0.0022 individuals per km^2 from May to October and 0.0048 individuals per km^2 from November to April in waters off Oregon and Washington.

Northern Fur Seal (*Callorhinus ursinus*)

Population Status

Census data suggest an increasing population trend. Two stocks of northern fur seals are recognized in U.S. waters: an Eastern Pacific stock and a San Miguel Island stock (Carretta et al. 2007a).

- The Eastern Pacific stock, with an estimated 721,935 individuals, includes the Pribilof Island breeding group in the Bering Sea (Carretta et al. 2007a). It is a strategic stock because it is considered depleted under the MMPA (Angliss and Outlaw 2005).
- The smaller San Miguel Island stock is not considered to be depleted under the MMPA (Carretta et al. 2006). It includes approximately 4,190 individuals (Carretta et al. 2007a). Abundance has increased steadily, except for severe declines in 1983 and 1988 that were associated with climatic oscillations (DeLong and Antonelis 1991; Melin and DeLong 2000; Testa 2005).

Distribution

The northern fur seal is a highly oceanic species, spending all but 35 to 45 days per year at sea (Gentry 2002). They are usually sighted 44 mi (70 km) to 81 mi (130 km) from land along the continental shelf and slope, seamounts, submarine canyons, and sea valleys, where there are upwellings of nutrient-rich water (Kajimura 1984). The subpolar continental shelf and shelf break from the Bering Sea to California provides suitable feeding habitat (NMFS 1993a). Although rookeries are typically composed of a rocky substrate, northern fur seals use sandy beaches for breeding on San Miguel Island (Bonnell et al. 1983; Baird and Hanson 1997). Both the Eastern Pacific and the San Miguel Island stocks occur in the NWTRC Study Area.

Eastern Pacific northern fur seals migrate along continental margins from low-latitude winter foraging areas to northern breeding islands (Gentry 1998). Adult females and juveniles leave the breeding islands in November and concentrate around the continental margins of the North Pacific, including areas off British Columbia, Washington, Oregon, and California, in January and February (Gentry 1981; Ream et al. 2005). Adult males generally migrate only as far south as the Gulf of Alaska (Kajimura 1984). Some northern fur seals remain near the Pribilof Islands year-round (Bigg 1990). The northward migration begins in March, and most of this stock has left the offshore area by June (Antonelis and Fiscus 1980). Adult females and juveniles from the San Miguel stock are found in offshore waters of northern California, Oregon, and Washington from October through May or early June. They return to the rookery islands to pup and breed in June and July (DeLong personal communication 2006).

Feeding/Reproduction

Northern fur seals are solitary at sea but tend to congregate in food-rich areas where as many as 100 individuals have been sighted (Antonelis and Fiscus 1980; Kajimura 1984). Northern fur seals feed opportunistically on a variety of fish and squids species throughout their range (Kajimura 1984). They occur from southern California north to the Bering Sea and west to the Okhotsk Sea and Honshu Island, Japan (Carretta et al. 2006). The largest rookery is on St. Paul and St. George Islands in the Pribilof Islands Archipelago in Alaska. Smaller breeding colonies are located on the Kuril Islands, Robben Island, and the Commander Islands in Russia; Bogoslof Island in the southeastern Bering Sea; and San Miguel and the Farallon Islands in California (Pyle et al. 2001; Robson 2002).

Northern fur seals are gregarious during the breeding season and maintain a complex social structure on the rookeries. On San Miguel Island, pupping season is from late May through July (DeLong 1982). Pups are born between June and August on the Pribilof Islands (York 1987). Pups are weaned at around 4 months (Gentry 1998).

Acoustics

Northern fur seals produce underwater clicks, and in-air bleating, barking, coughing, and roaring sounds (Schusterman 1978; Thomson and Richardson 1995). Males vocalize (roar) almost continuously at rookeries (Gentry 1998). Females and pups produce airborne bawls to reunite after separation (Thomson and Richardson 1995).

The hearing ability of this species has been measured in air and underwater by behavioral methods. Of all the pinniped species for which hearing information is available, the northern fur seal is the most sensitive to airborne sound (Moore and Schusterman 1987). In air, this species can hear sounds ranging from 0.1 to 36 kHz, with best sensitivity from 2 to 16 kHz and a hearing loss at around 4 or 5 kHz (Moore and Schusterman 1987; Babushina et al. 1991; Babushina 1999). Underwater hearing ranges from 0.5 Hz to 40 kHz, is most sensitive from 2 to 32 kHz, and has a sensitivity that is 15 to 20 dB better than in the air (Moore and Schusterman 1987; Babushina et al. 1991).

Information Specific to the Northwest Training Range Complex Study Area

Northern fur seals are present in the OPAREA and Study Area year-round (Bonnell et al. 1992), but are most abundant between January and May. Sightings are more common off the northern Washington and Vancouver Island coasts in winter, and off central and southern Oregon in spring (Bonnell et al. 1992; Laake personal communication 2005). Bonnell et al. (1992) estimated a northern fur seal density of 0.040 individuals per km^2 from November to April in waters off Oregon and Washington. Migrating northern fur seals are commonly found in deep waters (>6,562 ft [>2,000 m]) offshore of Oregon and Washington (Bonnell et al. 1992), and they rarely haul out on land during migrations (Bonnell et al. 1983). Some individuals, mostly juveniles, make their way into the Strait of Juan de Fuca and Puget Sound each year (Everitt et al. 1979).

The area of primary occurrence for the northern fur seal along the outer coast in the NWTRC Study Area is in waters seaward of the 328 ft (100 m) depth. The area of secondary occurrence is in waters inshore of the 328 ft (100 m) depth. Inland waters of the Puget Sound are an area of rare occurrence for this species.

California Sea Lion (*Zalophus californianus*)

Population Status

The U.S. stock of California sea lions uses the NWTRC Study Area. The estimated stock is 237,000 and the minimum population size of this stock is 141,842 individuals (Carretta et al. 2007a). This number is from counts during the 2001 breeding season of animals that were ashore at the four major rookeries in southern California and at haulout sites north to the Oregon/California border. Sea lions that were at sea or were hauled out at other locations were not counted (Carretta et al. 2007a).

Distribution

During the summer, California sea lions breed on islands from the Gulf of California to the Channel Islands and seldom travel more than about 31 mi (50 km) from the islands (Bonnell et al. 1983). The primary rookeries are located on the California Channel Islands of San Miguel, San Nicolas, Santa Barbara, and San Clemente (Le Boeuf and Bonnell 1980; Bonnell and Dailey 1993). Their distribution shifts to the northwest in fall and to the southeast during winter and spring, probably in response to changes in prey availability (Bonnell and Ford 1987). In the non-breeding season, adult and subadult males migrate northward along the coast to central and northern California, Oregon, Washington, and Vancouver Island, are occasionally sighted hundreds of miles (kilometers) offshore (Jefferson et al. 1993), and return south the following spring (Mate 1975; Bonnell et al. 1983). Females and juveniles tend to stay closer to the rookeries (Bonnell et al. 1983).

They also enter bays, harbors, and river mouths (Jefferson et al. 1993) and often haul out on man-made structures such as piers, jetties, offshore buoys, and oil platforms (Riedman 1990). California sea lions in the Puget Sound haul out on log booms and U.S. Navy submarines, and are often seen rafted off river mouths (Jeffries et al. 2000; DoN 2001a).

Feeding/Reproduction

California sea lions feed on a wide variety of prey, including many species of fish and squid (Everitt et al. 1981; Roffe and Mate 1984; Antonelis et al. 1990; Lowry et al. 1991). The sea lions typically feed over the continental shelf. California sea lions prefer to breed on sandy, remote beaches (Le Boeuf 2002) near productive upwelling zones where prey is easily available to lactating females (Heath 2002). California sea lions are gregarious during the breeding season and social on land during other times. Females give birth in May and June. Pups are weaned between six months and a year or longer (Riedman 1990). Sexual maturity occurs at around four to five years of age (Heath 2002).

Acoustics

In air, California sea lions make raucous barking sounds; these have most of their energy at less than 2 kHz (Thomson and Richardson 1995). Females produce barks, squeals, belches, and growls in the frequency range of 0.25 to 5 kHz, while pups make bleating sounds at 0.25 to 6 kHz (Thomson and Richardson 1995). California sea lions produce two types of underwater sounds: clicks (or short-duration sound pulses) and barks (Schusterman et al. 1966, 1967; Schusterman and Balliet 1969). All underwater sounds have most of their energy below 4 kHz (Schusterman et al. 1967).

Audiograms are available for the California sea lion. The range of maximum sensitivity underwater is between 1 and 28 kHz, and functional underwater High-frequency hearing limits are between 35 and 40 kHz, with peak sensitivities from 15 to 30 kHz (Schusterman et al. 1972). The California sea lion shows relatively poor hearing at frequencies below 1 kHz (Kastak and Schusterman 1998). In air, the effective upper hearing limit is approximately 36 kHz and the best range of sound detection is from 2 to 16 kHz (Schusterman 1974).

Information Specific to the Northwest Training Range Complex Study Area

California sea lions occur in the NWTRC throughout the year but are most abundant between fall and late spring (September through May) during the non-breeding season (Bonnell et al. 1983; NMFS 1997a; Jeffries et al. 2000). Bonnell et al. (1992) estimated California sea lion densities of 0.00092 individuals per km^2 from May to October and 0.032 individuals per km^2 from November to April in waters off Oregon and Washington. Most of the animals in the Study Area are large, adult males that migrate along the coast, usually within 12 mi (20 km) from the shore (Bonnell et al. 1992). They are mostly sighted along the shelf break and continental slope (Bonnell et al. 1983; Calambokidis et al. 2004b) or at haulout sites along the coasts and inland waters. Periods of use and main haulout sites are as follows (NMFS 1997a; Gearin et al. 2001; DeLong personal communication 2006):

- In Washington waters, they are present from around September through May and are concentrated in the Strait of Juan de Fuca and in Puget Sound (NMFS 1997a; Jeffries et al. 2000). Main haulout sites include offshore rocks near Bodeltech Island area west of Cape Alava, Waadah Island, and numerous navigation buoys south and west of Whidbey Island (Jeffries et al. 2000)
- They are present along the coast of Oregon from October to April (NMFS 1997a). Main haulout sites include the Columbia River (South Jetty), Cascade Head, Cape Arago, and Orford and Rogue Reefs.
- They utilize the northern coast of California mainly during May and June, and September and October (Bonnell et al. 1983). Main haulout sites include St. George Reef, Castle Rock, and Farallon and Año Nuevo Islands.

The areas of primary occurrence for the California sea lion include the shore to the shelf break around haulout sites along the outer coast, and the Puget Sound. There is an area of secondary occurrence seaward of the primary occurrence area to a generalized water depth of 6,562 ft (2,000 m). There is a rare occurrence for the California sea lion seaward of the area of secondary occurrence.

3.9.1.3 Current Requirements and Practices

As summarized in Chapter 5, there is a comprehensive suite of protective mitigation measures and SOPs implemented by the Navy to avoid and reduce impacts to marine mammals. In particular, the following categories of measures all serve to reduce or eliminate potential impacts of Navy activities on marine mammals that may be present in the vicinity of training activities:

- Training personnel and watchstander to identify and locate nearby marine mammals;

- Maintaining minimum buffer zones for surface vessel approach to marine mammals;
- Maintaining minimum aircraft overflight buffer zones of critical habitat and pinniped rookeries and haulout sites;
- Reducing sonar emissions when marine mammals are in the vicinity of training activities;
- Establishing marine mammal-free exclusion zones for underwater detonations of explosives; and
- Conducting pre- and post-exercise surveys.

3.9.2 Environmental Consequences

3.9.2.1 Approach to Analysis

This section describes potential environmental effects associated with conducting naval activities for three alternative scenarios in the NWTRC. The activities include active sonar activities; surface vessel, submarine, and aircraft warfare training activities; weapons firing and non-explosives ordnance use; electronic combat; discharges of expendable materials; and mine countermeasure training. These activities are configured in various combinations to define specific warfare areas.

This section distinguishes between United States territorial waters (shoreline to 12 nm [22 km]) and non-territorial waters, (seaward of 12 nm [22 km]) for the purposes of applying the appropriate regulations (National Environmental Policy Act [NEPA] or Executive Order [EO]12114) to analyze potential environmental effects. Proposed mitigation measures have been developed to minimize potential environmental effects. Chapter 5 details these measures. An overview of the types of mitigation measures is presented in this section for the reviewer's convenience.

Regulatory Framework

The MMPA and ESA prohibit the unauthorized harassment of marine mammals and endangered species, and provide the regulatory processes for authorizing any such harassment that might occur incidental to an otherwise lawful activity. These two acts establish the context for determining potentially adverse impacts to marine mammals from military activities.

Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972 established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction. The act further regulates "takes" of marine mammals in the global commons (that is, the high seas) by vessels or persons under U.S. jurisdiction. The term "take," as defined in Section 3 (16 USC 1362) of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." "Harassment" was further defined in the 1994 amendments to the MMPA, which provided two levels of harassment, Level A (potential injury) and Level B (potential disturbance).

The National Defense Authorization Act of Fiscal Year 2004 (Public Law 108-136) amended the definition of harassment as applied to military readiness activities or scientific research activities conducted by or on behalf of the federal government, consistent with Section 104(c)(3) [16 USC 1374 (c)(3)]. The Fiscal Year 2004 National Defense Authorization Act adopted the definition of "military readiness activity" as set forth in the Fiscal Year 2003 National Defense Authorization Act (Public Law 107-314). Military training activities within the NWTRC Study Area constitute military readiness activities as that term is defined in Public Law 107-314 because training activities constitute "training and operations of the Armed Forces that relate to combat" and constitute "adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat use."

For military readiness activities, the relevant definition of harassment is any act that:

- Injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment").
- Disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered ("Level B harassment") [16 USC 1362 (18)(B)(i)(ii)].

Section 101(a)(5) of the MMPA directs the Secretary of the Department of Commerce to allow, upon request, the incidental (but not intentional) taking of marine mammals by U.S. citizens who engage in a specified activity (exclusive of commercial fishing), if certain findings are made and regulations are issued. Permission will be granted by the Secretary for the incidental take of marine mammals if the taking will have a negligible impact on the species or stock and will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses.

In support of the Proposed Action, the Navy is requesting a Letter of Authorization (LOA) pursuant to Section 101(a)(5)(A) of the MMPA. After the application is reviewed by NMFS, a Notice of Receipt of Application will be published in the Federal Register. Publication of the Notice of Receipt of Application will initiate the 30-day public comment period, during which time anyone can obtain a copy of the application by contacting NMFS. In addition, the MMPA requires NMFS to develop regulations governing the issuance of a LOA and to publish these regulations in the Federal Register. Specifically, the regulations for each allowed activity establish (1) permissible methods of taking, and other means of affecting the least practicable adverse impact on such species or stock and its habitat, and on the availability of such species or stock for subsistence, and (2) requirements for monitoring and reporting of such taking. For military readiness activities (as described in the National Defense Authorization Act), a determination of "least practicable adverse impacts" on a species or stock that includes consideration, in consultation with the DoD, of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

Several species of marine mammals occur in the NWTRC Study Area. Accordingly, the Navy has initiated the MMPA compliance process with the NMFS.

Endangered Species Act

The Endangered Species Act (ESA) of 1973 established protection over and conservation of threatened and endangered species and the ecosystems upon which they depend. An "endangered" species is a species that is in danger of extinction throughout all or a significant portion of its range, while a "threatened" species is one that is likely to become endangered within the foreseeable future throughout all or in a significant portion of its range. The USFWS and NMFS jointly administer the ESA and are also responsible for the listing of species (designating a species as either threatened or endangered). The USFWS has primary management responsibility for management of terrestrial and freshwater species, while the NMFS has primary responsibility for marine species and anadromous fish species (species that migrate from saltwater to freshwater to spawn). The ESA allows the designation of geographic areas as critical habitat for threatened or endangered species.

The ESA requires federal agencies to conserve listed species and consult with the USFWS and/or NMFS to ensure that proposed actions that may affect listed species or critical habitat are consistent with the requirements of the ESA. The ESA specifically requires agencies not to "take" or "jeopardize" the continued existence of any endangered or threatened species, or to destroy or adversely modify habitat critical to any endangered or threatened species. Under Section 9 of the ESA, "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect. Under Section 7 of the ESA, "jeopardize" means to engage in any action that would be expected to reduce appreciably the likelihood of the survival and recovery of a listed species by reducing its reproduction, numbers, or distribution.

Regulations implementing the ESA expand the consultation requirement to include those actions that "may affect" a listed species or adversely modify critical habitat. If an agency's proposed action would take a listed species, the agency must obtain an incidental take statement from the responsible wildlife agency. Consultation is complete once NMFS prepares a final Biological Opinion and issues an incidental take statement.

Nine marine mammal species that are listed as endangered under the ESA could potentially occur in the Study Area. Accordingly, the Navy has initiated the ESA Section 7 consultation process with NMFS. Critical habitat for two listed marine mammal species has been designated under the ESA in the Study Area. Critical habitat for the southern resident killer whale stock is designated in Puget Sound and for specific Steller sea lion rookeries along the Oregon and California coasts.

Executive Order 12114

EO 12114 directs federal agencies to provide for informed decision making for major federal actions outside the United States, including the global commons, the environment of a non participating foreign nation, or impacts on protected global resources. An OEIS is required when an action has the potential to significantly harm the environment of the global commons. "Global commons" are defined as "geographical areas that are outside of the jurisdiction of any nation, and include the oceans outside territorial limits (outside 12 nm [22.2 km] from the coast) and Antarctica. Global commons do not include contiguous zones and fisheries zones of foreign nations" (32 CFR 187.3). The Navy has published procedures for implementing EO 12114 in 32 CFR 187, Environmental Effects Abroad of Major Department of Defense Actions, as well as the October 2007 Office of the Chief of Naval Operations Instruction (OPNAVINST) 5090.1C.

Unlike NEPA, EO 12114 does not require a scoping process. However, the EIS and OEIS have been combined into one document, as permitted under NEPA and EO 12114, in order to reduce duplication. Therefore, the scoping requirements found in NEPA were implemented with respect to actions occurring seaward of U.S. territorial waters, and discussions regarding scoping requirements will reference the combined NWTRC EIS/OEIS.

Study Area

The Study Area for marine mammals is analogous to the "action area," for purposes of analysis under Section 7 of the ESA.

Data Sources

A comprehensive and systematic review of relevant literature and data was conducted to complete this analysis. Of the available scientific and technical literature (both published and unpublished), the following types of documents were utilized: journals, books, periodicals, bulletins, Department of Defense operations reports, theses, dissertations, endangered species recovery plans, species management plans, stock assessment reports, environmental impact statements, range complex management plans, and other technical reports published by government agencies, private businesses, or consulting firms. Scientific and technical literature was also consulted during the search for geographic location data (geographic coordinates) on the occurrence of marine resources within the Study Area.

Information was collected from the following sources to summarize the occurrence of and to evaluate the impacts to marine mammal species in the Study Area:

- Marine resource assessment (MRA) for the PACNW operating area and marine mammal density estimates for the Pacific Northwest Study Area;

- University on-line databases: Ingenta, Web of Science; Aquatic Sciences and Fisheries Abstracts, Science Direct, Synergy, BIOSIS previews;
- The Internet, including various databases and related websites: National Oceanic and Atmospheric Administration (NOAA)-Coastal Services Center, NMFS, Ocean Biogeographic Information System, U.S. Geological Survey, WhaleNet, Blackwell-Science, FishBase, Food and Agriculture Organization, Federal Register, Pacific and North Pacific Fishery Management Councils;
- Federal and state agencies: the Department of the Navy, Pacific Fishery Management Council, NMFS Highly Migratory Species Division, NMFS Northwest Fisheries Science Center, NMFS Southwest Fisheries Science Center, NMFS Alaska Fisheries Science Center, NMFS Northwest Regional Office, NMFS Office of Habitat Protection, NMFS Office of Protected Resources, NOAA: Marine Managed Areas Inventory, USFWS Ecological Services Field Offices, U.S. Environmental Protection Agency, U.S. Geological Survey: Sirenia Project, Bureau of Land Management, Minerals Management Service, California Department of Fish and Game, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife; and
- Marine resource experts and specialists.

Marine Mammal Density Estimates

Estimates of marine mammal densities for the Study Area were obtained from the *Final Marine Mammal and Sea Turtle Density Estimates for the Pacific Northwest Study Area* (DoN 2007). The abundance of most cetaceans along the U.S. West Coast has been estimated since 1991 for waters off California and since 1996 for waters off Oregon and Washington (Barlow 1995; Barlow 2003; Barlow and Forney 2007). These estimates are based on shipboard surveys conducted by the Southwest Fisheries Science Center (SWFSC) during the summer and fall (late July to early December) in 1991, 1993, 1996, 2001, and 2005. These estimates are used to develop NMFS Stock Assessment Reports; to interpret the impacts of human-caused mortality due to fishery bycatch, ship strikes, and other sources; and to evaluate the ecological role of cetaceans in the eastern North Pacific.

The *MRA for the Pacific Northwest Operating Area* provided detailed information on the marine species known to occur in the Study Area (DoN 2006). The MRA provided information on the physical description, life history, and general distribution patterns for marine mammals. Areas of occurrence for each species were depicted on maps indicating “primary,” “secondary,” or “rare” occurrence. Quantitative density estimates were not included.

For offshore areas, predictive species-habitat models were built for those species with sufficient numbers of sightings to estimate densities for the Study Area. The methods used for predictive species-habitat modeling were consistent with those used by DoN (2007), and followed a stepwise forward/backward variable selection approach developed by Ferguson et al. (2006). Detailed descriptions of the model building and selection process can be found in DoN (2007). For species with insufficient numbers of sightings, density estimates were obtained from Barlow and Forney (2007). They used multiple covariate line-transect methods based on the 1991-2005 SWFSC shipboard survey data to produce the most recent cetacean abundance estimates available. These estimates are not stratified according to the Navy’s specific Study Areas, but they do provide representative numbers for the Study Area as a whole. Similar to the densities estimated from the models, they provide representative numbers for the “summer” season only (late July to early December).

For inland waters aerial line-transect surveys were conducted by the National Marine Mammal Laboratory (NMML) in 2002 and 2003 to estimate harbor porpoise abundance off the coasts of Oregon, Washington, and southern British Columbia, as well as the inland waters that include areas of interest to the Navy (Laake 2007). Harbor porpoise density estimates derived from these data were included in the report. Density estimates for other cetacean species known to occur in inland waters are not available. In order to roughly estimate the abundance of other cetacean species sighted during the surveys, data from the 2002-2003 surveys were prorated relative to harbor porpoise.

General Approach to Analysis

Each alternative analyzed in this EIS/OEIS includes several warfare areas (for example, anti-surface warfare (ASUW) and anti-submarine warfare (ASW)). Most warfare areas include multiple types of training activities (for example, ship sinking exercise (SINKEX) or anti-submarine warfare tracking exercise (TRACKEX)). Likewise, many activities (for example, vessel movements, aircraft overflights, and weapons firing) are conducted for an operation, and those activities typically are common to many activities. For example, many of the activities involve Navy vessel movements and aircraft overflights. Accordingly, the marine mammals analysis is organized by specific activity and/or stressors associated with that activity, rather than warfare area.

The following general steps were used to analyze the potential environmental consequences of the alternatives to marine mammals:

- Identify those aspects of the proposed action that are likely to act as stressors to marine mammals by having a direct or indirect effect on the physical, chemical, and biotic environment. As part of this step, the spatial extent of these stressors, including changes in that spatial extent over time, were identified. The results of this step identified those aspects of the proposed action that required detailed analysis in this EIS/OEIS.
- Identify marine mammal resources that may occur in the action area.
- Identify the marine mammal resources that are likely to co-occur with the stressors in space and time, and the nature of that co-occurrence (exposure analysis).
- Determine whether and how marine mammals are likely to respond given their exposure and available scientific knowledge of their responses (response analysis).
- Determine the risks those responses pose to marine mammals and the significance of those risks.
- Estimate the effectiveness of proposed mitigation measures in avoiding, offsetting, and reducing the intensity of any potential adverse impacts to marine mammals.
- Determine implications of the estimated risks under the ESA and MMPA.

Warfare Areas and Associated Environmental Stressors

The Navy used a screening process to identify aspects of the proposed action that could act as stressors to marine mammals. Navy subject matter experts analyzed the warfare areas and activities included in the proposed action to identify specific activities that could act as stressors. Public and agency scoping comments, previous environmental analyses, previous agency consultations, laws, regulations, executive orders, and resource-specific information were also evaluated. This process was used to organize the information presented and analyzed in the affected environment and environmental consequences sections of this EIS/OEIS. Potential stressors and the type of effect to marine mammals include:

- Vessel movements;
- Aircraft overflights;
- Non-explosive practice ordnance;
- High-explosive ordnance (underwater detonations and explosive ordnance);
- Active sonar; and

- Expended materials (ordnance related materials, targets, self-protection flares, sonobuoys, and marine markers).

As discussed in Section 3.2 (Air Quality) and Section 3.4 (Water Resources) of this EIS, some water and air pollutants would be released into the environment as a result of the proposed action. Those sections indicated that any increases in water or air pollutant concentrations resulting from Navy training would be negligible and localized. Impacts to water and air quality would be less than significant. Thus, water and air quality changes would have no effect or negligible effects on marine mammals. Accordingly, the effects of water and air quality changes on marine mammals are not addressed further in this EIS/OEIS.

Assessing Marine Mammal Responses to Sound

Marine mammals respond to various types of man-made sounds introduced in the ocean environment. Responses are typically subtle and can include shorter surfacings, shorter dives, fewer blows per surfacing, longer intervals between blows (breaths), ceasing or increasing vocalizations, shortening or lengthening vocalizations, and changing frequency or intensity of vocalizations (National Research Council of the National Academies [NRC] 2005). However, it is not known how these responses relate to significant effects (for example, long-term effects or population consequences) (NRC 2005). Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic sources, the marine mammals that may be present in the vicinity of the sound, and the effects that sound may have on the physiology and behavior of those marine mammals. The Navy enlisted the expertise of the NMFS as the cooperating agency in the preparation of this EIS/OEIS.

In estimating the potential for marine mammals to be exposed to an acoustic source, the following actions were completed:

- Evaluated potential effects within the context of existing and current regulations, thresholds, and criteria.
- Identified all acoustic sources that will be used during active sonar activities.
- Identified the location, season, and duration of the action to determine which marine mammal species are likely to be present.
- Estimated the number of marine mammals (i.e., density) of each species that will likely be present in the respective OPAREAs during active sonar activities.
- Applied the applicable acoustic threshold criteria to the predicted sound exposures from the proposed activity. The results were then evaluated to determine whether the predicted sound exposures from the acoustic model might be considered harassment.
- Considered potential harassment within the context of the affected marine mammal population, stock, and species to assess potential population viability. Particular focus on recruitment and survival were provided to analyze whether the effects of the action can be considered to have negligible effects to species' populations.

Figure 3.9-3 shows the general analytical framework used to apply the specific thresholds discussed in this section. The framework is organized from left to right and addresses the physics of sound propagation (Physics), the potential physiological processes associated with sound exposure (Physiology), the potential behavioral processes that might be affected as a function of sound exposure (Behavior), and the immediate effects these changes may have on functions the animal is engaged in at the time of exposure (Life Function – Proximate). These compartmentalized effects are extended to longer-term life functions (Life Function – Ultimate) and into population and species effects. Throughout the framework, dotted and solid lines are used to connect related events. Solid lines designate those effects that will happen; dotted lines designate those that might happen but must be considered (including those hypothesized to occur but for which there is no direct evidence).

Some boxes are colored according to how they relate to the definitions of harassment under the MMPA. Red boxes correspond to events that are injurious. By prior ruling and usage, these events would be considered as Level A harassment under the MMPA. Yellow boxes correspond to events that have the potential to qualify as Level B harassment under the MMPA. Based on prior ruling, the specific instance of Temporary Threshold Shift (TTS) is considered as Level B harassment. Boxes that are shaded from red to yellow have the potential for injury and behavioral disturbance.

Physics

Sound emitted from a source immediately begins to attenuate due to propagation loss. Uniform animal distribution was overlain onto the calculated sound fields to assess if animals were physically present at sufficient received sound levels to be considered "exposed" to the sound. If the animal was determined to be exposed, two possible scenarios were considered with respect to the animal's physiology– effects on the auditory system and effects on non-auditory system tissues. These are not independent pathways and both were considered since the same sound could affect both auditory and non-auditory tissues. Note that the model did not account for any animal response; rather the animals were considered stationary, accumulating energy until the threshold was tripped.

Physiology

Potential impacts to the auditory system were assessed by considering the characteristics of the received sound (that is the amplitude, frequency, and duration) and the sensitivity of the exposed animals. Some of these assessments were numerically based (e.g., TTS, permanent threshold shift [PTS], perception). Others were qualitative, due to lack of information, or were extrapolated from other species for which information exists. Potential physiological responses to the sound exposure were ranked in descending order, with the most severe impact (auditory trauma) occurring at the top and the least severe impact occurring at the bottom (the sound is not perceived).

- Auditory trauma represents direct mechanical injury to hearing related structures, including tympanic membrane rupture, disarticulation of the middle ear ossicles, and trauma to the inner ear structures such as the organ of Corti and the associated hair cells. Auditory trauma is always injurious but could be temporary and not result in PTS. Auditory trauma is always assumed to result in a stress response.
- Auditory fatigue refers to a loss of hearing sensitivity after sound stimulation. The loss of sensitivity persists after the cessation of the sound. The mechanisms responsible for auditory fatigue differ from auditory trauma and would primarily consist of metabolic exhaustion of the hair cells and cochlear tissues. The features of the exposure (e.g., amplitude, frequency, duration, temporal pattern) and the individual animal's susceptibility would determine the severity of fatigue and whether the effects were temporary (TTS) or permanent (PTS). Auditory fatigue (PTS or TTS) is always assumed to result in a stress response.
- Sounds with sufficient amplitude and duration to be detected among the background ambient noise are considered to be perceived. This category includes sounds from the threshold of audibility through the normal dynamic range of hearing (i.e., not capable of producing fatigue). To determine whether an animal perceives the sound, the received level, frequency, and duration of the sound are compared to what is known of the species' hearing sensitivity.

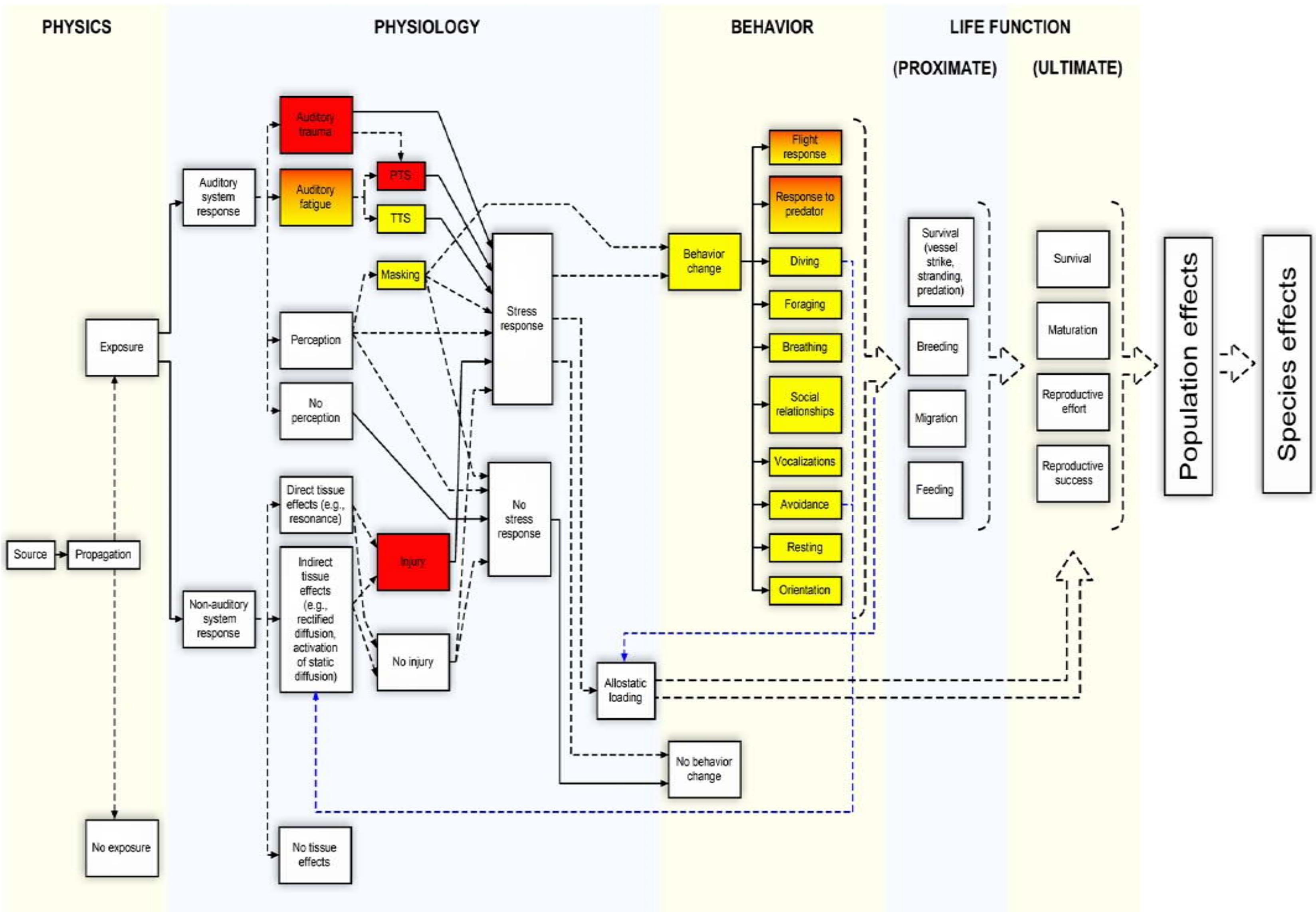


Figure 3.9-3: Analytical Framework for Evaluating Sonar Effects to Marine Mammals

- Since audible sounds may interfere with an animal's ability to detect other sounds at the same time, perceived sounds have the potential to result in auditory masking. Unlike auditory fatigue, which always results in a stress response because the sensory tissues are being stimulated beyond their normal physiological range, masking may or may not result in a stress response, depending on the degree and duration of the masking effect. Masking may also result in a unique circumstance where an animal's ability to detect other sounds is compromised without the animal's knowledge. This could conceivably result in sensory impairment and subsequent behavior change; in this case, the change in behavior is the lack of a response that would normally be made if sensory impairment did not occur. For this reason, masking also may lead directly to behavior change without first causing a stress response.
- The features of perceived sound are also used to judge whether the sound exposure is capable of producing a stress response. Factors to consider in this decision include the probability of the animal being naïve or experienced with the sound.
- The received level is not of sufficient amplitude, frequency, and duration to be perceptible by the animal. By extension, this does not result in a stress response (not perceived).

Potential impacts to tissues other than those related to the auditory system are assessed by considering the characteristics of the sound and the known or estimated response characteristics of nonauditory tissues. Some of these assessments can be numerically based (e.g., exposure required for rectified diffusion). Others will be necessarily qualitative, due to lack of information. Each of the potential responses may or may not result in a stress response.

- Direct tissue effects – Direct tissue responses to sound stimulation may range from tissue shearing (injury) to mechanical vibration with no resulting injury. Any tissue injury would produce a stress response, whereas noninjurious stimulation may or may not.
- Indirect tissue effects – Based on the amplitude, frequency, and duration of the sound, it must be assessed whether exposure is sufficient to indirectly affect tissues. For example, the hypothesis that rectified diffusion occurs is based on the idea that bubbles that naturally exist in biological tissues can be stimulated to grow by an acoustic field. Under this hypothesis, one of three things could happen: (1) bubbles grow to the extent that tissue hemorrhage occurs (injury); (2) bubbles develop to the extent that a complement immune response is triggered or nervous tissue is subjected to enough localized pressure that pain or dysfunction occurs (a stress response without injury); or (3) the bubbles are cleared by the lung without negative consequence to the animal. The probability of rectified diffusion, or any other indirect tissue effect, will necessarily be based on what is known about the specific process involved.
- No tissue effects – The received sound is insufficient to cause either direct (mechanical) or indirect effects to tissues. No stress response occurs.

The Stress Response

The acoustic source is considered a potential stressor if, by its action on the animal, via auditory or nonauditory means, it may produce a stress response in the animal. The term "stress" has taken on an ambiguous meaning in the scientific literature, but with respect to Figure 3.9-3 and the later discussions of allostasis and allostatic loading, the stress response will refer to an increase in energetic expenditure that results from exposure to the stressor and which is predominantly characterized by either the stimulation of the sympathetic nervous system (SNS) or the hypothalamic-pituitary-adrenal (HPA) axis (Reeder and Kramer 2005).

The presence and magnitude of a stress response in an animal depends on a number of factors. These include the animal's life history stage, the environmental conditions, reproductive or developmental state, and experience with the stressor.

The stress response may or may not result in a behavioral change, depending on the characteristics of the exposed animal. However, provided a stress response occurs, it was assumed that some contribution is made to the animal's total stress load that could affect its life functions.

If the acoustic source did not produce tissue effects, was not perceived by the animal, or did not produce a stress response by any other means, it was assumed the exposure did not contribute to its stress load. Additionally, without a stress response or auditory masking, it was assumed that there would be no behavioral change. Conversely, any immediate effect of exposure that produced an injury was assumed to also produce a stress response and contribute to total stress load.

Behavior

Acute stress responses may or may not cause a behavioral reaction. However, all changes in behavior were expected to result from an acute stress response. This expectation was based on the idea that some sort of physiological trigger must exist to change any behavior. The exception to this rule is the case of masking. The presence of a masking sound may not produce a stress response, but may interfere with the animal's ability to detect and discriminate biologically relevant signals. The inability to detect and discriminate biologically relevant signals hinders the potential for normal behavioral responses to auditory cues and was thus considered a behavioral change.

Numerous behavioral changes could occur as a result of stress response. For each potential behavioral change, the magnitude in the change and the severity of the response was estimated. Certain conditions, such as stampeding (i.e., flight response) or a response to a predator, might have a probability of resulting in injury. For example, a flight response, if significant enough, could produce a stranding event. Under the MMPA, such an event would be considered a Level A harassment. Each altered behavior may also have the potential to disrupt biologically significant events (e.g., breeding or nursing) and may need to be qualified as Level B harassment. All behavioral disruptions have the potential to contribute to the total stress load.

Special considerations were given to the potential for avoidance and disrupted diving patterns. Due to past incidents of beaked whale strandings associated with sonar operations, feedback paths were provided between avoidance and diving and indirect tissue effects. This feedback accounted for the hypothesis that variations in diving behavior and/or avoidance responses could result in nitrogen tissue supersaturation and nitrogen off-gassing, possibly to the point of deleterious vascular bubble formation.

Life Functions

Proximate Life Functions

Proximate life history functions are the functions that the animal is engaged in at the time of acoustic exposure. The disruption of these functions, and the magnitude of the disruption, is something that must be considered in determining how the ultimate life history functions are affected. Consideration of the magnitude of the effect to each of the proximate life history functions is dependent upon the life stage of the animal. For example, an animal on a breeding ground which is sexually immature will suffer relatively little consequence to disruption of breeding behavior when compared to an actively displaying adult of prime reproductive age.

Ultimate Life Functions

The ultimate life functions are those that enable an animal to contribute to the population (or stock, or species, etc.). The impact to ultimate life functions will depend on the nature and magnitude of the perturbation to proximate life history functions. Depending on the severity of the response to the stressor, acute perturbations may have nominal to profound impacts on ultimate life functions. For example, unit-level use of sonar by a vessel transiting through an area that is utilized for foraging, but not for breeding, may disrupt feeding by exposed animals for a brief period of time. Because of the brevity of the perturbation, the impact to ultimate life functions may be negligible. By contrast, weekly training over a period of years may have a more substantial impact because the stressor is chronic. Assessment of the magnitude of the stress response from the chronic perturbation would require an understanding of how and whether animals acclimate to a specific, repeated stressor and whether chronic elevations in the stress response (e.g., cortisol levels) produce fitness deficits.

The proximate life functions are loosely ordered in decreasing severity of impact. Mortality (survival) has an immediate effect, in that no future reproductive success is feasible and there is no further addition to the population resulting from reproduction. Severe injuries may also lead to reduced survivorship (longevity) and prolonged alterations in behavior. The latter may further affect an animal's overall reproductive success and reproductive effort. Disruptions of breeding have an immediate impact on reproductive effort and may impact reproductive success. The magnitude of the effect will depend on the duration of the disruption and the type of behavior change that was provoked. Disruptions to feeding and migration can affect all of the ultimate life functions; however, the impacts to reproductive effort and success are not likely to be as severe or immediate as those incurred by mortality and breeding disruptions.

Application of the Framework

For each species in the region of a proposed action, the density and occurrence of the species relative to the timing of the proposed action was determined. The probability of exposing an individual was based on the density of the animals at the time of the action and the acoustic propagation loss. Based upon the calculated exposure levels for the individuals, or proportions of the population, an assessment for auditory and nonauditory responses was made. Based on the available literature on the bioacoustics, physiology, dive behavior, and ecology of the species, the process outlined in Figure 3.9-3 was used to assess the potential impact of the exposure to the population and species.

Physiological and Behavioral Effects

Sound exposure may affect multiple biological traits of a marine animal; however, the MMPA as amended directs which traits should be used when determining effects. Effects that address injury are considered Level A harassment. Effects that address behavioral disruption are considered Level B harassment.

The biological framework was structured according to potential physiological and behavioral effects resulting from sound exposure. The range of effects was then assessed to determine which qualify as injury or behavioral disturbance under MMPA regulations. Physiology and behavior are chosen over other biological traits because:

- They are consistent with regulatory statements defining harassment by injury and harassment by disturbance.
- They are components of other biological traits that may be relevant.
- They are a more sensitive and immediate indicator of effect.

A "physiological effect" was defined as one in which the "normal" physiological function of the animal was altered in response to sound exposure. Physiological function was any of a collection of processes ranging from biochemical reactions to mechanical interaction and operation of organs and tissues within an animal. Physiological effects ranged from the most significant of effects (i.e., mortality and serious injury) to lesser effects that defined the lower end of the physiological effects range, such as the noninjurious distortion of auditory tissues. This latter physiological effect was important to the integration of the biological and regulatory frameworks.

A "behavioral effect" is one in which the "normal" behavior or patterns of behavior of an animal were overtly disrupted in response to an acoustic exposure. Examples of behaviors of concern were derived from the harassment definitions in the MMPA and the ESA.

MMPA Exposure Zones

Two acoustic modeling approaches were used to account for both physiological and behavioral effects to marine mammals. The exposure zone modeled total energy. When using a threshold of accumulated energy, the areas of ocean in which Level A and Level B harassment would occur are called "exposure zones." As a conservative estimate, all marine mammals predicted to be in an exposure zone were considered exposed to accumulated sound levels within the applicable Level A or Level B harassment categories. Figure 3.9-4 illustrates exposure zones extending from a hypothetical, directional sound source.

The Level A exposure zone extended from the source out to the distance and exposure at which the slightest amount of injury is predicted to occur. The acoustic exposure that produced the slightest degree of injury is therefore the threshold of the Level A exposure zone. Use of the threshold associated with the onset of slight injury as the most distant point and least injurious exposure took into account all more serious injuries by inclusion within the Level A exposure zone. The Level B exposure zone began just beyond the point of slightest injury and extended outward from that point to include all animals that may possibly experience Level B harassment. Physiological effects extended beyond the range of slightest injury to a point where slight temporary distortion of the most sensitive tissue occurred but without destruction or loss of that tissue. The animals predicted to be in this exposure zone were assumed to experience Level B harassment due to temporary impairment of sensory function (i.e., altered physiological function) that could disrupt behavior.

Very high sound levels may rupture the eardrum or damage the small bones in the middle ear (Yost, 1994). Lower level exposures of sufficient duration may cause permanent or temporary hearing loss; such an effect is called a noise-induced threshold shift, or simply a threshold shift (TS) (Miller, 1974). A TS may be either temporary (TTS) or permanent (PTS). PTS does not equal permanent hearing loss; more correctly, it is a permanent loss of hearing sensitivity, usually over a subset of the animal's hearing range. Similarly, TTS is a temporary hearing sensitivity loss, usually over a subset of the animal's hearing range. Still lower levels of sound may result in auditory masking, which may interfere with an animal's ability to hear other concurrent sounds.

Noise-Induced Threshold Shifts

The amount of TS depends on the amplitude, duration, frequency, and temporal pattern of the sound exposure. Threshold shifts generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy lead to approximately equal effects (Ward, 1997). For intermittent sounds, less TS occurs than from a continuous exposure with the same energy because some recovery will occur between exposures (Kryter et al. 1966; Ward 1997).

The magnitude of a TS normally decreases with the amount of time post-exposure (Miller 1974). The amount of TS just after exposure is called the "initial TS." If the TS activity returns to zero (the threshold returns to the pre-exposure value), the TS is a TTS. Since the amount of TTS depends on the time postexposure, it is common to use a subscript to indicate the time in minutes after exposure (Quaranta et al. 1998). For example, TTS2 means a TTS measured 2 minutes after exposure. If the TS does not return to zero but leaves some finite amount of TS, then that remaining TS is a PTS. The distinction between PTS and TTS is based on whether there is a complete recovery of a TS following a sound exposure. Figure 3.9-5 shows two hypothetical TSs: one that completely recovers (i.e., a TTS) and one that does not completely recover, leaving some PTS.

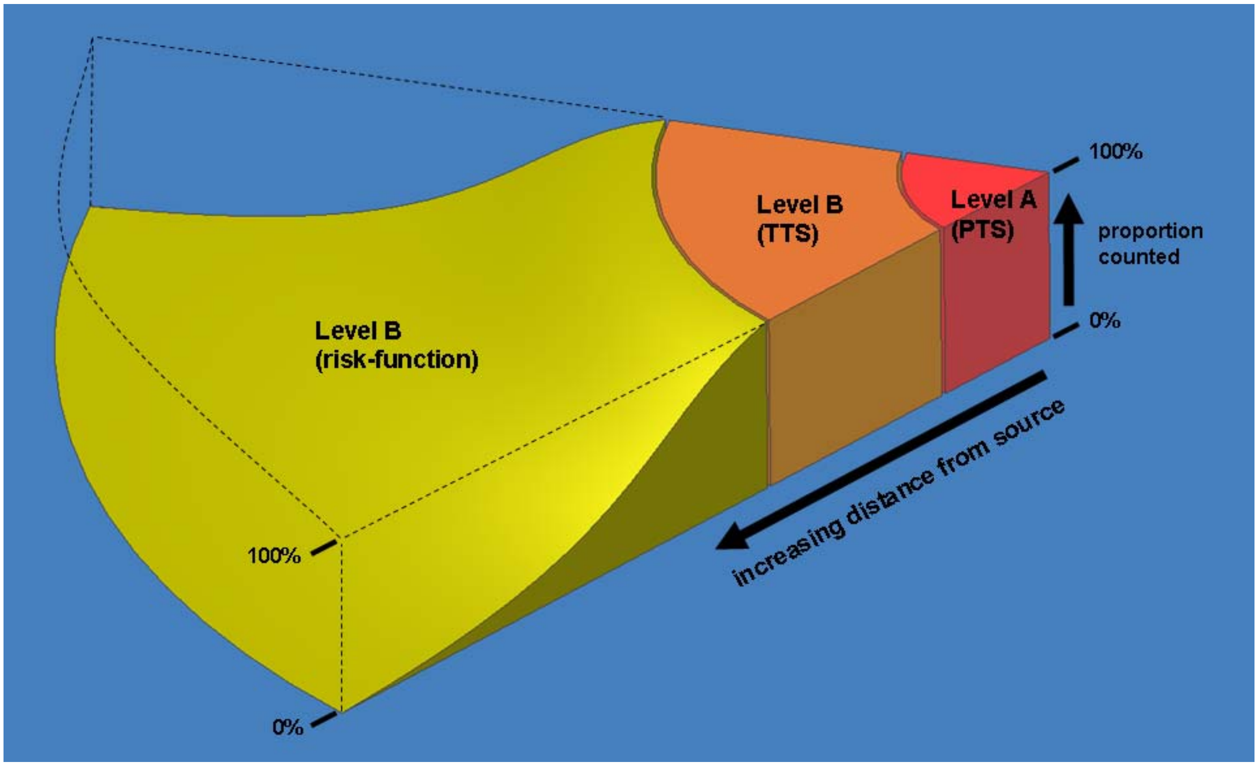


Figure 3.9-4: Relationships of Physiological and Behavioral Effects to Level A and Level B Harassment Categories

PTS, TTS, and Exposure Zones

PTS is nonrecoverable and therefore, qualifies as an injury and is classified as Level A harassment under the MMPA. The smallest amount of PTS (onset-PTS) is taken to be the indicator for the smallest degree of injury that can be measured. The acoustic exposure associated with onset-PTS is used to define the outer limit of the Level A exposure zone.

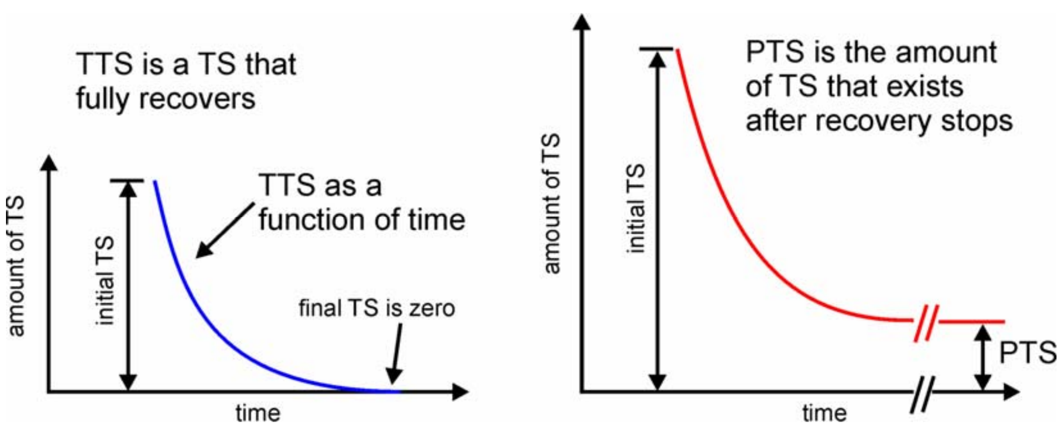


Figure 3.9-5: Relationship of TTS and PTS Recovery Characteristics

TTS is recoverable and, as in recent rulings (NOAA 2001; 2002a), is considered to result from the temporary, noninjurious distortion of hearing-related tissues. In the Study Area, the smallest measurable amount of TTS (onset-TTS) was taken as the best indicator for slight temporary sensory impairment.

Because it is considered noninjurious, the acoustic exposure associated with onset-TTS was used to define the outer limit of the portion of the Level B exposure zone attributable to physiological effects. This follows from the concept that hearing loss potentially affects an animal's ability to react normally to the sounds around it. Therefore, in this EIS/OEIS, the potential for TTS was considered as a Level B harassment that is mediated by physiological effects upon the auditory system.

Criteria and Thresholds for Physiological Effects

The most appropriate information from which to develop PTS/TTS criteria for marine mammals is an experimental measurement of PTS and TTS from marine mammal species of interest. TTS data exist for several marine mammal species and may be used to develop meaningful TTS criteria and thresholds. PTS data do not exist for marine mammals and are unlikely to be obtained. Therefore, PTS criteria must be developed from TTS criteria and estimates of the relationship between TTS and PTS.

TTS in Marine Mammals

A number of investigators measured TTS in marine mammals. These studies measured hearing thresholds in trained marine mammals before and after exposure to intense sounds. Some of the more important data obtained from these studies are onset TTS levels - exposure levels sufficient to cause a just-measurable amount of TTS, often defined as 6 dB of TTS (e.g., Schlundt et al. 2000). The existing marine mammal TTS data are summarized below.

Schlundt et al. (2000) reported the results of TTS experiments conducted with bottlenose dolphins and white whales exposed to one second tones. This paper included a re-analysis of preliminary TTS data released in a technical report by Ridgway et al. (1997). At frequencies of 3, 10, and 20 kHz), sound pressure level (SPL) necessary to induce measurable amounts (6 dB or more) of TTS were between 192 and 201 dB dB re 1 μPa^2 (energy level (EL) = 192 to 201 dB re 1 μPa^2-s). EL is a measure of the sound energy flow per unit area expressed in dB. EL is stated in decibels (dB) referenced to 1 micro Pascal squared second (dB re 1 µPa2-s) for underwater sound.

The TTS threshold is primarily based on the cetacean TTS data from Schlundt et al. (2000). Since these tests used short-duration tones similar to sonar pings, they are the most directly relevant data. The mean exposure EL required to produce onset-TTS in these tests was 195 dB re 1 µPa2-s. This result was corroborated by the short-duration tone data of Finneran et al. (2000 and 2003) and the long-duration sound data from Nachtigall et al. (2003, 2004). Together, these data demonstrated that TTS in cetaceans is correlated with the received EL and that onset- TTS exposures fit well by an equal-energy line passing through 195 dB re 1 µPa2-s.

Pinnipeds. For pinnipeds, the harassment thresholds for physiological effects are grouped by species indicated below.

California Sea Lions, Steller Sea Lions, and Northern Fur Seals:

- Level B (onset TTS) = 206 dB re 1 $\mu Pa^2 \cdot s$.
- Level A (onset PTS) = 226 dB re 1 $\mu Pa^2 \cdot s$.

Harbor Seals:

- Level B (onset TTS) = 183 dB re 1 $\mu Pa^2 \cdot s$.
- Level A (onset PTS) = 203 dB re 1 $\mu Pa^2 \cdot s$.

Northern Elephant Seals:

- Level B (onset TTS) = 204 dB re 1 μPa^2 ·s.
- Level A (onset PTS) = 224 dB re 1 μPa^2 ·s.

The thresholds for pinnipeds are based on the analysis conducted by Kastak et al (1999, 2005), which determined TTS criteria for three different species. The rationale for the 20-dB offset between onset-TTS and assumed onset-PTS is the same as for cetaceans.

Analytical Methodology – MMPA Behavioral Harassment for Mid-frequency Active/High-Frequency Active Sources

Based on available evidence, marine animals are likely to exhibit any of a suite of potential behavioral responses or combinations of behavioral responses upon exposure to sonar transmissions. Potential behavioral responses include, but are not limited to: avoiding exposure or continued exposure; behavioral disturbance (including distress or disruption of social or foraging activity); habituation to the sound; becoming sensitized to the sound; or not responding to the sound.

Existing studies of behavioral effects of human-made sounds in marine environments remain inconclusive, partly because many of those studies have lacked adequate controls, applied only to certain kinds of exposures (which are often different from the exposures being analyzed in the study), and had limited ability to detect behavioral changes that may be significant to the biology of the animals that were being observed. These studies are further complicated by the wide variety of behavioral responses marine mammals exhibit and the fact that those responses can vary substantially by species, individuals, and the context of an exposure. In some circumstances, some individuals will continue normal behavioral activities in the presence of high levels of human-made noise. In other circumstances, the same individual or other individuals may avoid an acoustic source at much lower received levels (Richardson et al. 1995; Wartzok et al. 2003; Southall et al. 2007). These differences within and between individuals appear to result from a complex interaction of experience, motivation, and learning that are difficult to quantify and predict.

It is possible that some marine mammal behavioral reactions to anthropogenic sound may result in strandings. Several “mass stranding” events—strandings that involve two or more individuals of the same species (excluding a single cow–calf pair)—that have occurred over the past two decades have been associated with naval activities, seismic surveys, and other anthropogenic activities that introduced sound into the marine environment. Sonar exposure has been identified as a contributing cause or factor in five specific mass stranding events: Greece in 1996; the Bahamas in March 2000; Madeira, Portugal in 2000; the Canary Islands in 2002, and Spain in 2006 (Advisory Committee Report on Acoustic Impacts on Marine Mammals 2006).

In these circumstances, exposure to acoustic energy has been considered a potential indirect cause of the death of marine mammals (Cox et al. 2006). A popular hypothesis regarding a potential cause of the strandings is that tissue damage results from a “gas and fat embolic syndrome” (Fernandez et al. 2005; Jepson et al. 2003; 2005). Models of nitrogen saturation in diving marine mammals have been used to suggest that altered dive behavior might result in the accumulation of nitrogen gas such that the potential for nitrogen bubble formation is increased (Houser et al. 2001; Zimmer and Tyack 2007). If so, this mechanism might explain the findings of gas and bubble emboli in stranded beaked whales. It is also possible that stranding is a behavioral response to a sound under certain contextual conditions and that the subsequently observed physiological effects of the strandings (e.g., overheating, decomposition, or internal hemorrhaging from being on shore) were the result of the stranding and not the direct result of exposure to sonar (Cox et al. 2006).

Risk Function Adapted from Feller (1968)

The particular acoustic risk function developed by the Navy and NMFS estimates the probability of behavioral responses that NMFS would classify as harassment for the purposes of the MMPA given exposure to specific received levels of MFA sonar. The mathematical function is derived from a solution in Feller (1968) for the probability as defined in the SURTASS LFA Sonar Final OEIS/EIS (DoN 2001d), and relied on in the Supplemental SURTASS LFA Sonar EIS (DoN 2007d) for the probability of MFA sonar risk for MMPA Level B behavioral harassment with input parameters modified by NMFS for MFA sonar for mysticetes, odontocetes, and pinnipeds.

In order to represent a probability of risk, the function should have a value near zero at very low exposures, and a value near one for very high exposures. One class of functions that satisfies this criterion is cumulative probability distributions, a type of cumulative distribution function. In selecting a particular functional expression for risk, several criteria were identified:

- The function must use parameters to focus discussion on areas of uncertainty;
- The function should contain a limited number of parameters;
- The function should be capable of accurately fitting experimental data; and
- The function should be reasonably convenient for algebraic manipulations.

As described in DoN (2001d), the mathematical function below is adapted from a solution in Feller (1968) where:

- R = risk (0 – 1.0);
- L = received Level (RL) in dB;
- B = basement RL in dB; (120 dB);
- K = the RL increment above basement in dB at which there is 50 percent risk; and
- A = risk transition sharpness parameter (A=10 odontocetes [except harbor porpoises/pinnipeds; A=8 mysticetes]).

In order to use this function, the values of the three parameters (B, K, and A) need to be established. As further explained later in this section, the values used in this analysis are based on three sources of data: TTS experiments conducted at SSC and documented in Finneran et al. (2001, 2003, and 2005); Finneran and Schlundt (2004); reconstruction of sound fields produced by the USS SHOUP associated with the behavioral responses of killer whales observed in Haro Strait and documented in NMFS (2005d); DoN (2004); and Fromm (2004a, 2004b); and observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components documented in Nowacek et al. (2004). The input parameters, as defined by NMFS, are based on very limited data that represent the best available science at this time.

Data Sources Used For Risk Function

There is widespread consensus that cetacean response to MFA sound signals needs to be better defined using controlled experiments (Cox et al. 2006; Southall et al. 2007). The Navy is contributing to an ongoing behavioral response study in the Bahamas that is anticipated to provide some initial information on beaked whales, the species identified as the most sensitive to MFA sonar. NMFS is leading this international effort with scientists from various academic institutions and research organizations to conduct studies on how marine mammals respond to underwater sound exposures.

Until additional data is available, NMFS and the Navy have determined that the following three data sets are most applicable for the direct use in developing risk function parameters for MFA sonar. These data sets represent the only known data that specifically relate altered behavioral responses to exposure to MFA sound sources. Until applicable data sets are evaluated to better qualify harassment from HFA sources, the risk function derived for MFA sources will apply to HFA.

Data from SSC's Controlled Experiments

Most of the observations of the behavioral responses of toothed whales resulted from a series of controlled experiments on bottlenose dolphins and beluga whales conducted by researchers at SSC's facility in San Diego, California (Finneran et al. 2001, 2003, 2005; Finneran and Schlundt 2004; Schlundt et al. 2000). In experimental trials with marine mammals trained to perform tasks when prompted, scientists evaluated whether the marine mammals performed these tasks when exposed to mid-frequency tones. Altered behavior during experimental trials usually involved refusal of animals to return to the site of the sound stimulus. This refusal included what appeared to be deliberate attempts to avoid a sound exposure or to avoid the location of the exposure site during subsequent tests (Schlundt et al. 2000, Finneran et al. 2002). Bottlenose dolphins exposed to 1-second (sec) intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1µPa root mean square (rms), and beluga whales did so at received levels of 180 to 196 dB and above. Test animals sometimes vocalized after an exposure to impulsive sound from a seismic watergun (Finneran et al. 2002). In some instances, animals exhibited aggressive behavior toward the test apparatus (Ridgway et al. 1997; Schlundt et al. 2000).

1. Finneran and Schlundt (2004) examined behavioral observations recorded by the trainers or test coordinators during the Schlundt et al. (2000) and Finneran et al. (2001, 2003, 2005) experiments featuring 1-sec tones. These included observations from 193 exposure sessions (fatiguing stimulus level > 141 dB re 1µPa) conducted by Schlundt et al. (2000) and 21 exposure sessions conducted by Finneran et al. (2001, 2003, 2005). The observations were made during exposures to sound sources at 0.4 kHz, 3 kHz, 10 kHz, 20 kHz, and 75 kHz. The TTS experiments that supported Finneran and Schlundt (2004) are further explained below:

a. Schlundt et al. (2000) provided a detailed summary of the behavioral responses of trained marine mammals during TTS tests conducted at SSC San Diego with 1-sec tones. Schlundt et al. (2000) reported eight individual TTS experiments. Fatiguing stimuli durations were 1-sec; exposure frequencies were 0.4 kHz, 3 kHz, 10 kHz, 20 kHz and 75 kHz. The experiments were conducted in San Diego Bay. Because of the variable ambient noise in the bay, low-level broadband masking noise was used to keep hearing thresholds consistent despite fluctuations in the ambient noise. Schlundt et al. (2000) reported that "behavioral alterations," or deviations from the behaviors the animals being tested had been trained to exhibit, occurred as the animals were exposed to increasing fatiguing stimulus levels.

b. Finneran et al. (2001, 2003, 2005) conducted TTS experiments using tones at 3 kHz. The test method was similar to that of Schlundt et al. (2000) except the tests were conducted in a pool with very low ambient noise level (below 50 dB re 1 µPa2/hertz [Hz]), and no masking noise was used. Two separate experiments were conducted using 1-sec tones. In the first, fatiguing sound levels were increased from 160 to 201 dB SPL. In the second experiment, fatiguing sound levels between 180 and 200 dB SPL were randomly presented.

Data from Studies of Baleen (Mysticetes) Whale Responses

The only mysticete data available resulted from a field experiments in which baleen whales (mysticetes) were exposed to sounds ranging in frequency from 0.05 kHz (ship noise playback) to 4.5 kHz (alert stimulus) (Nowacek et al. 2004). Behavioral reactions to an alert stimulus, consisting of a combination of tones and frequency and amplitude modulated signals ranging in frequency from 0.5 kHz to 4.5 kHz, was the only portion of the study used to support the risk function input parameters.

2. Nowacek et al. (2004, 2007) documented observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components. To assess risk factors involved in ship strikes, a multi-sensor acoustic tag was used to measure the responses of whales to passing ships and experimentally tested their responses to controlled sound exposures, which included recordings of ship noise, the social sounds of conspecifics and a signal designed to alert the whales. The alert signal was 18 minutes of exposure consisting of three 2-minute signals played sequentially three times over. The three signals had a 60 percent duty cycle and consisted of: (1) alternating 1-sec pure tones at 0.5 kHz and 0.85 kHz; (2) a 2-sec logarithmic down-sweep from 4.5 kHz to 0.5 kHz; and (3) a pair of low (1.5 kHz)-high (2.0 kHz) sine wave tones amplitude modulated at 0.12 kHz and each 1-sec long. The purposes of the alert signal were (a) to provoke an action from the whales via the auditory system with disharmonic signals that cover the whales' estimated hearing range; (b) to maximize the signal to noise ratio (obtain the largest difference between background noise) and c) to provide localization cues for the whale. Five out of six whales reacted to the signal designed to elicit such behavior. Maximum received levels ranged from 133 to 148 dB re 1μPa/√Hz.

Observations of Killer Whales in Haro Strait in the Wild

In May 2003, killer whales (Orcinus orca) were observed exhibiting behavioral responses while USS SHOUP was engaged in MFA sonar activities in the Haro Strait in the vicinity of Puget Sound, Washington. Although these observations were made in an uncontrolled environment, the sound field associated with the sonar operations had to be estimated, and the behavioral observations were reported for groups of whales, not individual whales, the observations associated with the USS SHOUP provide the only data set available of the behavioral responses of wild, non-captive animal upon exposure to the AN/SQS-53 MFA sonar.

3. NMFS (2005a); DoN (2004); Fromm (2004a, 2004b) documented reconstruction of sound fields produced by USS SHOUP associated with the behavioral response of killer whales observed in Haro Strait. Observations from this reconstruction included an estimate of 169.3 dB SPL which represents the mean received level at a point of closest approach within a 500 m wide area in which the animals were exposed. Within that area, the estimated received levels varied from approximately 150 to 180 dB SPL.

Limitations of the Risk Function Data Sources

There are substantial limitations and challenges to any risk function derived to estimate the probability of marine mammal behavioral responses; these are largely attributable to sparse data. Ultimately there should be multiple functions for different marine mammal taxonomic groups, but the current data are insufficient to support them. The goal is unquestionably that risk functions be based on empirical measurement.

The risk function presented here is based on three data sets that NMFS and Navy have determined are the best available science at this time. The Navy and NMFS acknowledge each of these data sets has limitations.

While NMFS considers all data sets as being weighted equally in the development of the risk function, the Navy believes the SSC San Diego data is the most rigorous and applicable for the following reasons:

- The data represents the only source of information where the researchers had complete control over and ability to quantify the noise exposure conditions.
- The altered behaviors were identifiable due to long term observations of the animals.
- The fatiguing noise consisted of tonal exposures with limited frequencies contained in the MFA sonar bandwidth.

However, the Navy and NMFS do agree that the following are limitations associated with the three data sets used as the basis of the risk function:

- The three data sets represent the responses of only four species: trained bottlenose dolphins and beluga whales, North Atlantic right whales in the wild and killer whales in the wild.
- None of the three data sets represent experiments designed for behavioral observations of animals exposed to MFA sonar.
- The behavioral responses of marine mammals that were observed in the wild are based solely on an estimated received level of sound exposure; they do not take into consideration (due to minimal or no supporting data):
  - Potential relationships between acoustic exposures and specific behavioral activities (e.g., feeding, reproduction, changes in diving behavior, etc.), variables such as bathymetry, or acoustic waveguides; or
  - Differences in individuals, populations, or species, or the prior experiences, reproductive state, hearing sensitivity, or age of the marine mammal.

SSC San Diego Trained Bottlenose Dolphins and Beluga Data Set:

- The animals were trained animals in captivity; therefore, they may be more or less sensitive than cetaceans found in the wild (Domjan 1998).
- The tests were designed to measure TTS, not behavior.
- Because the tests were designed to measure TTS, the animals were exposed to much higher levels of sound than the baseline risk function (only two of the total 193 observations were at levels below 160 dB re 1 μPa^2-s).
- The animals were not exposed in the open ocean but in a shallow bay or pool.
- The tones used in the tests were 1-second pure tones similar to MFA sonar.

North Atlantic Right Whales in the Wild Data Set

- The observations of behavioral response were from exposure to alert stimuli that contained mid-frequency components, but were not similar to an MFA sonar ping. The alert signal was 18 minutes of exposure consisting of three 2-minute signals played sequentially three times over. The three signals had a 60 percent duty cycle and consisted of: (1) alternating 1-sec pure tones at 0.5 kHz and 0.85 kHz; (2) a 2-sec logarithmic down-sweep from 4.5 kHz to 0.5 kHz; and (3) a pair of low (1.5 kHz)-high (2.0 kHz) sine wave tones amplitude modulated at 0.12 kHz and each 1-sec long. This 18-minute alert stimuli is in contrast to the average 1-sec ping every 30 sec in a comparatively very narrow frequency band used by military sonar.
- The purpose of the alert signal was, in part, to provoke an action from the whales through an auditory stimulus.

Killer Whales in the Wild Data Set

- The observations of behavioral harassment were complicated by the fact that there were other sources of harassment in the vicinity (other vessels and their interaction with the animals during the observation).
- The observations were anecdotal and inconsistent. There were no controls during the observation period, with no way to assess the relative magnitude of the any observed response as opposed to baseline conditions.

Input Parameters for the Feller-Adapted Risk Function

The values of B, K, and A need to be specified in order to utilize the risk function defined later in this section s. The risk continuum function approximates the dose-response function in a manner analogous to pharmacological risk assessment (DoN 2001d). In this case, the risk function is combined with the distribution of sound exposure levels to estimate aggregate impact on an exposed population.

Basement Value for Risk – The B Parameter

The B parameter defines the basement value for risk, below which the risk is so low that calculations are impractical. This 120 dB level is taken as the estimated received level (RL) below which the risk of significant change in a biologically important behavior approaches zero for the MFA sonar risk assessment. This level is based on a broad overview of the levels at which multiple species have been reported responding to a variety of sound sources, both mid-frequency and other, was recommended by the scientists, and has been used in other publications. The Navy recognizes that for actual risk of changes in behavior to be zero, the signal-to-noise ratio of the animal must also be zero.

The K Parameter

NMFS and the Navy used the mean of the following values to define the midpoint of the function: (1) the mean of the lowest received levels (185.3 dB) at which individuals responded with altered behavior to 3 kHz tones in the SSC data set; (2) the estimated mean received level value of 169.3 dB produced by the reconstruction of the USS SHOUP incident in which killer whales exposed to MFA sonar (range modeled possible received levels: 150 to 180 dB); and (3) the mean of the 5 maximum received levels at which Nowacek et al. (2004) observed significantly altered responses of right whales to the alert stimuli than to the control (no input signal) is 139.2 dB SPL. The arithmetic mean of these three mean values is 165 dB SPL. The value of *K* is the difference between the value of *B* (120 dB SPL) and the 50 percent value of 165 dB SPL; therefore, *K*=45.

Risk Transition – The A Parameter

The A parameter controls how rapidly risk transitions from low to high values with increasing received level. As the A parameter increases, the slope of the risk function increases. For very large values of A, the risk function can approximate a threshold response or step function. NMFS has recommended that Navy use A = 10 as the value for odontocetes (except harbor porpoises), and pinnipeds (Figure 3.9-6) and A = 8 for mysticetes (Figure 3.9-7) (NMFS 2008b).

Justification for the Steepness Parameter of A=10 for the Odontocete Curve

The NMFS independent review process described in the Hawaii Range Complex (HRC) Final EIS/OEIS (DoN 2008) provided the impetus for the selection of the parameters for the risk function curves. One scientist recommended staying close to the risk continuum concept as used in the SURTASS LFA sonar EIS. This scientist opined that both the basement and slope values; B=120 dB and A=10 respectively, from the SURTASS LFA sonar risk continuum concept are logical solutions in the absence of compelling data to select alternate values supporting the Feller-adapted risk function for MFA sonar. Another scientist indicated a steepness parameter needed to be selected, but did not recommend a value. Four scientists did not specifically address selection of a slope value. After reviewing the six scientists' recommendations, the two NMFS scientists recommended selection of A=10. Direction was provided by NMFS to use the A=10 curve for odontocetes based on the scientific review of potential risk functions explained in Section 4.1.2.4.9.2 of HRC Final EIS/OEIS (DoN 2008).

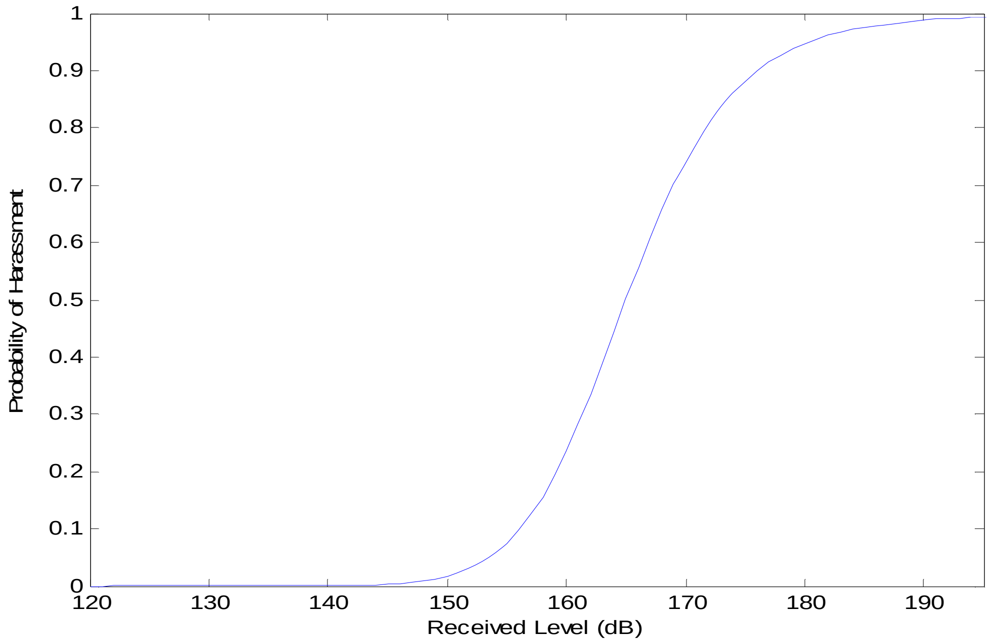


Figure 3.9-6: Risk Function Curve for Odontocetes (except harbor porpoises) (toothed whales) and Pinnipeds

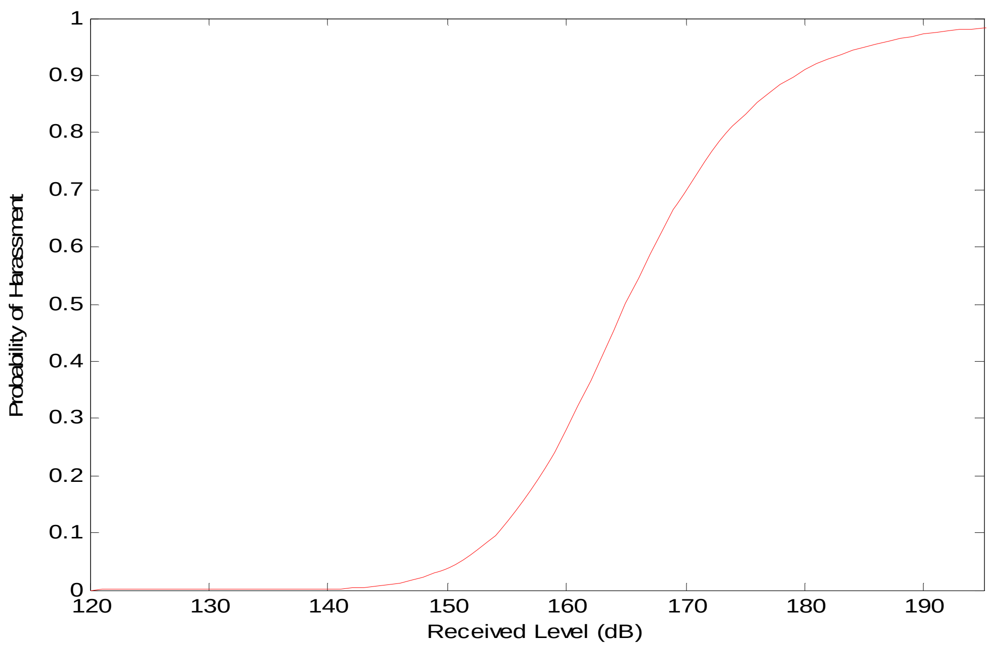


Figure 3.9-7: Risk Function Curve for Mysticetes (Baleen Whales)

As background, a sensitivity analysis of the A=10 parameter was undertaken and presented in Appendix D of the SURTASS/LFA FEIS (DoN 2001d). The analysis was performed to support the A=10 parameter for mysticete whales responding to a low-frequency sound source, a frequency range to which the mysticete whales are believed to be most sensitive to. The sensitivity analysis results confirmed the increased risk estimate for animals exposed to sound levels below 165 dB. Results from the Low Frequency Sound Scientific Research Program (LFS SRP) phase II research showed that whales (specifically gray whales in their case) did scale their responses with received level as supported by the A=10 parameter (Buck and Tyack 2000). In the second phase of the LFS SRP research, migrating gray whales showed responses similar to those observed in earlier research (Malme et al. 1983, 1984) when the LF source was moored in the migration corridor (2 km [1 nm] from shore). The study extended those results with confirmation that a louder SL elicited a larger scale avoidance response. However, when the source was placed offshore (4 km [2 nm] from shore) of the migration corridor, the avoidance response was not evident. This implies that the inshore avoidance model – in which 50 percent of the whales avoid exposure to levels of 141 + 3 dB – may not be valid for whales in proximity to an offshore source (DoN 2001d). As concluded in the SURTASS LFA Sonar Final OEIS/EIS (DoN 2001d), the value of A=10 produces a curve that has a more gradual transition than the curves developed by the analyses of migratory gray whale studies (Malme et al. 1984; Buck and Tyack 2000; and SURTASS LFA Sonar EIS, Subchapters 1.43, 4.2.4.3 and Appendix D, and NMFS 2008b).

Justification for the steepness parameter of A=8 for the Mysticete Curve

The Nowacek et al. (2004) study provides the only available data source for a mysticete species behaviorally responding to a sound source (i.e., alert stimuli) with frequencies in the range of tactical mid-frequency sonar (1-10 kHz), including empirical measurements of received levels (RLs). While there are fundamental differences in the stimulus used by Nowacek et al. (2004) and tactical mid-frequency sonar (e.g., source level, waveform, duration, directionality, likely range from source to receiver), they are generally similar in frequency band and the presence of modulation patterns. Thus, while they must be considered with caution in interpreting behavioral responses of mysticetes to mid-frequency sonar, they seemingly cannot be excluded from this consideration given the overwhelming lack of other information. The Nowacek et al. (2004) data indicate that five out the six North Atlantic right whales exposed to an alert stimuli "significantly altered their regular behavior and did so in identical fashion" (i.e., ceasing feeding and swimming to just under the surface). For these five whales, maximum RLs associated with this response ranged from rms pressure levels of 133-148 dB (re 1 µPa).

When six scientists (one of them being Nowacek) were asked to independently evaluate available data for constructing a dose response curve based on a solution adapted from Feller (1968), the majority of them (4 out of 6; one being Nowacek) indicated that the Nowacek et al. (2004) data were not only appropriate but also necessary to consider in the analysis. While other parameters associated with the solution adapted from Feller (1968) were provided by many of the scientists (i.e., basement parameter [B], increment above basement where there is 50 percent risk [K]), only one scientist provided a suggestion for the risk transition parameter, A.

A single curve may provide the simplest quantitative solution to estimating behavioral harassment. However, the policy decision, by NMFS-OPR, to adjust the risk transition parameter from A=10 to A=8 for mysticetes and create a separate curve was based on the fact the use of this shallower slope better reflected the increased risk of behavioral response at relatively low RLs suggested by the Nowacek et al. (2004) data. In other words, by reducing the risk transition parameter from 10 to 8, the slope of the curve for mysticetes is reduced. This results in an increase the proportion of the population being classified as behaviorally harassed at lower RLs. It also slightly reduces the estimate of behavioral response probability at quite high RLs, though this is expected to have quite little practical result owing to the very limited probability of exposures well above the mid-point of the function. This adjustment allows for a slightly more conservative approach in estimating behavioral harassment at relatively low RLs for mysticetes compared to the odontocete curve and is supported by the only dataset currently available. It should be noted that the current approach (with A=8) still yields an extremely low probability for behavioral responses at RLs between 133-148 dB, where the Nowacek data indicated significant responses in a majority of whales studied. (Note: Creating an entire curve based strictly on the Nowacek et al. [2004] data alone for mysticetes was advocated by several of the reviewers and considered inappropriate, by NMFS-OPR, since the sound source used in this study was not identical to tactical mid-frequency sonar, and there were only 5 data points available). The policy adjustment made by NMFS-OPR was also intended to capture some of the additional recommendations and considerations provided by the scientific panel (i.e., the curve should be more data driven and that a greater probability of risk at lower RLs be associated with direct application of the Nowacek et al. 2004 data).

Basic Application of the Risk Function and Relation to the Current Regulatory Scheme

The risk function is used to estimate the percentage of an exposed population that is likely to exhibit behaviors that would qualify as harassment (as that term is defined by the MMPA applicable to military readiness activities, such as the Navy's testing and training with MFA sonar) at a given received level of sound. For example, at 165 dB SPL (dB re 1µPa RMS, the risk (or probability) of harassment is defined according to this function as 50 percent, and Navy/NMFS applies that by estimating that 50 percent of the individuals exposed at that received level are likely to respond by exhibiting behavior that NMFS would classify as behavioral harassment. The risk function is not applied to individual animals, only to exposed populations.

The data used to produce the risk function were compiled from four species that had been exposed to sound sources in a variety of different circumstances. As a result, the risk function represents a general relationship between acoustic exposures and behavioral responses that is then applied to specific circumstances. That is, the risk function represents a relationship that is deemed to be generally true, based on the limited, best-available science, but may not be true in specific circumstances. In particular, the risk function, as currently derived, treats the received level as the only variable that is relevant to a marine mammal's behavioral response. However, we know that many other variables—the marine mammal's gender, age, and prior experience; the activity it is engaged in during an exposure event, its distance from a sound source, the number of sound sources, and whether the sound sources are approaching or moving away from the animal—can be critically important in determining whether and how a marine mammal will respond to a sound source (Southall et al. 2007). The data that are currently available do not allow for incorporation of these other variables in the current risk functions; however, the risk function represents the best use of the data that are available.

NMFS and Navy made the decision to apply the MFA risk function curve to HFA sources due to lack of available and complete information regarding HFA sources. As more specific and applicable data become available for MFA/HFA sources, NMFS can use these data to modify the outputs generated by the risk function to make them more realistic. Ultimately, data may exist to justify the use of additional, alternate, or multi-variate functions. As mentioned above, it is known that the distance from the sound source and whether it is perceived as approaching or moving away can affect the way an animal responds to a sound (Wartzok et al. 2003). In the HRC example, animals exposed to received levels between 120 and 130 dB may be more than 65 nm (131,651 yds) from a sound source; those distances would influence whether those animals might perceive the sound source as a potential threat, and their behavioral responses to that threat. Though there are data showing marine mammal responses to sound sources at that received level, NMFS does not currently have any data that describe the response of marine mammals to sounds at that distance (or to other contextual aspects of the exposure, such as the presence of higher frequency harmonics), much less data that compare responses to similar sound levels at varying distances. However, if data were to become available that suggested animals were less likely to respond (in a manner NMFS would classify as harassment) to certain levels beyond certain distances, or that they were more likely to respond at certain closer distances, the Navy will re-evaluate the risk function to try to incorporate any additional variables into the "take" estimates.

Last, pursuant to the MMPA, an applicant is required to estimate the number of animals that will be "taken" by their activities. This estimate informs the analysis that NMFS must perform to determine whether the activity will have a "negligible impact" on the species or stock. Level B (behavioral) harassment occurs at the level of the individual(s) and does not assume any resulting population-level consequences, though there are known avenues through which behavioral disturbance of individuals can result in population-level effects. Alternately, a negligible impact finding is based on the lack of likely adverse effects on annual rates of recruitment or survival (i.e., population-level effects). An estimate of the number of Level B harassment takes, alone, is not enough information on which to base an impact determination. In addition to considering estimates of the number of marine mammals that might be "taken" through harassment, NMFS must consider other factors, such as the nature of any responses (their intensity, duration, etc.), the context of any responses (critical reproductive time or location, migration, etc.), or any of the other variables mentioned in the first paragraph (if known), as well as the number and nature of estimated Level A takes, the number of estimated mortalities, and effects on habitat. Generally speaking, the Navy and NMFS anticipate more severe effects from takes resulting from exposure to higher received levels (though this is in no way a strictly linear relationship throughout species, individuals, or circumstances) and less severe effects from takes resulting from exposure to lower received levels.

As an example, the distances and distribution at which harassment may occur at different received bands from 53C mid-frequency sonar are presented in Table 3.9-3 and are illustrated in Figure 3.9-8.

Specific Consideration for Harbor Porpoises

The information currently available regarding these inshore species that inhabit shallow and coastal waters suggests a very low threshold level of response for both captive and wild animals. Threshold levels at which both captive (e.g. Kastelein et al. 2000, 2005, 2006) and wild harbor porpoises (e.g. Johnston 2002) responded to sound (e.g. acoustic harassment devices (ADHs), acoustic deterrent devices (ADDs), or other non-pulsed sound sources) is very low (e.g. ~120 dB SPL), although the biological significance of the disturbance is uncertain. Therefore, Navy will not use the risk function curve as presented but will apply a step function threshold of 120 dB SPL estimate take of harbor porpoises (i.e., assumes that all harbor porpoises exposed to 120 dB or higher MFAS/HFAS will respond in a way NMFS considers behavioral harassment).

Table 3.9-3: Harassments at Each Received Level Band From 53C

Received Level (dB SPL)	Distance at which Levels Occur in NWTRC	Percent of Harassments Occurring at Given Levels
Below 140	51 km - 130 km	<1
140<Level<150	25 km – 51 km	2
150<Level<160	10 km – 25 km	18
160<Level<170	3 km – 10 km	43
170<Level<180	560 m – 3 km	28
Above 180	0 m – 560 m	<9

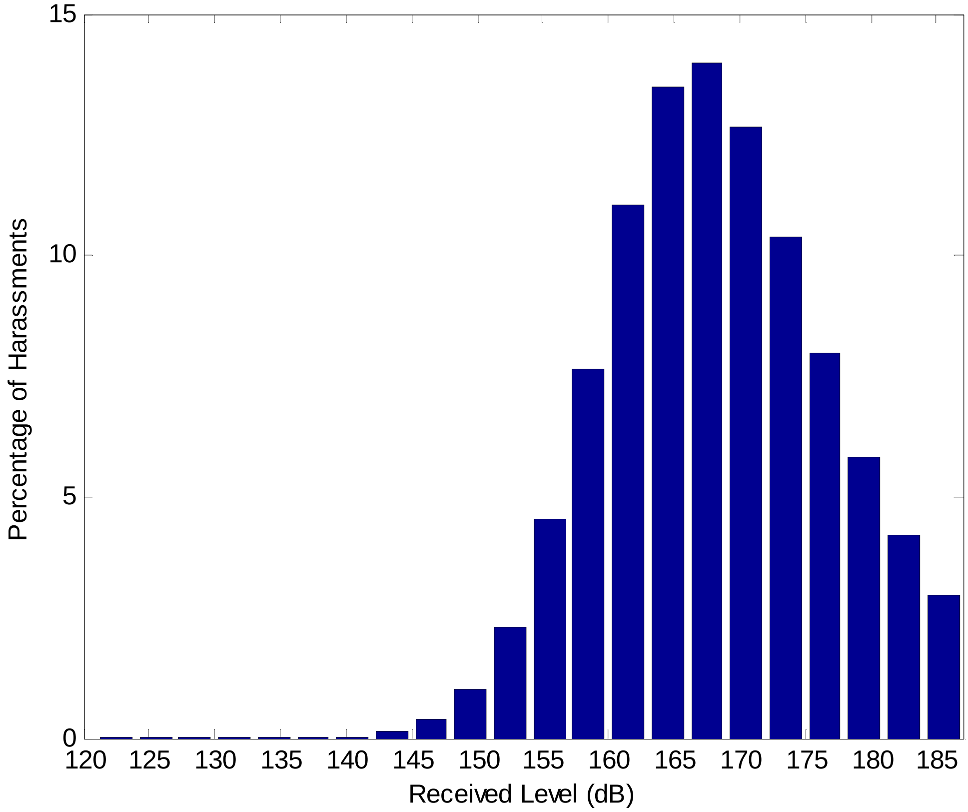


Figure 3.9-8: Approximate Percentage of Behavioral Harassments for Every 5-Degree Band of Received Level from the 53C

Cetacean Stranding Events

When a live or dead marine mammal swims or floats onto shore and becomes "beached" or incapable of returning to sea, the event is termed a "stranding" (Perrin and Geraci 2002; Geraci and Lounsbury 2005; NMFS 2007b). The legal definition for a stranding within the United States is that "a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance" (16 U.S.C. 1421h).

The majority of animals that strand are dead or moribund (i.e., dying) (NMFS 2007b). For animals that strand alive, human intervention through medical aid and/or guidance seaward may be required for the animal to return to the sea. If unable to return to sea, rehabilitation at an appropriate facility may be determined as the best opportunity for animal survival. An event where animals are found out of their normal habitat is may be considered a stranding depending on circumstances even though animals do not necessarily end up beaching (Southhall 2006).

Three general categories can be used to describe strandings: single, mass, and unusual mortality events. The most frequent type of stranding is a single stranding, which involves only one animal (or a mother/calf pair) (NMFS 2007b).

Mass stranding involves two or more marine mammals of the same species other than a mother/calf pair (Wilkinson 1991), and may span one or more days and range over several miles (Simmonds and Lopez-Jurado 1991; Frantzis 1998; Walsh et al. 2001; Freitas 2004). In North America, only a few species typically strand in large groups of 15 or more and include sperm whales, pilot whales, false killer whales, Atlantic white-sided dolphins, white-beaked dolphins, and rough-toothed dolphins (Walsh et al. 2001). Some species, such as pilot whales, false-killer whales, and melon-headed whales occasionally strand in groups of 50 to 150 or more (Geraci et al. 1999). All of these normally pelagic off-shore species are highly sociable and usually infrequently encountered in coastal waters. Species that commonly strand in smaller numbers include pygmy killer whales, common dolphins, bottlenose dolphins, Pacific white-sided dolphin Frasier's dolphins, gray whale and humpback whale (West Coast only), harbor porpoise, Cuvier's beaked whales, California sea lions, and harbor seals (Mazzuca et al. 1999, Norman et al. 2004, Geraci and Lounsbury 2005).

Unusual mortality events (UMEs) can be a series of single strandings or mass strandings, or unexpected mortalities (i.e., die-offs) that occur under unusual circumstances (Dierauf and Gulland 2001; Harwood 2001; Gulland 2006; NMFS 2007b). These events may be interrelated: for instance, at-sea die-offs lead to increased stranding frequency over a short period of time, generally within one to two months. As published by the NMFS, revised criteria for defining a UME include the following (Hohn et al. 2006):

1. A marked increase in the magnitude or a marked change in the nature of morbidity, mortality, or strandings when compared with prior records.
2. A temporal change in morbidity, mortality, or strandings is occurring.
3. A spatial change in morbidity, mortality, or strandings is occurring.
4. The species, age, or sex composition of the affected animals is different than that of animals that are normally affected.
5. Affected animals exhibit similar or unusual pathologic findings, behavior patterns, clinical signs, or general physical condition (e.g., blubber thickness).
6. Potentially significant morbidity, mortality, or stranding is observed in species, stocks or populations that are particularly vulnerable (e.g., listed as depleted, threatened or endangered or declining). For example, stranding of three or four right whales may be cause for great concern whereas stranding of a similar number of fin whales may not.
7. Morbidity is observed concurrent with or as part of an unexplained continual decline of a marine mammal population, stock, or species.

UMEs are usually unexpected, infrequent, and may involve a significant number of marine mammal mortalities. As discussed below, unusual environmental conditions are probably responsible for most UMEs and marine mammal die-offs (Vidal and Gallo-Reynoso 1996; Geraci et al. 1999; Walsh et al. 2001; Gulland and Hall 2005).

Reports of marine mammal strandings can be traced back to ancient Greece (Walsh et al. 2001). Like any wildlife population, there are normal background mortality rates that influence marine mammal population dynamics, including starvation, predation, aging, reproductive success, and disease (Geraci et al. 1999; Carretta et al. 2007). Strandings in and of themselves may be reflective of this natural cycle or, more recently, may be the result of anthropogenic sources (i.e., human impacts). Current science suggests that multiple factors, both natural and man-made, may be acting alone or in combination to cause a marine mammal to strand (Geraci et al. 1999; Culik 2002; Perrin and Geraci 2002; Geraci and Lounsbury 2005; NRC 2006). While post stranding data collection and necropsies of dead animals are attempted in an effort to find a possible cause for the stranding, it is often difficult to pinpoint exactly one factor that can be blamed for any given stranding. An animal suffering from one ailment becomes susceptible to various other influences because of its weakened condition, making it difficult to determine a primary cause. In many stranding cases, scientists never learn the exact reason for the stranding. Specific potential stranding causes can include both natural and human influenced (anthropogenic) causes as listed below:

- Natural Stranding Causes
  - Disease
  - Natural toxins
  - Weather and climatic influences
  - Navigation errors
  - Social cohesion
  - Predation
- Human Influenced (Anthropogenic) Stranding Causes
  - Fisheries interaction
  - Vessel strike
  - Pollution and ingestion
  - Noise

Specific beaked whale stranding events associated with potential naval activities are as follows:

- May 1996: Greece (NATO/US)
- March 2000: Bahamas (US)
- May 2000: Portugal, Madeira Islands (NATO/US)
- September 2002: Canary Islands (NATO/US)
- January 2006: Spain, Mediterranean Sea coast (NATO/US)

These events represent a small overall number of animals (40 animals) over an 11 year period and not all worldwide beaked whale strandings can be linked to naval activity (ICES 2005a; 2005b; Podesta et al. 2006). Four (Greece, Portugal, Spain) of the five events occurred during NATO exercises or events where DoN presence was limited. One (Bahamas) of the five events involved only DoN ships. These five events are described briefly below. For detailed information on these events, refer to Appendix E, Cetacean Stranding Report.

- May 1996 Greece - Twelve Cuvier's beaked whales (*Ziphius cavirostris*) stranded along the coast of the Kyparissiakos Gulf on May 12 and 13, 1996 (Frantzis 1998). From May 11 through May 15, the NATO research vessel Alliance was conducting sonar tests with signals of 0.6 kHz and 3 kHz and rms SPL of 228 and 226 dB re 1μPa, respectively (D'Amico and Verboom 1998; D'Spain et al. 2006). The timing and the location of the testing encompassed the time and location of the whale strandings (Frantzis 1998). However, because information for the necropsies was incomplete and inconclusive, the cause of the stranding cannot be precisely determined.

- March 2000, Bahamas –Seventeen marine mammals comprised of Cuvier's beaked whales, Blainville's beaked whales (*Mesoplodon densirostris*), minke whales (*Balaenoptera acutorostrata*), and one spotted dolphin (*Stenella frontalis*), stranded along the Northeast and Northwest Providence Channels of the Bahamas Islands on March 15-16, 2000 (Evans and England 2001). The strandings occurred over a 36-hour period and coincided with DoN use of mid-frequency active sonar within the channel. Navy ships were involved in tactical sonar exercises for approximately 16 hours on March 15. The ships, which operated the AN/SQS-53C and AN/SQS-56, moved through the channel while emitting sonar pings approximately every 24 seconds. The timing of pings was staggered between ships and average source levels of pings varied from a nominal 235 dB SPL (AN/SQS-53C) to 223 dB SPL (AN/SQS-56). The center frequency of pings was 3.3 kHz and 6.8 to 8.2 kHz, respectively. Passive acoustic monitoring records demonstrated that no large scale acoustic activity besides the Navy sonar exercise occurred in the times surrounding the stranding event. The mechanism by which sonar could have caused the observed traumas or caused the animals to strand was undetermined.

- May 2000, Madeira Island, Portugal – Three Cuvier's beaked whales stranded on two islands in the Madeira Archipelago, Portugal, from May 10 – 14, 2000 (Cox et al. 2006). A joint NATO amphibious training exercise, named "Linked Seas 2000," which involved participants from 17 countries, took place in Portugal during May 2 – 15, 2000. The timing and location of the exercises overlapped with that of the stranding incident. Although the details about whether or how sonar was used during "Linked Seas 2000" is unknown, the presence of naval activity within the region at the time of the strandings suggested a possible relationship to Navy activity.

- September 2002, Canary Islands – On September 24, 2002, 14 beaked whales stranded on Fuerteventura and Lanzaote Islands in the Canary Islands (Jepson et al. 2003). At the time of the strandings, an international naval exercise called Neo-Tapon 2002 that involved numerous surface warships and several submarines was being conducted off the coast of the Canary Islands. Tactical mid-frequency active sonar was utilized during the exercises, and strandings began within hours of the onset of the use of mid-frequency sonar (Fernández et al. 2005). The association of NATO mid-frequency sonar use close in space and time to the beaked whale strandings, and the similarity between this stranding event and previous beaked whale mass strandings coincident with sonar use, suggests that a similar scenario and causative mechanism of stranding may be shared between the events.

- January 2006, Spain – The Spanish Cetacean Society reported an atypical mass stranding of four beaked whales that occurred January 26 to 28, 2006, on the southeast coast of Spain near Mojacar (Gulf of Vera) in the Western Mediterranean Sea. From January 25 - 26, 2006, a NATO surface ship group (seven ships including one U.S. ship under NATO operational command) conducted active sonar training against a Spanish submarine within 50 nm of the stranding site. According to the pathologists, a likely cause of this type of beaked whale mass stranding event may have been anthropogenic acoustic activities. However, no detailed pathological results confirming this supposition have been published to date, and no positive acoustic link was established as a direct cause of the stranding.

By comparison, potential impacts to all species of cetaceans worldwide from fishery related mortality can be orders of magnitude more significant (100,000s of animals versus 10s of animals) (Culik 2002; ICES, 2005b; Read et al. 2006). This does not negate the influence of any mortality or additional stressor to small, regionalized sub-populations which may be at greater risk from human related mortalities (fishing, vessel strike, sound) than populations with larger oceanic level distribution or migrations. ICES (2005a) noted, however, that taken in context of marine mammal populations in general, sonar is not a major threat, or significant portion of the overall ocean noise budget. A constructive framework and continued research based on sound scientific principles is needed in order to avoid speculation as to stranding causes, and to further our understanding of potential effects or lack of effects from military mid frequency sonar (Bradshaw et al. 2006; ICES 2005b; Barlow and Gisiner 2006; Cox et al. 2006).

Refer to Appendix E, Cetacean Stranding Report, for additional information on the history of stranding, a description of the above-listed stranding events, a review of the many different possible reasons for stranding, as well as the stranding investigation findings and conclusions.

Explosives Modeling and Analysis

The effects of an underwater explosion on a marine mammal depends on many factors, including the size, type, and depth of both the animal and the explosive charge; the depth of the water column; the standoff distance between the charge and the animal; and the sound propagation properties of the environment. Potential impacts can range from brief acoustic effects (such as behavioral disturbance), tactile perception, physical discomfort, slight injury of the internal organs and the auditory system, to death of the animal (Yelverton et al. 1973; O'Keeffe and Young 1984; DoN 2001). Non-lethal injury includes slight injury to internal organs and the auditory system; however, delayed lethality can be a result of individual or cumulative sublethal injuries (DoN 2001a). Short-term or immediate lethal injury would result from massive combined trauma to internal organs as a direct result of proximity to the point of detonation (DoN 2001a).

The exercises that use underwater explosives include Surface-to-Surface Gunnery Exercise (S-S GUNEX), Air-to-Surface Bombing Exercise (BOMBEX), Anti-Submarine Tracking Exercise (TRACKEX), Sinking Exercise (SINKEX), Missile Exercises (MISSILEX), Mine Warfare (MIW) Training, and Explosive Ordnance Disposal (EOD) Range. Tables 2-9 and 2-10 summarize the number of events per year and specific areas where each occurs for each type of ordnance used for each alternative.

Analytical Framework for Assessing Marine Mammal Response to Underwater Detonations

Criteria and thresholds for estimating the exposures from a single explosive activity on marine mammals were established for the Seawolf Submarine Shock Test Final Environmental Impact Statement (FEIS) ("Seawolf") and subsequently used in the USS Winston S. Churchill (DDG-81) Ship Shock FEIS ("Churchill") (DoN 1998, 2001b). NMFS adopted these criteria and thresholds in its final rule on unintentional taking of marine animals occurring incidental to the shock testing (NOAA, 1998). In addition, this section reflects a revised acoustic criterion for small underwater explosions (that is, 23 psi [1.6 kg/cm^2] instead of previous acoustic criteria of 12 pounds per square inch [0.8 kg/cm^2] for peak pressure over all exposures), which is based on an incidental harassment authorization (IHA) issued to the Air Force (NOAA 2006b). Figure 3.9-4 depicts the acoustic impact framework used in this assessment.

Although the thresholds and criteria used to determine effects resulting from impulsive sound were originally developed to assess impacts under the MMPA (Level A and Level B harassment), these thresholds and criteria are also used to assess impacts under the ESA (Harm and Harassment). Table 3.9-4 summarizes the effects, criteria, and thresholds used in the assessment for impulsive sounds.

For single explosion injury, two criteria were used: eardrum rupture (that is tympanic-membrane [TM] rupture) and onset of slight lung injury. These criteria are considered indicative of the onset of injury. The criterion for mortality for marine mammals used in the CHURCHILL Final EIS (DoN 2001b) is "onset of severe lung injury." This is a conservative approach because it corresponds to a 1 percent chance of mortal injury, and yet any animal experiencing onset severe lung injury is counted as a lethal exposure.

- The threshold is stated in terms of the Goertner (1982) modified positive impulse with value "indexed to 31 psi-ms." Because the Goertner approach depends on propagation, source/animal depths, and animal mass in a complex way, the actual impulse value corresponding to the 31-psi-ms index is a complicated calculation. Again, to be conservative, CHURCHILL used the mass of a calf dolphin (at 27 lb. [12.2 kg]), so that the threshold index is 30.5 psi-ms (Table 3.9-4).

Two criteria are used for injury: onset of slight lung hemorrhage and 50 percent eardrum rupture (tympanic membrane [TM] rupture). These criteria are considered indicative of the onset of injury (Table 3.9.5).

- The threshold for onset of slight lung injury is calculated for a small animal (a dolphin calf weighing 27 lb [12.2 kg.]), and is given in terms of the "Goertner modified positive impulse," indexed to 13 psi-ms (DoN 2001b). This threshold is conservative because the positive impulse needed to cause injury is proportional to animal mass, and therefore, Larger animals require a higher impulse to cause the onset of injury.

- The threshold for TM rupture corresponds to a 50 percent rate of rupture (i.e., 50 percent of animals exposed to the level are expected to suffer TM rupture); this threshold is stated in terms of an EL value of 205 dB re 1 μPa2-s. The criterion reflects that TM rupture is not necessarily a serious or life-threatening injury, but is a useful index of possible injury that is well correlated with measures of permanent hearing impairment (e.g., Ketten 1998 indicates a 30 percent incidence of permanent threshold shift [PTS] at the same threshold).

The following criteria is used for non-injurious harassment temporary threshold shift (TTS), which is a temporary, recoverable, loss of hearing sensitivity (NMFS 2001; DoN 2001b).

- A threshold of 12 pounds per square inch (0.8 kg/cm^2) peak pressure was developed for 10,000-lb (4,536-kg) charges as part of the CHURCHILL Final EIS (DoN 2001b, [FR70/160, 19 Aug 05; FR 71/226, 24 Nov 06]). It was introduced to provide a more conservative safety zone for TTS when the explosive or the animal approaches the sea surface (for which case the explosive energy is reduced but the peak pressure is not). Navy policy is to use a 23 pounds per square inch (1.6 kg/cm^2) criterion for explosive charges less than 2,000 lbs (907 kg) and the 12 psi (0.8 kg/cm^2) criterion for explosive charges larger than 2,000 lbs (907 kg). This is below the level of onset of TTS for an odontocete (Finneran et al. 2002). All explosives modeled for the NWTRC are less than 1,500 lbs (680 kg).

<u>Thresholds and Criteria for Non-Injurious Physiological Effects</u>

The criterion for non-injurious harassment is TTS — a slight, recoverable loss of hearing sensitivity (DoN 2001). In this case, there are two thresholds: Level B/ESA-Harassment (with TTS) and peak pressure thresholds. Exposure is assumed to occur if either of the thresholds is exceeded.

TTS-Energy Threshold

The first threshold is a 182 dB re 1 μPa^2-s maximum energy flux density level in any 1/3-octave band. For large explosives frequency range cutoffs at 0.01 and 0.1 kHz make a difference in the range estimates. For small explosives, as what was modeled for this analysis, the spectrum of the shot arrival was broad, and there was essentially no difference in impact ranges for toothed whales or baleen whales.

The TTS energy threshold for explosives was derived from the Space and Naval Warfare Systems Center (SSC) pure-tone tests for TTS. The pure-tone threshold (192 dB as the lowest value) was modified for explosives by (a) interpreting it as an energy metric, (b) reducing it by 10 dB to account for the time constant of the mammal ear, and (c) measuring the energy in 1/3-octave bands, the natural filter band of the ear. The resulting threshold was 182 dB re 1 μPa^{2-}s in any 1/3-octave band. The energy threshold usually dominates and was used in the analysis to determine potential Level B/ESA-Harassment exposures for single explosion ordnance.

Table 3.9-4: Effects Analysis Criteria and Thresholds for Impulsive Sounds

	Criterion	Metric	Threshold	Comments	Source
Mortality & Injury	**Mortality** Onset of extensive lung hemorrhage	**Shock Wave** Goertner modified positive impulse	**30.5 psi-msec***	All marine mammals (dolphin calf)	Goertner 1982
	Slight Injury Onset of slight lung hemorrhage	**Shock Wave** Goertner modified positive impulse	**13.0 psi-msec***	All marine mammals (dolphin calf)	Goertner 1982
	Slight Injury 50% TM Rupture	**Shock Wave** Energy Flux Density (EFD) for *any single exposure*	**205 dB re 1μPa²-sec**	All marine mammals	DoN 2001b
Harassment	**Temporary Auditory Effects** TTS	**Noise Exposure** greatest EFD in any 1/3-octave band *over all exposures*	**182 dB re 1μPa²-sec**	Odontocetes greatest EFD for frequencies ≥100 Hz and mysticetes ≥10 Hz	NMFS 2005a, NMFS 2006
	Temporary Auditory Effects TTS	**Noise Exposure** Peak Pressure for *any single exposure*	**23 psi**	All marine mammals	DoN 2001b
	Behavioral Modification	**Noise Exposure** greatest EFD in any 1/3-octave band *over all exposures*	**177 dB re 1μPa²-sec**	For odontocetes greatest EFD for frequencies ≥100 Hz and for mysticetes ≥10 Hz	NMFS

Notes:

Goertner, J.F. 1982. Predictions of underwater explosion safe ranges for sea mammals. Naval Surface Weapons Center, White Oak Laboratory, Silver Spring, MD. NSWC/WOL TR-82-188. 25 pp.

DoN. 2001b. USS Churchill Shock Trail FEIS. February 2001.

NMFS. 2005. Notice of Issuance of an Incidental Harassment Authorization, Incidental to Conducting the Precisions Strike Weapon (PSW) Testing and training by Elgin Air Force base in the Gulf of Mexico. Federal register 70:48675-48591.

NMFS. 2006. Incidental Takes of Marine Mammals Incidental to Specified Activities: Naval Explosive Ordnance Disposal School Training Operations at Eglin Air Force Base, Florida. NMFS Federal Register 71(199):60693-60697.

NMFS. Briefed NMFS for VAST-IMPASS, U.S. Air Force uses 176 dB for permit applications at Eglin Gulf test and training range (EGTTR)

TTS-Peak Pressure Threshold

The second threshold was stated in terms of peak pressure at 23 psi (about 225 dB re 1 μPa). This threshold was derived from the Churchill threshold. However, peak pressure and energy scale at different rates with charge weight, so that ranges based on the peak-pressure threshold are much greater than those for the energy metric when charge weights are small-even when source and animal are away from the surface. To more accurately estimate TTS for smaller shots while preserving the safety feature provided by the peak pressure threshold, the peak pressure threshold was appropriately scaled for small shot detonations. This scaling was based on the similitude formulas (Urick 1983) used in virtually all compliance documents for short ranges. Further, the peak-pressure threshold for marine mammal TTS for explosives offers a safety margin for a source or an animal near the ocean surface.

Thresholds and Criteria for Behavioral Effects

For a single explosion the TTS was the criterion for Level B ESA-Harassment. In other words, because behavioral disturbance for a single explosion is likely to be limited to a short-lived startle reaction, use of the TTS criterion was considered sufficient protection and therefore behavioral effects (without TTS) are not considered for single explosions.

Acoustic Effects Analysis

The impacts on marine mammals from underwater detonations are based on a modeling approach that considers several factors to ensure an accurate estimation of effects by species.

The impact areas of the underwater detonations are derived from mathematical calculations and models that predict the distances to which threshold noise levels would travel. The equations for the models consider the amount of net explosive, the properties of detonations under water, and environmental factors such as depth of the explosion, overall water depth, water temperature, and bottom type.

The result of the analysis is an area known as the zone of influence (ZOI). A ZOI is based on an outward radial distance from the point of detonation, extending to the limit of a particular threshold level in a 360-degree area. Thus, there are separate ZOIs for mortality, injury (hearing-related injury and slight, non-fatal lung injury), and harassment (temporary threshold shift, or TTS, and sub- TTS). The ZOIs are also influenced by the body size and species of marine mammal exposed. Given the radius, and assuming noise spreads outward in a spherical manner, the entire area ensonified (i.e., exposed to the specific noise level being analyzed) is estimated. The radius is assumed to extend from the point of detonation in all directions, allowing calculation of the affected area.

The number of marine mammal takes is estimated by applying marine mammal density to the ZOI (area) for each detonation type. Species density for most cetaceans is presented in Table 3-9.1 as reported by Carretta et al. (2007b) and Angliss and Outlaw (2008). The density data were conservatively to approximately two standard deviations to obtain 99 percent confidence, and a submergence correction factor was applied to account for the presence of submerged, uncounted animals. The model-specific adjustments applied for each type of detonation are described in the following paragraphs.

GUNEX

Modeling was completed for surface gunnery exercises that take place in the open ocean to provide gunnery practice for Navy ship crews. Exercises can involve a variety of surface targets that are either stationary or maneuverable. Gun systems employed against surface targets include the 5-inch, 76-mm, 57-mm, .50-caliber and the 7.62-mm. The ZOI, when multiplied by the estimated animal densities and total number of events, provides exposure estimates for that animal species for the given gunnery system.

BOMBEX

Modeling was completed for three explosive weights involved in BOMBEX, each assumed detonation at 3.3-ft (1-m) depth. The NEW used in simulations of the MK82, MK83 and MK84 explosives are 192.2 lb (87.2 kg), 415.8 lb (188.6 kg), 944.7 lb (428.5 kg), respectively. The ZOI, when multiplied by the estimated animal densities and total number of events, provides exposure estimates for that animal species for the given bomb source.

SINKEX

Explosives detonated underwater introduce loud, impulsive, broadband sounds into the marine environment. Three source parameters influence the effect of an explosive: the weight of the explosive warhead, the type of explosive material, and the detonation depth. The net explosive weight (or NEW) accounts for the first two parameters. The NEW of an explosive is the weight of only the explosive material in a given round, referenced to the explosive power of TNT.

The detonation depth of an explosive is particularly important due to a propagation effect known as surface-image interference increasingly. For sources located near the sea surface, a distinct interference pattern arises from the coherent sum of the two paths that differ only by a single reflection from the pressure-release surface. As the source depth and/or the source frequency decreases, these two paths increasingly, destructively interfere with each other, reaching total cancellation at the surface (barring surface-reflection scattering loss).

For the NWTRC there are two types of explosive sources: demolition charges and ordnance (MK-48 torpedo; HARM, Maverick, Hellfire and Harpoon missiles; MK-82, MK-83 and MK-84 bombs; and 5-inch rounds and 76 mm rounds). Demolition charges are typically modeled as detonating near the middle of the water column. The MK-48 torpedo detonates immediately below the hull of its target (nominally 50 ft [15 m]). A source depth of 7 ft (2.0 m) is used for bombs and missiles that do not strike their target. For the gunnery rounds, a source depth of 1 foot (0.3 m) is used. The NEW for these sources are as follows:

- Demolition charge – 20 lbs (9.1 kg),
- MK-48 – 851 lbs (386.0 kg),
- Maverick – 78.5 lbs (35.6 kg),
- Harpoon – 448 lbs (203.2 kg),
- MK-82 – 238 lbs (108.0 kg),
- MK-83 – 574 lbs (260.4 kg),
- 5-inch rounds – 9.54 lbs (4.3 kg), and
- 76-mm rounds – 1.6 lbs (0.7 kg)

The exposures expected to result from these sources are computed on a per in-water explosive basis. The cumulative effect of a series of explosives can often be derived by simple addition if the detonations are spaced widely in time or space, allowing for sufficient animal movements to ensure a different population of animals is considered for each detonation.

The cases in which simple addition of the exposures estimates may not be appropriate are addressed by the modeling of a "representative" sinking exercise (SINKEX). In a SINKEX, a decommissioned surface ship is towed to a specified deep-water location and there used as a target for a variety of weapons. Although no two SINKEXs are ever the same, a representative case derived from past exercises is described in the Programmatic SINKEX Overseas Environmental Assessment (DoN 2006c) for the Western North Atlantic.

In a SINKEX, weapons are typically fired in order of decreasing range from the source with weapons fired until the target is sunk. A torpedo is used after all ordnance have been expended if the target is still afloat. Because the target may sink at any time during the exercise, the actual number of weapons used can vary widely. In the representative case, however, all of the ordnances are assumed expended; this represents the worst case of maximum exposure.

The sequence of weapons firing for the representative SINKEX is described in Table 3.9-5. Guided weapons are nearly 100 percent accurate and are modeled as hitting the target (that is, no underwater acoustic effect) in all but two cases: (1) the Maverick is modeled as a miss to represent the occasional miss, and (2) the MK-48 torpedo intentionally detonates in the water column immediately below the hull of the target. Unguided weapons are more frequently off-target and are modeled according to the statistical hit/miss ratios. Note that these hit/miss ratios are artificially low in order to demonstrate a worst-case scenario; they should not be taken as indicative of weapon or platform reliability.

Table 3.9-5: Representative SINKEX Weapons Firing Sequence

Time (Local)	Event Description
0900	Range Control Officer receives reports that the exercise area is clear of non-participant ship traffic, marine mammals, and sea turtles.
0909	Hellfire missile fired, hits target.
0915	2 HARM missiles fired, both hit target (5 minutes apart).
0930	1 Penguin missile fired, hits target.
0940	3 Maverick missiles fired, 2 hit target, 1 misses (5 minutes apart).
1145	1 SM-1 fired, hits target.
1147	1 SM-2 fired, hits target.
1205	5 harpoon missiles fired, all hit target (1 minute apart).
1300-1335	7 live and 3 inert MK-82 bombs dropped – 7 hit target, 2 live and 1 inert miss target (4 minutes apart).
1355-1410	4 MK-83 bombs dropped – 3 hit target, 1 misses target (5 minutes apart).
1500	Surface gunfire commences – 400 5-inch rounds fired (1 every 6 seconds), 280 hit target, 120 miss target.
1700	MK-48 torpedo fired, hits, and sinks target.

MINEX

The Comprehensive Acoustic System Simulation/Gaussian Ray Bundle (CASS/GRAB) (OAML 2002) model, modified to account for impulse response, shock-wave waveform, and nonlinear shock-wave effects, was run for acoustic-environmental conditions derived from the Oceanographic and Atmospheric Master Library (OAML) standard databases. The explosive source was modeled with standard similitude formulas. Because all the sites were shallow (less than 164 ft [50 m]), propagation model runs were made for bathymetry in the range from 33 ft (10 m) to 132 ft (40 m).

Impact Thresholds

In addition to the impact thresholds described previously, this EIS/OEIS analyzes potential effects to marine mammals in the context of the MMPA, ESA (listed species only), the NEPA, and EO 12114. The factors used to assess the significance of effects vary under these Acts and are discussed below.

For purposes of compliance with the MMPA, effects of the action were analyzed to determine if an alternative would result in Level A or Level B harassment of marine mammals. For military readiness activities under the MMPA, the relevant definition of harassment is any act that:

- Injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment). For active sonar activities this is equivalent to a sound exposure received by the marine mammals of 215 dB of received energy (EL, or energy level) or greater.
- Disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered (Level B harassment) [16 USC 1362 (18)(B)(i)(ii)]. For active sonar

activities this is equivalent to a sound exposure received by the marine mammals of greater than or equal to 190 dB EL but less than 195 dB of EL for behavioral disturbance and greater than or equal to 195 dB EL but less than 215 dB of EL for physiological disturbance or effects. The basement value for MFA/HFA sonar risk is 120 dB. This level is taken as the estimated received level below which the risk of significant change in a biologically important behavior approaches zero.

- For purposes of MMPA compliance, exceeding the modeled exposure of 0.5 animals presumes a "take" and requires Navy Action Proponents to seek authorization from the appropriate regulatory agency.

For purposes of ESA compliance, effects of the action were analyzed to make a determination of effect for listed species (for example, no effect or may affect). The definitions used in making the determination of effect under Section 7 of the ESA are based on the USFWS and NMFS *Endangered Species Consultation Handbook* (USFWS and NMFS 1998).

- “No effect” is the appropriate conclusion when a listed species or its designated critical habitat will not be affected, either because the species will not be present or because the project does not have any elements with the potential to affect the species or modify designated critical habitat. “No effect” does not include a small effect or an effect that is unlikely to occur.
- If effects are insignificant (in size) or discountable (extremely unlikely), a “may affect” determination is appropriate. Insignificant effects relate to the magnitude or extent of the impact (for example, they must be small and would not rise to the level of a take of a species).
- For ESA protected marine mammals, if quantitative analysis indicates a modeled exposure exceeds 0.05 protected marine mammals, then there is a presumption that the proposed activity "may affect" the protected marine mammal thus triggering consultation with the appropriate regulatory agency pursuant to reference.
- Discountable effects are those extremely unlikely to occur and based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.

For purposes of ESA compliance relative to listed critical habitats for the southern resident killer whale (NMFS 2006e) and Steller sea lion (NMFS 1993b), effects of the action were analyzed to make a determination of no destruction or adverse modification of critical habitats. The factors used in making the determination of effect are based on whether proposed Navy actions are likely to destroy or change the biological or physical primary constituent elements (PCEs) of the critical habitat that are considered essential for the conservation of the species. The species-specific PCEs are described in the Federal Register announcement listing the final critical habitat ruling for each species.

The factors outlined above were also considered in determining the significance of effects under NEPA and EO 12114.

3.9.2.2 Current Protective Measures

The Navy has implemented a comprehensive suite of protective measures that reduce impacts to marine mammals that might result from Navy training and testing activities in the NWTRC. In order for the NMFS and the USFWS to make the findings necessary to issue a BE and a LOA under MMPA, it may be necessary for NMFS and USFWS to require additional mitigation or monitoring measures beyond those addressed in this DEIS/OEIS. These measures could include measures considered, but eliminated in this EIS/OEIS, or as yet undeveloped measures. The public will have an opportunity, through the MMPA process, both to provide information to NMFS in the comment period following NMFS' Notice of Receipt of the application for an LOA, and to review any additional mitigation or monitoring measures that NMFS might propose in the comment period at the proposed rule stage. The final suite of measures developed as a result of the MMPA process would be identified and analyzed in the Final EIS/OEIS.

Effective training and testing dictate that ship, submarine, and aircraft participants utilize their sensors and exercise weapons to their optimum capabilities as required by the mission. Standard operating procedures and mitigation measures are employed to avoid and minimize potential adverse effects of training. A comprehensive list of mitigation measures that would be utilized for training activities analyzed in the NWTRC EIS/OEIS in order to minimize potential for impacts on marine mammals is presented in Chapter 5.

Chapter 5 includes mitigation measures that are followed for all types of exercises; those that are associated with a particular type of training event; and those that apply generally to all Navy training at sea. For major exercises, the applicable mitigation measures are incorporated into a naval message which is disseminated to all of the units participating in the exercise or training event and applicable responsible commands. Appropriate measures are also provided to non-Navy participants (other DoD and allied forces) as information in order to ensure their use by these participants.

The extensive set of protective measures avoids, minimizes, and reduces potential adverse effects of surface, air, and subsurface training and testing activities on marine mammals. In general the protective measures include:

- Training personnel (watchstanders) to detect and report the presence of marine mammals so that activities can be stopped or altered to prevent conflicts or injuries.
- Conducting pre-training site surveys to detect and clear training areas of marine mammals that might be affected by activities before training activities are initiated.
- Adjusting sonar emission and operating procedures to avoid damage to susceptible marine mammals when they are detected in the vicinity of naval activities.
- Adjusting vessel, bombing, aircraft, and underwater detonation activities when marine mammals are known to be present in the area or when their presence is detected during a training exercise.
- Maintaining protective buffer zones around ships and other vessels when marine mammals are known to be present or when they are detected within established distances of ships and sonar exercises.
- Maintaining marine mammal exclusion zones around training areas that involve underwater detonations.
- Coordinating with NMFS before, during, and after major training exercises and reporting incidences that may have involved marine mammals.

The effectiveness of these protective measures was considered in determining the impacts of the proposed alternatives to marine mammals.

Navy shipboard lookouts (also referred to as “watchstanders”) are highly qualified and experienced observers of the marine environment. Their duties require that they report all objects sighted in the water to the Officer of the Deck (e.g., trash, a periscope, marine mammals, sea turtles) and all disturbances (e.g., surface disturbance, discoloration) that may be indicative of a threat to the vessel and its crew. There are personnel serving as lookouts on station at all times (day and night) when a ship or surfaced submarine is moving through the water. Navy lookouts undergo extensive training in order to qualify as a lookout. This training includes on-the-job instruction under the supervision of an experienced lookout, followed by completion of the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). The Navy includes marine species awareness as part of its training for its bridge lookout personnel on ships and submarines. Lookouts are trained how to look for marine species, and report sightings to the Officer of the Deck so that action may be taken to avoid the marine species or adjust the exercise to minimize effects to the species. Marine Species Awareness Training was updated in 2006, and the additional training materials are now included as required training for Navy ship and submarine lookouts. Additionally, all Commanding Officers and Executive Officers (CO/XOs) of units involved in training exercises are required to undergo marine species awareness training. This training addresses the lookout's role in environmental protection, laws governing the protection of marine species, Navy stewardship commitments, and general observation information to aid in avoiding interactions with marine species.

3.9.2.3 No Action Alternative

<u>Vessel Movements</u>

<u>Overview</u>

Many of the ongoing and proposed activities within the Study Area involve maneuvers by various types of surface ships, boats, and submarines (collectively referred to as vessels). Vessel movements have the potential to affect marine mammals by directly striking or disturbing individual animals. The probability of vessel and marine mammal interactions occurring in the Study Area is dependant upon several factors including numbers, types, and speeds of vessels; the regularity, duration, and spatial extent of activities; the presence/absence and density of marine mammals; and protective measures implemented by the Navy. During training activities, speeds vary and depend on the specific training activity. Activities involving vessel movements occur intermittently and are variable in duration, ranging from a few hours up to 2 weeks. Approximately 490 activities that involve Navy vessels occur within the Study Area during a typical year. These activities are widely dispersed throughout the OPAREA, which is a vast area encompassing 122,468 nm^2 (420,054 km^2) Consequently, the density of ships within the Study Area at any given time is extremely low.

<u>Disturbance Associated with Vessel Movements</u>

Marine mammals are frequently exposed to vessels due to research, ecotourism, commercial and private vessel fishing traffic, and government activities. The presence of vessels has the potential to alter the behavior patterns of marine mammals. It is difficult to differentiate between responses to vessel sound and visual cues associated with the presence of a vessel; thus, it is assumed that both play a role in prompting reactions from animals (NMFS 2008a). Anthropogenic sound has increased in the marine environment over the past 50 years (Richardson et al. 1995; NRC 2003) and can be attributed to vessel traffic, marine dredging and construction, oil and gas drilling, geophysical surveys, sonar, and underwater explosions (Richardson et al. 1995). Vessel strikes are rare, but do occur and can result in injury (NMFS 2008a).

Marine mammals react to vessels in a variety of ways. Some respond negatively by retreating or engaging in antagonistic responses while other animals ignore the stimulus altogether (Watkins 1986; Terhune and Verboom 1999). The ESA-listed marine mammal species (blue, fin, humpback, North Pacific right, sei, southern resident killer, and sperm whales; Steller sea lion; and sea otter) that occur in the Study Area are not generally documented to approach vessels in their vicinity. The predominant reaction is either neutral or avoidance behavior, rather than attraction behavior. If available, additional information regarding each listed species is provided below.

Blue and Sei Whales

There is little information on blue whale or sei whale response to vessel presence (NMFS 1998b, 1998c). Sei whales have been observed ignoring the presence of vessels and passing close to the vessel (Weinrich et al. 1986). The response of blue and sei whales to vessel traffic is assumed to be similar to that of the other baleen whales, ranging from avoidance maneuvers to disinterest in the presence of vessels. Any behavioral response would be short-term in nature.

Fin and Humpback Whales

Fin whales have been observed altering their swimming patterns by increasing speed, changing their heading, and changing their breathing patterns in response to an approaching vessel (Jahoda et al. 2003). Observations have shown that when vessels remain 328 ft (100 m) or farther from fin and humpback whales, they were largely ignored (Watkins et al. 1981). Only when vessels approached more closely did the fin whales in the study alter their behavior by increasing time at the surface and engaging in evasive maneuvers. The humpback whales did not exhibit any avoidance behavior (Watkins et al. 1981). However, in other instances humpback whales did react to vessel presence. In a study of regional vessel traffic, Baker et al. (1983) found that when vessels were in the area, the respiration patterns of the humpback whales changed. The whales also exhibited two forms of behavioral avoidance when vessels were between 0 and 6,562 ft (2,000 m) away (Baker et al. 1983): 1) horizontal avoidance (changing direction and/or speed) when vessels were between 6,562 ft (2,000 m) and 13,123 ft (4,000 m) away, or 2) vertical avoidance (increased dive times and change in diving pattern).

Based on existing studies, it is likely that fin and humpback whales would have little reaction to vessels that maintain a reasonable distance from the animals. The distance that will provoke a response varies based on many factors including, but not limited to, vessel size, geographic location, and individual animal tolerance levels (Watkins et al. 1981; Baker et al. 1983; Jahoda et al. 2003). Should the vessels approach close enough to invoke a reaction, animals may engage in avoidance behaviors and/or alter their breathing patterns. Reactions exhibited by the whales would be temporary in nature. They would be expected to return to their pre-disturbance activities once the vessel has left the area.

North Pacific Right Whale

Although very little data exists examining the relationship between vessel presence and significant impact to the North Pacific right whale, it is thought that any impacts would be minor and/or temporary in nature (NMFS 2005b). In the North Pacific, ship strikes may pose a potential threat to North Pacific right whales. However, because of their rare occurrence and scattered distribution, it is impossible to assess the threat of ship strikes to this species at this time. For these reasons, the NMFS has not identified ship collisions as major threat because the estimated annual rate of human-caused mortality and serious injury appears minimal (NMFS 2008d). Through 2002 there were no reports of ship strikes of the North Pacific right whale by large ships along the U.S. West Coast and Canada (Jensen and Silber 2003). In addition, North Pacific right whales are protected through measures such as the 500-yd (1,500-m) no-approach limit, which affords them additional protection and further alleviates any effect vessel traffic might have on behavior or distribution (NMFS 2005b).

Sperm Whale

Sperm whales generally show little to no reaction to ships, except on close approaches (within several hundred meters); however, some did show avoidance behavior such as quick diving (Würsig et al. 1998). In addition, in the presence of whale watching and research boats, changes in respiration and echolocation patterns were observed in male sperm whales (Richter et al. 2006). Disturbance from boats did not generally result in a change in behavior patterns and is short-term in nature (Magalhães et al. 2002).

Southern Resident Killer Whale

In Washington and British Columbia killer whale watching of the northern and southern residents has become an important regional tourist industry since the late 1970s. Both commercial and private vessels engage in whale watching. The number of vessels engaged in this activity increased from a few boats and fewer than 1,000 passengers annually in the early 1980s to about 41 companies with 76 boats and more than 500,000 passengers annually in 2006 (Koski 2007). The growth of whale watching during the past 20 years has meant that killer whales in the region are experiencing increased exposure to vessel traffic. Not only do greater numbers of boats accompany the whales for longer periods of the day, but there has also been a gradual lengthening of the viewing season. Several studies have linked vessels with short-term behavioral changes in northern and southern resident killer whales (Kruse 1991, Kriete 2002, Williams et al. 2002; Bain et al. 2006), although whether it is the presence and activity of the vessel, the sounds of the vessel or a combination these factors is not well understood. Individual whales have been observed to react in a variety of ways to whale-watching vessels. Responses include swimming faster, adopting less predictable travel paths, making shorter or longer dives, moving into open water, and altering normal patterns of behavior at the surface (Kruse 1991; Williams et al. 2002; Bain et al. 2006), while in some cases, no disturbance seems to occur. Avoidance tactics often vary between encounters and the sexes, with the number of vessels present and their proximity, activity, size, and “loudness” affecting the reaction of the whales (Williams et al. 2002). Avoidance patterns often become more pronounced as boats approach closer.

The potential impacts of whale watching on killer whales remain controversial and inadequately understood. Although numerous short-term behavioral responses to whalewatching vessels have been documented, no studies have yet demonstrated a long-term adverse effect from whale watching on the health of any killer whale population in the northeastern Pacific (NMFS 2008b). Both resident populations have shown strong site fidelity to their traditional summer ranges despite more than 25 years of whale-watching activity (as well as even longer periods of intense commercial fishing vessel activity (NMFS 2008b). There are no reported instances of killer whale strikes, mortality, or injury reported because of these vessel activities (NMFS 2008b). Voluntary compliance with NMFS 2006 guidelines (Be Whale Wise) for maintaining space separations between vessels and killer whales and for reducing vessel speed within certain distances of whales are thought to have contributed to minimizing killer whale disturbances.

Delphinids

Species of delphinids can vary widely in their reaction to vessels. Many exhibit mostly neutral behavior, but there are frequent instances of observed avoidance behaviors (Hewitt 1985; Würsig et al. 1998). In addition, approaches by vessels can elicit changes in behavior, including a decrease in resting behavior or change in travel direction (Bejder et al. 2006). Alternately, many of the delphinid species exhibit behavior indicating attraction to vessels. This can include solely approaching a vessel (observed in harbor porpoises and minke whales) (David 2002), but many species such as common, rough-toothed and bottlenose dolphins are frequently observed bow riding or jumping in the wake of a vessel (Norris and Prescott 1961; Shane et al. 1986; Würsig et al. 1998; Ritter 2002). These behavioral alterations are short-term and would not result in any lasting effects.

Vessel traffic related to the proposed activity would pass near marine mammals only on an incidental basis. Most of the studies mentioned previously examine the reaction of animals to vessels that approach and intend to follow or observe an animal (i.e., whale watching vessels, research vessels, etc.). Reactions to vessels not pursuing the animals, such as those transiting through an area or engaged in training exercises, may be similar but would likely result in less stress to the animal because they would not intentionally approach animals. In fact, Navy mitigation measures include several provisions to avoid approaching marine mammals (see Chapter 5 for a detailed description of mitigation measures). As previously noted, all quick avoidance maneuvers are short-term alterations and not expected to permanently impact an animal. Most studies have ascertained the short-term response to vessel sound and vessel traffic (Watkins et al. 1981; Baker, et al. 1983; Magalhães et al. 2002); however, the long-term implications of ship sound on marine mammals is largely unknown (NMFS 2007b).

Marine mammals exposed to a passing Navy vessel may not respond at all, or they could exhibit a short-term behavioral response, but not to the extent where natural behavioral patterns would be abandoned or significantly altered. Human disturbance to wild animals may elicit similar reactions to those caused by natural predators (Gill et al. 2001; Beale and Monaghan 2004). Behavioral responses may also be accompanied by a physiological response (Romero 2004), although this is very difficult to study in the wild. Short-term exposures to stressors result in changes in immediate behavior (Frid 2003). Repeated exposure to stressors, including human disturbance such as vessel disturbance and anthropogenic sound, can result in negative consequences to the health and viability of an individual or population. Chronic stress can result in decreased reproductive success (Beale and Monaghan 2004), decreased energy budget (Frid 2003), displacement from habitat (Southerland and Crockford 1993), and lower survival rates of offspring (Lordi et al. 2000). At this time, it is unknown what the long-term implications of chronic stress may be on marine mammal species.

Vessel movements under the No Action Alternative are not expected to result in chronic stress because, as discussed above, Navy vessel density in the Study Area would remain low and the Navy implements mitigation measures to avoid marine mammals. General disturbance associated with vessel movements may affect ESA-listed marine mammals. This same disturbance is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, vessel disturbance in territorial waters would have no notable impact on marine mammals. Furthermore, in accordance with EO 12114, harm to marine mammals from vessel disturbance in non-territorial waters would be minimal. The Navy is working with NMFS through the ESA consultation and MMPA permitting processes accordingly.

Vessel Collisions with Marine Mammals

Ship strikes are known to affect large whales in the Study Area. The most vulnerable marine mammals are those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (for example, the sperm whale). In addition, some baleen whales, such as the North Atlantic right whale seem generally unresponsive to vessel sound, making them more susceptible to vessel collisions (Nowacek et al. 2004). These species are primarily large, slow moving whales. Smaller marine mammals (for example, bottlenose dolphin) move quickly throughout the water column and are often seen riding the bow wave of large ships. Marine mammal responses to vessels may include avoidance and changes in dive pattern (NRC 2003).

A review of recent reports on ship strikes provides some insight regarding the types of whales, locations and vessels involved. It also reveals significant gaps in the data. The Large Whale Ship Strike Database provides a summary of the 292 worldwide confirmed or possible whale/ship strikes from 1975 through 2002 (Jensen and Silber, 2003). The report notes that the database represents a minimum number of collisions, because the vast majority probably go undetected or unreported. In contrast, Navy vessels are likely to detect any strike that does occur, and they are required to report all ship strikes involving marine mammals. Overall, the percentages of Navy traffic relative to overall large shipping traffic are very small (on the order of 2 percent).

The ability of a ship to avoid a collision and to detect a collision depends on a variety of factors, including environmental conditions, ship design, size, and manning. The majority of ships participating in NWTRC training activities have a number of advantages for avoiding ship strikes as compared to most commercial merchant vessels, including the following:

- Navy ships have their bridges positioned forward, offering good visibility ahead of the bow.
- Crew size is much larger than that of merchant ships allowing for more potential observers on the bridge.

- Dedicated lookouts are posted during a training activity scanning the ocean for anything detectible in the water; anything detected is reported to the Officer of the Deck.
- Navy lookouts receive extensive training including Marine Species Awareness Training designed to provide marine species detection cues and information necessary to detect marine mammals.
- Navy ships are generally much more maneuverable than commercial merchant vessels.

The Navy has adopted mitigation measures to reduce the potential for collisions with surfaced marine mammals. For a thorough discussion of mitigation measures, please see Chapter 5. Briefly, these measures include:

- At all times when vessels are underway, trained lookouts are used to detect all objects on the surface of the water, including marine mammals.
- Reasonable and prudent actions are implemented to avoid the close interaction of Navy assets and marine mammals.
- Navy personnel are required to use caution and operate the vessel at a slow and safe speed consistent with mission so as to avoid a collision with any marine animal and to be able to stop within a distance appropriate to the prevailing circumstances and conditions.
- Maneuvering to keep away from any observed marine mammal.

In contrast to the North Atlantic right whale conditions, ship strikes and entanglement impacts to the North Pacific right whale population may face less of a threat (NMFS 2007a) because of their rare occurrence and scattered distribution in the Study Area. Thus, the estimated annual rate of human-caused mortality and serious injury appears minimal.

Sea otters often allow close approaches by boats, but tend to avoid heavily disturbed areas. They do, however, reoccupy those areas in times of less traffic. Sea otters seldom venture more than 1 mi (1-2 km) offshore (Lance et al. 2004), making their interaction with Navy vessels engaged in training activities very unlikely. Accidental collisions between sea otters and support-base boat traffic are unlikely, because of the otters' mobility and their nearshore distribution (MMS 2008). Vessel collisions and disturbances are not recognized significant threats to Steller sea lion, and the southern resident killer whales.

Based on the implementation of Navy mitigation measures and the relatively low density of Navy ships in the Study Area, the likelihood that a vessel collision would occur under the No Action Alternative is very low. Vessel collisions may affect mysticetes and sperm whales in the Study Area. There would be no effect on sea otter and Steller sea lion. In accordance with NEPA, vessel collisions in territorial waters would have no significant impact on marine mammals. Furthermore, vessel collisions in non-territorial waters would not cause significant harm to marine mammals in accordance with EO 12114. The Navy is working with NMFS through the ESA consultation and MMPA permitting processes accordingly.

Aircraft Overflights

Overview

Various types of fixed-wing aircraft and helicopters are used in training exercises throughout the Study Area. These aircraft overflights would produce airborne noise and some of this energy would be transmitted into the water. Marine mammals could be exposed to noise associated with subsonic and supersonic fixed-wing aircraft overflights and helicopter activities while at the surface or while submerged. In addition to sound, marine mammals could react to the shadow of a low-flying aircraft and/or, in the case of helicopters, surface disturbance from the downdraft.

Transmission of sound from a moving airborne source to a receptor underwater is influenced by numerous factors and has been addressed by Urick (1972), Young (1973), Richardson et al. (1995), Eller and Cavanagh (2000), Laney and Cavanagh (2000), and others. Sound is transmitted from an airborne source to a receptor underwater by four principal means:

- Direct path, refracted upon passing through the air-water interface;
- Direct-refracted paths reflected from the bottom in shallow water;
- Lateral (evanescent) transmission through the interface from the airborne sound field directly above; and
- Scattering from interface roughness due to wave motion.

Aircraft sound is refracted upon transmission into water because sound waves move faster through water than through air (a ratio of about 0.23:1). Based on this difference, the direct sound path is totally reflected if the sound reaches the surface at an angle more than 13 degrees from vertical. As a result, most of the acoustic energy transmitted into the water from an aircraft arrives through a relatively narrow cone with a 26 degree apex angle extending vertically downward from the aircraft (Figure 3.9-9). The intersection of this cone with the surface traces a "footprint" directly beneath the flight path, with the width of the footprint being a function of aircraft altitude.

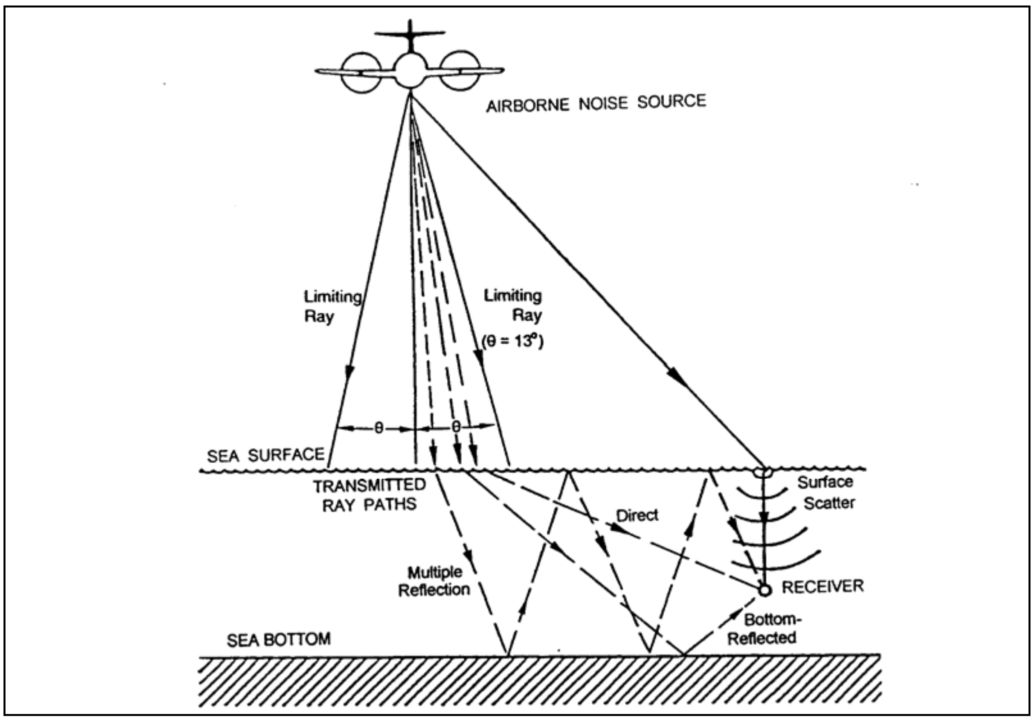


Figure 3.9-9: Characteristics of Sound Transmission through Air-Water Interface

The sound pressure field is actually doubled at the air-to-water interface because the large difference in the acoustic properties of water and air. For example, a sonic boom with a peak pressure of 10 pounds per square foot (48.8 kg/m^2) at the sea surface becomes an impulsive wave in water with a maximum peak pressure of 20 pounds per square foot (97.6 kg/m^2). The pressure and sound levels then decrease with increasing depth.

Eller and Cavanagh (2000) modeled estimates of sound pressure level as a function of time at selected underwater locations (receiver animal depths of 7 ft [2 m], 33 ft [10 m], and 164 ft [50 m]) for F-18 aircraft subsonic overflights (250 knots [463 km/hr]) at various altitudes (984 ft [300 m], 3,281 ft [1,000 m], and 9,842 ft [3,000 m]). As modeled for all deep water scenarios, the sound pressure levels ranged from approximately 120 to 150 dB (referenced to 1 microPascal [re 1 µPa]) in water. They concluded that it is difficult to construct cases (for any aircraft at any altitude in any propagation environment) for which the underwater sound is sufficiently intense and long lasting to cause harm to any form of marine life.

The maximum overpressures calculated for FA-18 aircraft supersonic overflights range from 5.2 pounds per square foot (psf) (25.4 kg/m^2) at 10,000 ft (3,048 m) to 28.8 psf (140.6 kg/m^2) at 1,000 ft (305 m) (Ogden 1997). Considering an extreme case of a sonic boom that generates maximum overpressure of 50 psf (244.1 kg/m^2) in air, it would become an impulsive wave in water with a maximum peak pressure of 100 psf (488.2 kg/m^2)or about 0.7 psi (0.05 kg/cm^2). Therefore, even a worst-case situation for sonic booms would produce a peak pressure in water well below the level that would cause harassment or injury to marine mammals (Laney and Cavanagh, 2000).

It should be noted that most of the aircraft overflight exposures analyzed in the studies mentioned above are different than Navy aircraft overflights. Survey and whale watching aircraft are expected to fly at lower altitudes than typical Navy fixed-wing overflights. Exposure durations would be longer for aircraft intending to observe or follow an animal. These factors might increase the likelihood of a response to survey or whale watching aircraft. Exposure to Navy overflights would be very brief, but the noise levels might be higher based on aircraft type and airspeed.

Fixed-Wing Aircraft Overflights

Approximately 7,478 fixed-wing sorties would occur in the OPAREA annually under the No Action Alternative with many of the sorties remaining above 6,000 ft (1,920 m). While fixed-wing aircraft activities can occur in Special Use Airspace throughout the Study Area, a majority of the sorties are associated with Air Combat Maneuver (ACM) training, which takes place in the Olympic MOA. Under the No Action Alternative, approximately 2,043 ACM sorties would occur annually (average of six sorties per day) and about 98 percent of the total sorties would be EA-6B aircraft. Altitudes range from approximately 6,000 ft (1,920 m) to 30,000 ft (9,144 m) and typical airspeeds range from very low (less than 100 knots [185.2 km/hr]) to high subsonic (less than 600 knots [1,111.2 km/hr]). Sound exposure levels at the sea surface from most ACM overflights are expected to be less than 93 dBA based on an EA-6B aircraft flying at an altitude of 5,000 ft (1,524 m) and an airspeed of 400 knots (740.8 km/hr). Although some ACM training involves supersonic flight which produces sonic booms, none of the locally-based aircraft are supersonic capable in normal training configuration. Since it is uncommon for supersonic aircraft to transit to the NWTRC for over water training, sonic booms due to Navy training flights in the OPAREA would be extremely rare.

Exposure to fixed-wing aircraft noise would be brief (seconds) as an aircraft quickly passes overhead. Exposures would be infrequent based on the transitory and dispersed nature of the overflights; repeated exposure to individual animals over a short period of time (hours or days) is extremely unlikely. Furthermore, the sound exposure levels would be relatively low to marine mammals that spend the majority of their time underwater.

Most observations of cetacean responses to aircraft overflights are from aerial scientific surveys that involve aircraft flying at relatively low altitudes and low airspeeds. Mullin et al. (1991) reported that sperm whale reactions to aerial survey aircraft (standard survey altitude of 750 ft [229 m]) were not consistent. Some sperm whales remained on or near the surface the entire time the aircraft was in the vicinity, while others dove immediately or a few minutes after the sighting.

Smultea et al. (2001) reported that a group of sperm whales responded to a circling aircraft (altitude of 800 ft [244 m] to 1,100 ft [335 m]) by moving closer together and forming a fan-shaped semi-circle with their flukes to the center and their heads facing the perimeter. Several sperm whales in the group were observed to turn on their sides, to apparently look up toward the aircraft. Richter et al. (2003) reported that the number of sperm whale blows per surfacing increased when recreational whale watching aircraft were present, but the changes in ventilation were small and probably of little biological consequence. The presence of whale watching aircraft also apparently caused sperm whales to turn more sharply, but did not affect blow interval, surface time, time to first click, or the frequency of aerial behavior (Richter et al. 2003). A review of behavioral observations of baleen whales indicates that whales will either demonstrate no behavioral reaction to an aircraft or, occasionally, display avoidance behavior such as diving (Koski et al. 1998). Smaller delphinids also generally display a neutral or startle response (Würsig et al. 1998). Species, such as *Kogia* spp. and beaked whales, that show strong avoidance behaviors with ship traffic, also exhibit disturbance reactions to aircraft (Würsig et al. 1998). Although there is little information regarding reactions to aircraft overflights for other cetacean species, it is expected that reactions would be similar to those described above; either no reaction or quick avoidance behavior.

Marine mammals exposed to a low-altitude fixed-wing aircraft overflights could exhibit a short-term behavioral response, but not to the extent where natural behavioral patterns would be abandoned or significantly altered. Fixed-wing aircraft overflights are not expected to result in chronic stress because it is extremely unlikely that individual animals would be repeatedly exposed to low altitude overflights. Fixed-wing aircraft overflights may affect ESA-listed marine mammals. This same disturbance is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, fixed-wing aircraft overflights over territorial waters would have no significant impact on marine mammals. Furthermore, fixed-wing aircraft overflights over non-territorial waters would not cause significant harm to marine mammals in accordance with EO 12114. The Navy is working with NMFS through the ESA consultation and MMPA permitting processes accordingly.

Helicopter Overflights

Approximately 96 helicopter sorties would occur in the Study Area annually under the No Action Alternative. Helicopter overflights can occur throughout the Study Area, but most would occur in the OLF Coupeville, NASWI Seaplane Base, and Crescent Harbor Range Areas during Insertion/Extraction activities under the No Action Alternative. Unlike fixed-wing aircraft, helicopter training activities can occur at low altitudes (75 ft [23 m] to 100 ft [30 m]), which increases the likelihood that marine mammals would respond to helicopter overflights. However, the only places that helicopters are below 500 ft [152 m] AGL over water is during training when personnel jump from the helicopter into water from 75 ft [23 m] to 100 ft [30 m] above the surface. Otherwise, helicopters are 500 ft [152 m] AGL or higher while in transit.

Very little data are available regarding reactions of cetaceans to helicopters. One study observed that sperm whales showed no reaction to a helicopter until the whales encountered the downdrafts from the helicopter rotors (Clarke 1956). Other species such as bowhead whale and beluga whales show a range of reactions to helicopter overflights, including diving, breaching, change in direction or behavior, and alteration of breathing patterns, with belugas exhibiting behavioral reactions more frequently than bowheads (38 percent and 14 percent of the time, respectively) (Patenaude et al. 2002). These reactions were less frequent as the altitude of the helicopter increased to 492 ft (150 m) or higher.

Sea otter reactions to low helicopter and fixed-winged aircraft overflights below 1,000 ft (305 m) above ground level included abandoning young pups while fleeing the disturbance (NOAA 1992 FEIS and Management Plan for the Proposed Monterey Bay National Marine Sanctuary Volume 1 June at http://montereybay.noaa.gov/intro/mbnms_eis/partIV_sII.html). California Department of Fish and Game regulations that prevent overflights below 1,000 ft (305 m) at the California Sea Otter Refuge adequately protect sea otters and other marine mammals from visual and acoustical disturbances.

The sea otter, three seal species (northern elephant, northern fur, and harbor), and two sea lion species (Steller and California) occur within the Study Area. All these species occur regularly in the Study Area. It is not likely that the sea otter, three seal species, and two sea lion species would be at or near the surface of the water in areas where helicopters overflights occur in the Study Area.

Helicopters are used in studies of several species of seals hauled out and is considered an effective means of observation (Gjertz and Børset 1992; Bester et al. 2002; Bowen et al. 2006), although they have been known to elicit behavioral reactions such as fleeing (Hoover 1988). Jehl and Cooper (1980) indicated that low-flying helicopters, humans on foot, sonic booms, and loud boat noises were the most disturbing influences to pinnipeds. In other studies, harbor and other species of seals and seal lions showed no reaction to helicopter overflights (Gjertz and Børset 1992). Among the pinnipeds, harbor seals are the most likely to startle; no serious disturbance was recorded among northern elephant seals. Numerous observations of marine mammal reactions (or lack of reaction) to aircraft have been reported. In most cases, airborne or waterborne noise from aircraft was the apparent stimulus (Richardson et al. 1995). Harbor seals have been noted to react to aircraft flyovers when on the beach. In the case of helicopter flyovers of less than 393 ft (120 m), mothers have abandoned newborn pups and retreated into the water. This behavior can result in permanent separation of newborn pups and subsequent death (Johnson, 1967). Other studies have shown less drastic reactions. Hoover (1988) reported strong reactions to aircraft below 200 ft (61 m), but minimal reaction to aircraft above 250 ft (76 m). Other studies have suggested that harbor seals can become sensitized to overflights and show little or no reaction after frequent exposure (Frost and Lowry1993; Bigg 1982 as cited in Johnson et al. 1989).

If animals do flush into the water, they may return to the haul-out site immediately, stay in the water for a length of time and then return to the haul-out, or temporarily haul-out at another site. Many factors contribute to the degree of behavioral modification, if any, including seasonality, group composition of the pinnipeds, type of activity they are engaged in, and noises they may be accustomed to experiencing. Short-term reactions such as startle or alert reactions are not likely to disrupt behavior patterns such as migrating, breeding, feeding and sheltering, nor would they be likely to result in serious injury to marine mammals. However, if startle reactions were accompanied by large-scale movements of marine mammals, such as stampedes into the water, the disruption could result in injury of individuals, especially if pups were present.

Marine mammals exposed to a low-altitude helicopter overflights under the No Action Alternative could exhibit a short-term behavioral response, but not to the extent where natural behavioral patterns would be abandoned or considerably altered. Helicopter overflights are not expected to result in chronic stress because it is extremely unlikely that individual animals would be repeatedly exposed. Helicopter overflights can occur throughout the Study Area, but most would occur in the OLF Coupeville, NASWI Seaplane Base, and Crescent Harbor Range Areas which are not in close proximity to known haul out areas or established rookeries. In addition, the Navy complies with restrictions prohibiting fixed wing aircraft or helicopter overflight or surface training activities within 3,000 ft (914 m) of Steller sea lion critical habitat (NMFS 1993b), rookeries or pinniped haulout areas (DoN 2002c). These mitigation measures minimize adverse reactions of seals and Steller sea lions to training activities. As such, helicopter overflights may affect ESA-listed marine mammals. These overflights are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, helicopter overflights over territorial waters would have no notable impact on marine mammals. Furthermore, in accordance with EO 12114, harm to marine mammals from helicopter overflights over non-territorial waters would be minimal. The Navy is working with NMFS through the ESA consultation and MMPA permitting processes accordingly.

Non-Explosive Practice Ordnance

Current Navy training activities include firing a variety of weapons that employ a variety of non-explosive training rounds, including naval gun shells, cannon shells, and small caliber ammunition. As part of this training, Navy regulations require visual clearance before the training exercise of any range where ordnance (including non-explosive inert practice ordnance) is to be dropped. This analysis focuses on non-explosive training rounds, while potential effects of explosive rounds are analyzed below in the explosions section.

The number of non-explosive practice ordnance events by type of projectile occurring for the No Action Alternative is presented in Table 2-10. Non-explosive practice ordnance includes naval gun shells (20-mm, 25-mm, 57-mm, 76-mm, and 5-in projectiles) and small arms rounds (7.62-mm and .50-caliber projectiles). Annually, there would be about 25,860 naval gun shell and about 59,720 small arms projectiles expended into the ocean with the No Action Alternative. Although use may be concentrated in W-237, ordnance is used in all areas of the NWTRC beyond 3 nm (6 km). The density of annual ordnance use would be approximately 0.7 items per nm^2 (3.4 km^2) over the 122,241 nm^2 (419,287 km^2) range. Given the relatively small sizes of whales, sea lions, and other marine mammals and the non-explosive ordnance used, the potential for marine mammals to be struck by ordnance is low.

Direct ordnance strikes and disturbance associated with sound from firing are potential stressors to other listed marine mammals. Ingestion of expended ordnance is also a potential concern for some marine mammals and is analyzed below under expended materials. The primary concern is potential exposure of marine mammals at or near the water's surface, which could result in injury or mortality.

While whales, dolphins, and sea lions could be exposed to direct ordnance strikes in training areas, the training exercises are intermittent and the animals are widely dispersed, which decreases the likelihood that in a given area an animal would be struck by a round or subjected repeatedly to additional rounds. The probability of a direct ordnance strike is further reduced by Navy mitigation measures (see Chapter 5). Non-explosive ordnance would have no effect on marine mammals. In accordance with NEPA, non-explosive ordnance use in territorial waters would have no significant impact on marine mammals. Furthermore, non-explosive ordnance use in non-territorial waters would not cause significant harm to marine mammals.

Weapons Firing Disturbance

Transmitted Gunnery Sound

A gun fired from a ship on the surface of the water propagates a blast wave away from the gun muzzle. This spherical blast wave reflects off and diffracts around objects in its path. As the blast wave hits the water, it reflects back into the air, transmitting a sound pulse back into the water in proportions related to the angle at which it hits the water.

Propagating energy is transmitted into the water in a finite region below the gun. A critical angle (about 13°, as measured from the vertical) can be calculated to determine the region of transmission in relation to a ship and gun (Dahlgren 2000).

The largest proposed shell size for these activities is a 5-inch shell. This will produce the highest pressure and all analysis will be done using this as a conservative measurement of produced and transmitted pressure, assuming that all other smaller ammunition sizes would fall under these levels.

Aboard the USS Cole in June 2000, a series of pressure measurements were taken during the firing of a five-inch gun. Average pressure measured approximately 200 decibels (dB) with reference pressure of one micro Pascal (dB re 1 µPa) at the point of the air and water interface. Based on the USS Cole data, down-range peak pressure levels were calculated to be less than 186 dB re 1 µPa at 328 ft (100 m) (Dahlgren 2000) and as the distance increases, the pressure would decrease.

In reference to the energy flux density (EFD) harassment criteria, the EFD levels (greatest in any 1/3 octave band above 0.01 kHz) of a 5-inch gun muzzle blast were calculated to be 190 dB with reference pressure of one micropascal squared in one second (dB re 1 μPa^2-sec) directly below the gun muzzle decreasing to 170 dB re 1 μPa^2-sec at 328 ft (100 m) into the water (Dahlgren 2000). The rapid dissipation of the sound pressure wave coupled with the mitigation measures implemented by the Navy (see Chapter 5 for details) to detect marine mammals in the area prior to conducting activities, would result in a blast from a gun muzzle having no effect on marine mammal species listed under the ESA. In accordance with NEPA there would be no significant impact to marine mammals from transmitted gunnery sound during training exercises within territorial waters. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from transmitted gunnery sound during training exercises in non-territorial waters.

Sound Transmitted Through Ship Hull

A gun blast will also transmit sound waves through the structure of the ship which can propagate into the water. The 2000 study aboard the USS Cole also examined the rate of sound pressure propagation through the hull of a ship (Dahlgren 2000). The structurally borne component of the sound consisted of low-level oscillations on the pressure time histories that preceded the main pulse, due to the air blast impinging on the water (Dahlgren 2000).

The structural component for a standard round was calculated to be 6.19 percent of the air blast (Dahlgren 2000). Given that this component of a gun blast was a small portion of the sound propagated into the water from a gun blast, and far less than the sound from the gun muzzle itself, the transmission of sound from a gun blast through the ship's hull would have no effect on species listed under the ESA. In accordance with NEPA there would be no significant impact to marine mammals from sound transmitted through a ship hull during training exercises within territorial waters. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from sound transmitted through a ship hull during training exercises in non-territorial waters. Furthermore, performing visual clearance of the range prior to conducting training exercises further reduce the likelihood of practice ordnance hitting marine mammals.

High Explosive Ordnance (Underwater Detonations and Explosive Ordnance)

Tables 2-9 and 2-10 summarize the number of events per year and specific areas where each occurs for each type of ordnance used for the No Action Alternative. Training at the Indian Island, Crescent Harbor, and Floral Point Underwater EOD Ranges will total 60 annual high-explosive detonations of charges ranging in size from less than 2.5-lb (1 kg) NEW to 20-lb (9 kg) NEW charges. In addition to these underwater charges, a total of 20 high-explosive bombs (MK-82, MK-83 and MK-84 types) will be detonated in the water annually.

The modeled explosive exposure harassment numbers by species (as derived using the methods described in Section 3.9.2.1) are presented in Table 3.9-6. The table indicates the potential for non-injurious (Level B) harassment, as well as the onset of injury (Level A) harassment to cetaceans. Behavioral effects modeling for underwater detonations indicate 170 annual exposures for the No Action Alternative that exceed the EFD threshold and potentially result in behavioral harassment. The modeling indicates 116 annual exposures under the No Action Alternative from underwater detonations that could result in TTS (Level B Harassment). The modeling indicates 11 annual exposures under the No Action Alternative to pressures from underwater detonations that could cause slight injury (Level A harassment) and one annual exposure under the No Action Alternative that could cause severe injury. These exposure modeling results are estimates of marine mammal underwater detonation sound exposures without consideration of standard mitigation and monitoring procedures. The implementation of the mitigation procedures presented in Chapter 5 will reduce the potential for marine mammal exposure and harassment through range clearance procedures.

Table 3.9-6: No Action Alternative Annual Underwater Detonation Exposures Summary

Species	Level B Exposure		Level A Exposure	
	Behavioral Effect	TTS 182 dB / 23 psi	50% TM Rupture 205 dB Slight Lung Injury or 23 psi-ms	Onset massive Lung Injury or Mortality 31 psi-ms
ESA Species				
Blue whale	0	0	0	0
Fin whale	6	3	1	0
Humpback whale	0	0	0	0
Sei whale	0	0	0	0
Sperm whale	7	4	1	0
Killer whale	0	0	0	0
Steller sea lion	2	1	0	0
Non-ESA Listed Species				
Gray whale	0	0	0	0
Minke whale	0	0	0	0
Baird's beaked whale	1	0	0	0
Bottlenose dolphin	0	0	0	0
Cuvier's beaked whale	1	0	0	0
Dall's porpoise	34	31	2	0
Harbor porpoise	8	5	1	0
Mesoplodont (other)	0	0	0	0
Northern right whale dolphin	6	3	0	0
Pacific white-sided dolphin	3	1	0	0
Pygmy or Dwarf sperm whale	0	0	0	0
Risso's Dolphin	5	2	0	0
Short-beaked common dolphin	24	11	1	0
Short-finned pilot whale	0	0	0	0
Striped dolphin	0	0	0	0
California sea lion	2	0	0	0
Harbor seal	29	16	3	1
Northern elephant seal	30	15	1	0
Northern fur seal	13	24	1	0
Total	**170**	**116**	**11**	**1**

Active Sonar

Naval exercises that use active and passive sonar include Antisubmarine Warfare (ASW) Tracking Exercise – Maritime Patrol Aircraft, Extended Echo Ranging (EER) ASW, Surface Ships ASW, Submarine ASW TRACKEX, Portable Undersea Tracking Range (PUTR); and Intelligence, Surveillance, and Reconnaissance (ISR) activities. Table 3.9-7 summarizes the type of exercise and number of events per year for each type of sonar used. Exposure to mid-frequency active sonar that is below or high-frequency active sonar that is above the functional hearing capability of marine mammal species may not elicit a behavioral response because the respective frequencies may be outside the functional hearing range of the animal. If the animal does react to sound outside their functional hearing range, their response may be less severe when compared to their response to a sound that is within their functional hearing range. Because risk function methods do not necessarily exclude sonar frequencies that are outside a species functional hearing range, marine mammal behavioral exposures in Table 3.9-8 may be an overestimate for some species.

Table 3.9-7: Number of Passive and Active Sonar Events in the NWTRC

Warfare Area	System	Number or Duration of Events per Year		
		No Action	Alternative 1	Alternative 2
Antisubmarine Warfare Tracking Exercise – Maritime Patrol Aircraft	SSQ-62 DICASS MFA Sonobuoy	844	865	886
Antisubmarine Warfare Tracking Exercise - Surface Ships	53C Surface Ship MFA Sonar	36 hours	39 hours	43 hours
	56 Surface Ship MFA Sonar	54 hours	58.5 hours	65 hours
Antisubmarine Warfare Tracking Exercise - Portable Undersea Tracking Range (PUTR)	MK-84 Ranging Pingers HFA Sonar	0 hours	0 hours	180 hours
	Uplink Transmissions MFA and HFA Sonar	0 hours	0 hours	150 hours
Mine Countermeasures Exercise	AN/BQS-15 HFA Sonar	0 hours	0 hours	42 hours
Antisurface Warfare - Sinking Exercise	MK-48 Torpedo HFA Sonar	1 torpedo run	2 torpedo runs	2 torpedo runs

Potential effects to marine mammals from mid-frequency active sonar (as derived using the methods described in Section 3.9.2.1) are presented in Table 3.9-8. Behavioral effects modeling for mid-frequency active sonar using the dose function methodology indicates 108,807 annual exposures for the No Action Alternative that exceed the SPL dose response curve and potentially result in behavioral harassment. The modeling also indicates 443 annual exposures that exceed the TTS threshold. The number of exposures that exceed the PTS threshold and result in Level A harassment from sonar is one harbor seal for the No Action Alternative.

Underwater detonation exposures with the No Action Alternative may affect the fin whale, sperm whale, and Steller sea lion. Underwater detonation exposures would have no effect to the blue whale, humpback whale, sei whale, and southern resident killer whale. Exposure effects to the sea otter and North Pacific right whale were not modeled because density data were unavailable for these species.

Level B sonar exposures with the No Action Alternative may affect the fin whale, sperm whale, Steller sea lion, blue whale, humpback whale, sei whale, and southern resident killer whale. Exposure effects to the sea otter and North Pacific right whale were not modeled because density data were unavailable for these species.

Table 3.9-8: No Action Alternative Annual Sonar Exposures Summary

Species	Level B Sonar Exposure		Level A Sonar Exposure
	Risk Function	TTS	PTS
ESA Species			
Blue whale	15	0	0
Fin whale	102	1	0
Humpback whale	11	0	0
Sei whale	1	0	0
Sperm whale	84	2	0
Killer whale	11	0	0
Steller sea lion	96	0	0
Non-ESA Listed Species			
Gray whale	4	0	0
Minke whale	7	0	0
Baird's beaked whale	9	0	0
Bottlenose dolphin	0	0	0
Cuvier's beaked whale	10	0	0
Dall's porpoise	3,747	123	0
Harbor porpoise	100,836	38	0
Mesoplodont (other)	11	0	0
Northern right whale dolphin	585	15	0
Pacific white-sided dolphin	436	19	0
Pygmy or Dwarf sperm whale	3	0	0
Risso's Dolphin	73	2	0
Short-beaked common dolphin	954	35	0
Short-finned pilot whale	2	0	0
Striped dolphin	31	1	0
California sea lion	238	0	0
Harbor seal	218	206	1
Northern elephant seal	243	0	0
Northern fur seal	1,080	1	0
Total	**108,807**	**443**	**1**

It should be noted, however, that these exposure modeling results are statistically derived estimates of potential marine mammal sonar exposures without consideration of standard mitigation and monitoring procedures. The caveats to interpretations of model results are explained previously. It is highly unlikely that a marine mammal would experience any long-term effects because the large NWTRC training areas makes individual mammals' repeated or prolonged exposures to high-level sonar signals unlikely. Specifically, mid-frequency active sonars have limited marine mammal exposure ranges and relatively high platform speeds. There is only one exposure that exceeds the PTS threshold and results in Level A harassment from sonar (Pacific harbor seal). Therefore, long term effects on individuals, populations or stocks are unlikely.

When analyzing the results of the acoustic exposure modeling to provide an estimate of effects, it is important to understand that there are limitations to the ecological data (diving behavior, migration or movement patterns and population dynamics) used in the model, and that the model results must be interpreted within the context of a given species' ecology.

As described previously, this analysis assumes that short-term non-injurious sound exposure levels predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment. Because of the time delay between pings, and platform speed, an animal encountering the sonar will accumulate energy for only a few sonar pings over the course of a few minutes. Therefore, exposure to sonar would be a short-term event, minimizing any single animal's exposure to sound levels approaching the harassment thresholds.

The implementation of the mitigation and monitoring procedures as addressed in Chapter 5 will further minimize the potential for marine mammal exposures to underwater detonations. When reviewing the acoustic exposure modeling results, it is also important to understand that the estimates of marine mammal sound exposures are presented without consideration of standard protective measure operating procedures. Chapter 5 presents details of the mitigation measures currently used for ASW activities including detection of marine mammals and power down procedures if marine mammals are detected within one of the safety zones. The Navy will work through the MMPA incidental harassment regulatory process to discuss the mitigation measures and their potential to reduce the likelihood for incidental harassment of marine mammals.

Expended Materials

Ordnance Related Materials

Ordnance related materials include various sizes of non-explosive training rounds and shrapnel from explosive rounds. These solid metal materials would quickly move through the water column and settle to the sea floor. These materials would become encrusted by natural processes and incorporated into the seafloor, with no significant accumulations in any particular area and no negative effects to water quality. However, benthic foraging marine mammals could be exposed to expended ordnance through ingestion. Ingestion of expended ordnance is not expected to occur in the water column because ordnance quickly sinks. Some materials such as an intact non-explosive training bomb would be too large to be ingested by a marine mammal, but many materials such as cannon shells, small caliber ammunition, and shrapnel could be ingested. Records indicate that generally metal debris ingested by marine mammals are small (*e.g.*, fishhooks, bottle caps, metal spring; Walker and Coe 1990). The effects of ingesting solid metal objects on marine mammals are unknown. Extensive literature searches reveal no studies related to potential toxic effects of ordnance ingestion by marine mammals. Ingestion of marine debris in general can cause digestive tract blockages or damage the digestive system (Stamper et. al. 2006; Gorzelany 1998). Relatively small objects with smooth edges such a cannon shell or small caliber ammunition might pass through the digestive tract without causing harm, while a piece of metal shrapnel with sharp edges would be more likely to cause damage.

The potential for ordnance ingestion depends on species-specific feeding habitats. Sea otters would not ingest ordnance because they feed in fairly shallow waters (about 328 ft [100 m]) and kelp beds along the coast where ordnance is not used. The Steller sea lion, and blue, fin, North Pacific right, southern resident killer, and sei whales feed at the surface or in the water column and would not ingest ordnance from the bottom. While humpback whales feed predominantly by lunging through the water after krill and fish, there have been instances of humpback whales disturbing the bottom in an attempt to flush prey, the northern sand lance (*Ammodytes dubius*) (Hain et al. 1995). Humpback whales are not expected to ingest ordnance because feeding in the OPAREA would be limited and they primarily feed in the water column.

Ordnance ingestion under the No Action Alternative would have no effect on the blue whale, fin whale, humpback whale, North Pacific right whale, or sei whale.

Although sperm whales feed predominantly on cephalopods, they also frequently feed on or near the bottom (Whitehead et al. 1992). In doing so, animals may ingest non-food items such as rocks and sand (NMFS 2006b). Sperm whales are known to incidentally ingest foreign objects while foraging (Walker and Coe 1990), suggesting that the potential exists to ingest debris that has settled on the ocean floor as a result of the proposed activities. Sperm whales display a strong offshore preference (Rice 1989) and are mostly associated with waters over the continental shelf edge, continental slope, and offshore waters (CETAP 1982; Hain et al. 1985; Smith et al. 1996; Waring et al. 2001; Davis et al. 2002). Consequently, the likelihood that a sperm whale would encounter and subsequently ingest a piece of expended ordnance is extremely low. Ordnance ingestion under the No Action Alternative may affect sperm whales.

Most non-listed marine mammal species feed at the surface or in the water column and would have a little chance of encountering expended ordnance on the bottom. Baleen and toothed whales, harbor seals, and other pinnipeds, which feed at the surface or in the water column, would not be expected to ingest ordnance from the bottom. Beaked whales have exhibited bottom feeding behavior using suction feeding techniques (MacLeod et al. 2003) and are known to incidentally ingest foreign objects while foraging (Walker and Coe 1990). Although the potential exists for ingestion of expended ordnance, the amount of ordnance that an animal would encounter is low. Ordnance related materials are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, ordnance related materials would have no significant impact on marine mammals in territorial waters. Furthermore, ordnance related materials would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

Target Related Materials

A variety of at-sea targets are used ranging from high-technology, remotely operated airborne and surface targets (such as, airborne drones and Seaborne Powered Targets) to low-technology floating at-sea targets (such as, inflatable targets) and towed banners. Many of the targets are designed to be recovered for reuse and are not destroyed during training. The expendable targets used in the Study Area are the Expendable Mobile Antisubmarine Warfare Training Target (EMATT) and MK-58 Marine Marker. These units are 2 to 3 ft in length, respectively, and sink to the bottom intact. Because of these characteristics, they present no ingestion hazard to marine mammals.

As discussed above for ordnance-related materials, species that feed on or near the bottom (which are the sperm whales and beaked whales) may encounter an expended target while feeding; however, the size of the target would prohibit any listed species from ingesting it. Therefore, the use of targets under the No Action Alternative would have no effect on listed marine mammals. Targets are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, targets would have no significant impact on marine mammals in territorial waters. Furthermore, targets would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

Marine Markers

The MK-58 marine marker produces chemical flames and regions of surface smoke and is used in various training exercises to mark a surface position to simulate divers, ships, and points of contact on the surface of the ocean. When the accompanying cartridge is broken, an area of smoke is released. The smoke dissipates in the air having little effect on the marine environment. The marker burns similar to a flare, producing a flame until all burn components have been used. While the light generated from the marker is bright enough to be seen up to 3 mi (5 km) away in ideal conditions, the resulting light would either be reflected off the water's surface or would enter the water and attenuate in brightness over depth. The point source of the light would be focused and be less intense than if an animal were to look to the surface and encounter the direct path of the sun. The MK-58 is composed of tin and contains two red phosphorus pyrotechnic candles and a seawater-activated battery. The MK-58 marine marker is 22 in (0.5 m) long and 5 in (0.1 m) in diameter, weighs 13 pounds (6 kg), and produces a yellow flame and white smoke for a minimum of 40 minutes and a maximum of 60 minutes (The Ordnance Shop 2007). The marker itself is not designed to be recovered and would eventually sink to the bottom and become encrusted and/or incorporated into the sediments. Approximately 296 marine markers would be used in the Study Area per year under the No Action Alternative.

It is unlikely that marine mammals would be exposed to any chemicals that produce either flames or smoke because these components are consumed in their entirety during the burning process. Animals are unlikely to approach and/or get close enough to the flame to be exposed to any chemical components.

Expended marine markers are a potential ingestion hazard for marine mammals while they are floating or after they sink to the bottom. However, the probability of ingestion is extremely low based on the low number of marine markers expended per year (296) versus the large operational area of the NWTRC. Marine marker ingestion under the No Action Alternative may affect ESA-listed marine mammals. The use of marine markers is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, there would be no significant impact to marine mammals from marine marker use during training exercises within territorial waters. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of marine markers during training exercises in non-territorial waters.

Sonobuoys

Five types of sonobuoys would be used under this alternative. Sonobuoys are deployed by either surface vessels or aircraft to either passively detect sounds created by submarines and/or surface vessels or to actively detect submerged or surface vessels by generating their own sonar signals. Sonobuoys are temporary devices that are activated once they contact ocean water. When their operating service life is attained, the sonobuoy shuts down and sinks to the ocean bottom to decompose. Under the No Action Alternative, approximately 9,132 sonobuoys would be deployed in the Study Area. Approximately 80 percent of the sonobuoys would be passive SSQ-53 DIFAR. About nine percent of all sonobuoys would employ active sonar emissions.

Aircraft-launched sonobuoys and flares (as well as torpedoes and EMATTs) deploy nylon parachutes of various sizes. At water impact, the parachute assembly is expended and sinks, as all of the material is negatively buoyant. Metallic components are heavy and will sink rapidly. Parachute and cord are lighter and sink more slowly. While these materials are suspended in the water column, they represent a potential entanglement risk to passing marine mammals in the area. An estimated 9,132 sonobuoys will be expended primarily in W-237 off the coast of Washington under the No Action Alternative (see Table 3.6-1). This excludes explosive ordnance training in the Puget Sound. Based on the W-237 size of 25,331 nm^2 and assuming an even distribution of activities, this amounts to 0.3 sonobuoy parachute assemblies per square nautical mile per year. Given this number of sonobuoys and flares deployed, the large size of the training areas, and the relatively low density of marine mammals in the area, the risk of a marine mammal encounter with sonobuoy and flare parachute assemblies, and other expended debris is unlikely. Entanglement and the eventual drowning of a marine mammal in a parachute assembly would be unlikely, since such an event would require the parachute to land directly on an animal, or the animal would have to swim into it before it sinks. The expended material will accumulate on the ocean floor and will be covered by sediments over time, remaining on the ocean floor and reducing the potential for entanglement. If bottom currents are present, the canopy may billow (bulge) and pose an entanglement threat to marine animals with bottom-feeding habits; however, the probability of a marine mammal encountering a submerged parachute assembly and the potential for accidental entanglement in the canopy or suspension lines is considered to be unlikely.

Expended sonobuoys are a potential ingestion hazard for marine mammals while they are floating, while they are descending to the seafloor, or after they sink to the bottom. However, the probability of ingestion is extremely low based on the number of passive sonobuoys expended per year (8,288), the low concentration (0.06/nm^2/year) compared to the size of the OPAREA, and their deployment at different times. Sonobuoy ingestion under the No Action Alternative may affect ESA-listed marine mammals. The use of passive sonobuoys is not expected to result in Level A or Level B harassment as defined by the MMPA. Effects of active sonobuoys are addressed above as part of the sonar analysis. In accordance with NEPA, there would be minimal impact to marine mammals from passive sonobuoy use during training exercises within territorial waters. In accordance with EO 12114, harm to marine mammals resulting from use of passive sonobuoys during training exercises in non-territorial waters would also be minimal.

Critical Habitats

Critical habitats are designated for both the southern resident killer whale and the Steller sea lion and both critical habitats occur within the Study Area. Department of Defense facilities within the Puget Sound and Strait of Juan de Fuca areas that occur within the overall boundaries of the critical habitat for the southern resident killer whale are excluded from critical habitat designation. Critical habitat for the Steller sea lion includes four rookeries that are located offshore of the California and Oregon coasts as was described previously.

Provisions of the ESA require a determination of whether proposed federal actions may destroy or adversely modify critical habitat. Critical habitat designation is based on the presence and condition of certain physical and biological habitat factors called primary constituent elements (PCEs) that are considered essential for the conservation of the listed species (USFWS and NMFS 1998; ESA §3[5][A][i]; 50 CFR §424.12[b]).

The PCEs for the southern resident killer whale critical habitat (NMFS 2006e) are as follows:

(1) Water quality to support growth and development;

(2) Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and

(3) Passage conditions to allow for migration, resting, and foraging.

Based on these PCEs and anticipated Navy activities in the critical habitat for the southern resident killer whale, none of the training and testing activities are expected to substantially change water quality conditions sufficiently to degrade existing water quality conditions (see section 3.4 Water Resources); decrease or substantially alter prey species abundance sufficiently to adversely affect southern resident killer whale individuals or populations (see section 3.7 Fish); or create barriers that would prevent or impede southern resident killer whale passage through the critical habitat. Therefore, in accordance with ESA consultation provisions to assess potential effects of proposed actions to critical habitat, it is concluded that Navy activities will not destroy or adversely modify critical habitat for the southern resident killer whale.

Steller sea lion PCEs are not specifically addressed by the Federal Register critical habitat announcement (NMFS 1993b) because the announcement pre-dated the current convention of describing the PCEs. However, critical habitat is defined for the California and Oregon Steller sea lion rookeries and associated air and aquatic zones as follows:

(1) Critical habitat includes an air zone that extends 3,000 ft (1 km) above areas historically occupied by sea lions at each major rookery in California and Oregon, measured vertically from sea level and

(2) Critical habitat includes an aquatic zone that extends 3,000 ft (1 km) seaward in State and Federally managed waters from the baseline or basepoint of each major rookery in California and Oregon.

Although the critical habitat locations are within the OPAREA, the rookeries are outside areas normally associated with Navy training and testing activities. In addition, the Navy has standard operating procedures that result in activities remaining outside the critical habitat zone around each rookery (FACSFAC SD Inst 3120.E, NAS Whidbey Inst 3770.1C). Therefore, there is very little likelihood that Navy sea and air activities will adversely affect the breeding rookeries for the Steller sea lion. Therefore, in accordance with ESA consultation provisions to assess potential effects of proposed actions to critical habitat, it is concluded that Navy activities will not destroy or adversely modify critical habitat for the Steller sea lion.

3.9.2.4 Alternative 1

Vessel Movements

The number of vessel operation hours per year involving vessel movements would increase by a total of about 4 percent compared to the No Action Alternative. This increase would include both training and transit activities for Alternative 1. These changes would result in increased potential for short-term behavioral reactions to naval vessels. Potential for collision would increase slightly compared to the No Action Alternative; however, Navy mitigation measures would reduce the probability. Vessel movements under Alternative 1 may affect ESA-listed marine mammals. Vessel movements are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, vessel movements would have no notable impact on marine mammals in territorial waters. Furthermore, vessel movements would cause minimal harm to marine mammals in non-territorial waters in accordance with EO 12114.

Aircraft Overflights

Alternative 1 would include a 20 percent increase in fixed-wing aircraft sorties per year and a 14 percent increase in helicopter sorties per year in the Study Area. As a result, the potential for marine mammals to be exposed to overflights would increase compared to baseline conditions. The magnitude of individual exposures could increase because Alternative 1 includes use of EA-18G aircraft. Some EA-18G training would involve supersonic flight, resulting in sonic booms, but such airspeeds are infrequent and occur above 30,000 ft (9,144 m) at least 30 nm (56 km) offshore, further reducing their potential for noise impacts. Peak noise levels generated by the SH-60 helicopters would be similar to the noise levels generated with the no action alternative.

The additional overflights may result in increased instances of behavioral disturbance due to sound, shadow-effects, and/or, in the case of helicopters, water column disturbance. Similar to the No Action Alternative, the responses would be limited to short-term behavioral or physiological reactions. Aircraft overflights under Alternative 1 may affect ESA-listed marine mammals. Aircraft overflights are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, aircraft overflights would have minimal impacts on marine mammals in territorial waters. Furthermore, aircraft overflights would not cause notable harm to marine mammals in non-territorial waters in accordance with EO 12114.

Non-Explosive Practice Ordnance

The number of non-explosive practice ordnance events by type of projectile occurring for Alternative 1 is presented in Table 2-10. Non-explosive practice ordnance includes naval gun shells (20-mm, 25-mm, 57-mm, 76-mm, and 5-in projectiles) and small arms rounds (7.62-mm and .50-caliber projectiles). Annually, there would be about 29,350 naval gun shell and about 66,360 small arms projectiles expended into the ocean with this alternative. Compared to the No Action Alternative, there would be increases of about 13 percent and 11 percent respectively, in naval gun shells and small arms projectiles. Although use may be concentrated in W-237, ordnance is used in all areas of the NWTRC beyond 3 nm (6 km). The density of annual ordnance use would be approximately 0.8 items per nm^2 (3.4 km^2) over the 122,241 nm^2 (419,287 km^2) range. Given the relatively small sizes of whales, sea lions, and other marine mammals and the non-explosive ordnance used, the potential for marine mammals to be struck by ordnance is low.

These changes would result in increased potential exposure of marine mammals to ordnance strikes; however, Navy standard operating procedures and mitigation measures would reduce the probability of strikes by modifying activities when marine mammals are known to be in the area. There would be no effect from use of non-explosive practice ordnance on ESA-listed marine mammals under Alternative 1. Non-explosive ordnance use is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, non-explosive practice ordnance would have no significant impact on marine mammals in territorial waters. Furthermore, non-explosive practice ordnance would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

High Explosive Ordnance (Underwater Detonations and Explosive Ordnance)

Tables 2-9 and 2-10 summarize the number of events per year and specific areas where each occurs for each type of ordnance used for Alternative 1. Training at the Indian Island, Crescent Harbor, and Floral Point Underwater EOD Ranges will total four annual high-explosive detonations of charges ranging in size from less than 2.5-lb (1 kg) NEW to 20-lb (9 kg) NEW charges (<2.5 lb [<1 kg] NEW, 2.5 lb [1 kg]NEW, 5 lb [2 kg] NEW, and 20 lb [9 kg] NEW). In addition, a total of 34 high-explosive bombs (MK-82, MK-83 and MK-84 types) will be detonated in the water annually. Detonation of this ordnance represents a 93 percent decrease of EOD underwater detonations and an increase of 70 percent for bomb detonations compared to the No Action Alternative. These changes would represent both increased and decreased potential for marine mammals exposure to detonation concussion effects, depending on the detonation location. Overall, there would be a 52 percent decrease in the total number of high-explosive detonations annually in the Study Area compared to the No Action Alternative.

The modeled explosive exposure harassment numbers by species are presented in Table 3.9-9. The table indicates the potential for non-injurious (Level B) harassment, as well as the onset of injury (Level A) harassment to cetaceans. Behavioral effects modeling for underwater detonations indicate 217 annual exposures for Alternative 1 that exceed the EFD threshold and potentially result in behavioral harassment. The modeling indicates 144 annual exposures under Alternative 1 from underwater detonations that could result in TTS (Level B Harassment). The modeling indicates 14 annual exposures under the Alternative 1 to pressures from underwater detonations that could cause slight injury (Level A harassment) and no annual exposures under the Alternative 1 that could cause severe injury. These exposure modeling results are estimates of marine mammal underwater detonation sound exposures without consideration of standard operating procedures and mitigation procedures. The implementation of the mitigation presented in Chapter 5 will reduce the potential for marine mammal exposure and harassment through range clearance procedures.

Active Sonar

Under Alternative 1 sonar use would increase for all sources, including 53C (three additional hours of usage compared to No Action Alternative) and 56 surface ship sonar (4.5 additional hours of usage compared to the No Action Alternative), 21 additional SSQ-62 sonobuoys would be deployed, and one additional torpedo run (Table 3.9-7). Behavioral effects modeling for mid-frequency active sonar using the dose function methodology indicates 117,354 annual exposures for Alternative 1 that exceeds the SPL dose response curve and potentially results in behavioral harassment (Table 3.9-10). The modeling also indicates 480 annual exposures that exceed the TTS threshold. The number of exposures that exceed the PTS threshold and result in Level A harassment from sonar is one for Alternative 1.

Exposure to mid-frequency active sonar that is below or high-frequency active sonar that is above the functional hearing capability of marine mammal species may not elicit a behavioral response because the respective frequencies may be outside the functional hearing range of the animal. If the animal does react to sound outside their functional hearing range, their response may be less severe when compared to their response to a sound that is within their functional hearing range. Because risk function methods do not necessarily exclude sonar frequencies that are outside a species functional hearing range, marine mammal behavioral exposures in Table 3.9-10 may be an overestimate for some species.

Table 3.9-9: Alternative 1 Annual Underwater Detonation Exposures Summary

Species	Level B Exposure		Level A Exposure	
	Behavioral Effect	TTS 182 dB / 23 psi	50% TM Rupture 205 dB Slight Lung Injury or 23 psi-ms	Onset massive Lung Injury or Mortality 31 psi-ms
ESA Species				
Blue whale	1	0	1	0
Fin whale	10	5	1	0
Humpback whale	0	0	0	0
Sei whale	0	0	0	0
Sperm whale	12	8	1	0
Killer whale	0	0	0	0
Steller sea lion	2	2	1	0
Non-ESA Listed Species				
Gray whale	0	0	0	0
Minke whale	0	0	0	0
Baird’s beaked whale	1	0	0	0
Bottlenose dolphin	0	0	0	0
Cuvier’s beaked whale	1	1	0	0
Dall’s porpoise	50	41	3	0
Harbor porpoise	9	5	1	0
Mesoplodont (other)	1	0	0	0
Northern right whale dolphin	8	5	1	0
Pacific white-sided dolphin	5	2	0	0
Pygmy or Dwarf sperm whale	1	0	0	0
Risso’s Dolphin	8	3	0	0
Short-beaked common dolphin	34	16	2	0
Short-finned pilot whale	0	0	0	0
Striped dolphin	0	0	0	0
California sea lion	2	0	0	0
Harbor seal	6	2	0	0
Northern elephant seal	47	24	2	0
Northern fur seal	19	30	1	0
Total	**217**	**144**	**14**	**0**

These exposure modeling results are estimates of marine mammal exposures without consideration of standard mitigation procedures. The implementation of the mitigation procedures presented in Chapter 5 will reduce the potential for marine mammal exposure and harassment through range clearance procedures.

Underwater detonation exposures with Alternative 1 may affect the blue whale, fin whale, sperm whale, and Steller sea lion. Underwater detonation exposures would have no effect to the humpback whale, sei whale, and southern resident killer whale. Exposure effects to the sea otter and North Pacific right whale were not modeled because density data were unavailable for these species.

Table 3.9-10: Alternative 1 Annual Sonar Exposures Summary

Species	Level B Sonar Exposure		Level A Sonar Exposure
	Risk Function	TTS	PTS
ESA Species			
Blue whale	16	0	0
Fin whale	111	2	0
Humpback whale	12	0	0
Sei whale	1	0	0
Sperm whale	91	2	0
Killer whale	12	0	0
Steller sea lion	103	0	0
Non-ESA Listed Species			
Gray whale	4	0	0
Minke whale	8	0	0
Baird’s beaked whale	10	0	0
Bottlenose dolphin	0	0	0
Cuvier’s beaked whale	11	0	0
Dall’s porpoise	4,051	133	0
Harbor porpoise	108,737	41	0
Mesoplodont (other)	12	0	0
Northern right whale dolphin	634	16	0
Pacific white-sided dolphin	473	21	0
Pygmy or Dwarf sperm whale	3	0	0
Risso’s Dolphin	78	2	0
Short-beaked common dolphin	1,034	38	0
Short-finned pilot whale	2	0	0
Striped dolphin	33	1	0
California sea lion	256	0	0
Harbor seal	235	223	1
Northern elephant seal	262	0	0
Northern fur seal	1,165	1	0
Total	**117,354**	**480**	**1**

Level B sonar exposures with Alternative 1 may affect the fin whale, sperm whale, Steller sea lion, blue whale, humpback whale, sei whale, and southern resident killer whale. Exposure effects to the sea otter and North Pacific right whale were not modeled because density data were unavailable for these species.

Expended Materials

Ordnance Related Materials

The number of activities that would include firing ordnance would increase in the Study Area under Alternative 1 (Table 2-10) and the number or rounds fired would increase by approximately 16 percent. Similar to the No Action Alternative, only sperm whales would potentially be exposed to expended ordnance via ingestion from the bottom. Based on sperm whale habitat preferences and known feeding behaviors discussed above, it is extremely unlikely that they would encounter and ingest expended ordnance. Ingestion of ordnance under Alternative 1 may affect the sperm whale. Ordnance ingestion under Alternative 1 would have no effect on the sea otter, Steller sea lion, southern resident killer whale, blue whale, fin whale, humpback whale, North Pacific right whale, or sei whale based on the feeding habits of these species. Ordnance related materials would not be expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, ordnance related materials would have no significant impact on marine mammals in territorial waters. Furthermore, ordnance related materials would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

Target Related Materials

The number of targets used in the Study Area would increase by about 15 percent under Alternative 1. As discussed above for the No Action Alternative, species that feed on or near the bottom (which are the sperm whales and beaked whales) may encounter an expended target while feeding; however, the size of the target would prohibit any listed species from ingesting it. Therefore, the use of targets under Alternative 1 would have no effect on listed marine mammals. Targets would not be expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, targets would have no significant impact on marine mammals in territorial waters. Furthermore, targets would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

Marine Markers

The number of marine markers used in the Study Area would increase under Alternative 1 from 296 to 305 per year. The probability of a marine mammal ingesting an expended marine marker would be essentially the same as under the No Action Alternative. Marine marker ingestion under Alternative 1 may affect ESA-listed marine mammals. The use of marine markers is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, there would be no significant impact to marine mammals from marine marker use during training exercises within territorial waters. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of marine markers during training exercises in non-territorial waters.

Sonobuoys

The number of passive and active sonobuoys would increase under Alternative 1. Approximately 9,423 sonobuoys would be deployed in the Study Area annually, which is an increase of about 3 percent compared to the No Action Alternative. The same relative proportion of passive to active sonobuoys would be used. Approximately 80 percent of the sonobuoys would be passive SSQ-53 directional frequency and ranging (DIFAR). About nine percent of all sonobuoys would employ active sonar emissions (SSQ-62 DICASS Active).

With regard to potential entanglement encounters between marine mammals and unrecovered sonobuoy and flare parachute assemblies expended during military activities, the effects for Alternative 1 would be essentially the same as those described for the No Action Alternative. Materials that are not recovered would sink; the amount that might remain on or near the sea surface would be low, and the density of such debris in the primary sonobuoy deployment area (W-271) would be a very low concentration (0.4 sonobuoy parachute assemblies per square nautical mile) with Alternative 1. Entanglement impacts to marine mammals from this and other expended debris are unlikely.

Expended sonobuoys are a potential ingestion hazard for marine mammals while they are floating, while they are descending to the seafloor, or after they sink to the bottom. However, the probability of ingestion is extremely low based on the low number of passive sonobuoys expended per year (8,558) and the low concentration (0.07/nm^2/year). Sonobuoy ingestion under Alternative 1 may affect ESA-listed marine mammals. The use of passive sonobuoys is not expected to result in Level A or Level B harassment as defined by the MMPA. Effects of active sonobuoys are addressed as part of the sonar analysis. In accordance with NEPA, there would be no significant impact to marine mammals from passive sonobuoy use during training exercises within territorial waters. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of passive sonobuoys during training exercises in non-territorial waters.

Critical Habitats

For the same reasons that were described for the No Action Alternative, it is expected that Alternative 1 will not destroy or adversely modify critical habitats for either the southern resident killer whale or the Steller sea lion. Although Alternative 1 will increase the number of activities, the locations of the activities will not change compared to No Action nor will the additional number of training and testing activities be large enough to affect or cause a noticeable change in the PCEs. Therefore, in accordance with ESA consultation provisions to assess potential effects of proposed actions to critical habitat, it is concluded that Navy activities of Alternative 1 will not destroy or adversely modify critical habitat for either the southern resident killer whale or the Steller sea lion.

3.9.2.5 Alternative 2

Vessel Movements

The number of vessel operation hours per year involving vessel movements would increase by a total of about 10 percent. This increase would include both training and transit activities for Alternative 2. These changes would result in increased potential for short-term behavioral reactions to naval vessels. Potential for collision would increase slightly compared to the No Action Alternative; however, Navy mitigation measures would reduce the probability. Vessel movements under Alternative 2 may affect ESA-listed marine mammals. Vessel movements are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, vessel movements would have no significant impact on marine mammals in territorial waters. Furthermore, vessel movements would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

Aircraft Overflights

Alternative 2 would include a 55 percent increase in fixed-wing aircraft sorties per year and a 14 percent increase in helicopter sorties per year in the Study Area compared to the No Action Alternative (existing conditions). The number of helicopter sorties per year for Alternative 2 would be the same as Alternative 1 and would occur in the same locations. As a result, the potential for marine mammals to be exposed to overflights would increase compared to baseline conditions. The magnitude of individual exposures could increase because Alternative 2 includes use of the EA-18G aircraft. Some EA-18G training would involve supersonic flight, resulting in sonic booms, but such airspeeds are infrequent and occur above 30,000 ft (9,144 meters) and at least 30 nm (56 km) offshore, further reducing their potential for noise impacts. Peak noise levels generated by the SH-60 helicopters would be similar to the noise levels generated with the no action alternative.

The additional overflights may result in increased instances of behavioral disturbance due to sound, shadow-effects, and/or, in the case of helicopters, water column disturbance. Similar to the No Action Alternative, the responses would be limited to short-term behavioral or physiological reactions. Aircraft overflights under Alternative 2 may affect ESA-listed marine mammals. Aircraft overflights are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, aircraft overflights would have no significant impact on marine mammals in territorial waters. Furthermore, aircraft overflights would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

Non-Explosive Practice Ordnance

The total number of non-explosive practice projectiles would increase with Alternative 2. The number of non-explosive practice ordnance events by type of projectile occurring for Alternative 2 is presented in Table 2-10. Non-explosive practice ordnance includes naval gun shells (20-mm, 25-mm, 57-mm, 76-mm, and 5-in projectiles) and small arms rounds (7.62-mm and .50-caliber projectiles). Annually, there would be about 53,340 naval gun shell and about 119,720 small arms projectiles expended into the ocean with this alternative. Compared to the No Action Alternative, there would be increases of about 106 percent and 100 percent respectively, in naval gun shells and small arms projectiles. Although use may be concentrated in W-237, ordnance is used in all areas of the NWTRC beyond 3 nm (6 km). The density of annual ordnance use would be approximately 1.5 items per nm^2 (3.4 km^2) over the 122,241 nm^2 (419,287 km^2) range. Given the relatively small sizes of whales, sea lions, and other marine mammals and the non-explosive ordnance used, the potential for marine mammals to be struck by ordnance is low.

These changes would result in increased potential exposure of marine mammals to non-explosive practice ordnance strikes; however, Navy standard operating procedures and mitigation measures would reduce the probability of strikes by modifying training activities when marine mammals are known to be in the area. There would be no effect from use of non-explosive practice ordnance on ESA-listed marine mammals under Alternative 2. Non-explosive ordnance use is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, non-explosive practice ordnance would have no significant impact on marine mammals in territorial waters. Furthermore, non-explosive practice ordnance would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

High Explosive Ordnance (Underwater Detonations and Explosive Ordnance)

There is no difference in the number or type of high-explosive ordnance detonations between Alternatives 1 and 2. Tables 2-9 and 2-10 summarize the number of events per year and specific areas where each occurs for each type of ordnance used for Alternative 2. Training at the Indian Island, Crescent Harbor, and Floral Point Underwater EOD Ranges will total four annual high-explosive detonations of charges ranging in size from less than 2.5-lb (1 kg) NEW to 20-lb (9 kg) NEW charges (<2.5 lb [<21 kg] NEW, 2.5 lb [1 kg] NEW, 5 lb [2 kg] NEW, and 20 lb [9 kg] NEW). In addition, a total of 34 high-explosive bombs (MK-82, MK-83 and MK-84 types) will be detonated in the water annually. Detonation of this ordnance represents a 93 percent decrease of EOD underwater detonations and an increase of 70 percent for bomb detonations compared to the No Action Alternative. These changes would represent both increased and decreased potential for marine mammals exposure to detonation concussion effects, depending on the detonation location. Overall, there would be a 52 percent decrease in the total number of high-explosive detonations annually in the Study Area compared to the No Action Alternative.

The modeled explosive exposure harassment numbers by species are presented in Table 3.9-11. The table indicates the potential for non-injurious (Level B) harassment, as well as the onset of injury (Level A) harassment to cetaceans. Behavioral effects modeling for underwater detonations indicate 262 annual exposures for Alternative 2 that exceed the EFD threshold and potentially result in behavioral harassment. The modeling indicates 199 annual exposures under Alternative 2 from underwater detonations that could result in TTS (Level B Harassment). The modeling indicates 14 annual exposures under Alternative 2 to pressures from underwater detonations that could cause slight injury (Level A harassment) and one annual exposure under Alternative 2 that could cause severe injury. These exposure modeling results are estimates of marine mammal underwater detonation sound exposures without consideration of standard mitigation procedures. The implementation of the mitigation procedures presented in Chapter 5 will reduce the potential for marine mammal exposure and harassment through range clearance procedures.

Active Sonar

Under Alternative 2 sonar use would increase for all sources, including 53C (seven additional hours of usage compared to No Action Alternative) and 56 surface ship sonar (11 additional hours of usage), SSQ-62 sonobuoys (increase of 42 sonobuoys compared to the No Action Alternative) and one additional torpedo run (Table 3.9-7). Behavioral effects modeling for mid-frequency active sonar using the dose function methodology indicates 128,583 annual exposures for Alternative 2 that exceeds the SPL dose response curve and potentially results in behavioral harassment (Table 3.9-12). The modeling also indicates 528 annual exposures that exceed the TTS threshold. The number of exposures that exceed the PTS threshold and result in Level A harassment from sonar is one for Alternative 2.

Exposure to mid-frequency active sonar that is below or high-frequency active sonar that is above the functional hearing capability of marine mammal species may not elicit a behavioral response because the respective frequencies may be outside the functional hearing range of the animal. If the animal does react to sound outside their functional hearing range, their response may be less severe when compared to their response to a sound that is within their functional hearing range. Because risk function methods do not necessarily exclude sonar frequencies that are outside a species functional hearing range, marine mammal behavioral exposures in Table 3.9-12 may be an overestimate for some species.

These exposure modeling results are estimates of marine mammal exposures without consideration of standard mitigation and monitoring procedures. The implementation of the mitigation and monitoring procedures presented in Chapter 5 will reduce the potential for marine mammal exposure and harassment through range clearance procedures.

Underwater detonation exposures with Alternative 2 may affect the blue whale, fin whale, sperm whale, and Steller sea lion. Underwater detonation exposures would have no effect to the humpback whale, sei whale, and southern resident killer whale. Exposure effects to the sea otter and North Pacific right whale were not modeled because density data were unavailable for these species.

Level B sonar exposures with Alternative 2 may affect the fin whale, sperm whale, Steller sea lion, blue whale, humpback whale, sei whale, and southern resident killer whale. Exposure effects to the sea otter and North Pacific right whale were not modeled because density data were unavailable for these species.

Alternative 2 would introduce approximately 390 hours annually of additional, mostly new high-frequency active sonar emissions into the marine environment (Table 3.9-7). These emissions are associated with training activities conducted at the PUTR and the submarine mine countermeasures range. These facilities are not components of the No Action Alternative and Alternative 1. The high-frequency sonar and mid-frequency uplink emissions were not included in the sonar modeling so potential marine mammals exposures from these sources were not estimated. However, it is unlikely that effects to marine mammals from these sonar sources would be significant because of the limited sonar emission times, rapid attenuation rate of high-frequency sonar, limited area affected by these sonar sources, and the mitigation measures employed by the Navy to exclude marine mammal presence in the training areas.

Table 3.9-11: Alternative 2 Annual Underwater Detonation Exposures Summary

Species	Level B Exposure		Level A Exposure	
	Behavioral Effect	TTS 182 dB / 23 psi	50% TM Rupture 205 dB Slight Lung Injury or 23 psi-ms	Onset massive Lung Injury or Mortality 31 psi-ms
ESA Species				
Blue whale	1	1	1	0
Fin whale	12	7	1	1
Humpback whale	0	0	0	0
Sei whale	0	0	0	0
Sperm whale	13	10	1	0
Killer whale	0	0	0	0
Steller sea lion	3	3	1	0
Non-ESA Listed Species				
Gray whale	0	0	0	0
Minke whale	0	0	0	0
Baird’s beaked whale	1	0	0	0
Bottlenose dolphin	0	0	0	0
Cuvier’s beaked whale	1	1	0	0
Dall’s porpoise	62	58	3	0
Harbor porpoise	9	5	1	0
Mesoplodont (other)	1	0	0	0
Northern right whale dolphin	11	7	1	0
Pacific white-sided dolphin	8	3	0	0
Pygmy or Dwarf sperm whale	1	0	0	0
Risso’s Dolphin	9	4	0	0
Short-beaked common dolphin	49	23	2	0
Short-finned pilot whale	0	0	0	0
Striped dolphin	0	1	0	0
California sea lion	2	1	0	0
Harbor seal	2	2	0	0
Northern elephant seal	53	29	2	0
Northern fur seal	24	44	1	0
Total	**262**	**199**	**14**	**1**

Table 3.9-12: Alternative 2 Annual Sonar Exposures Summary

Species	Level B Sonar Exposure		Level A Sonar Exposure
	Risk Function	TTS	PTS
ESA Species			
Blue whale	17	0	0
Fin whale	122	2	0
Humpback whale	13	0	0
Sei whale	1	0	0
Sperm whale	101	2	0
Killer whale	13	0	0
Steller sea lion	113	0	0
Non-ESA Listed Species			
Gray whale	4	0	0
Minke whale	9	0	0
Baird's beaked whale	11	0	0
Bottlenose dolphin	0	0	0
Cuvier's beaked whale	12	0	0
Dall's porpoise	4,458	147	0
Harbor porpoise	119,103	45	0
Mesoplodont (other)	13	0	0
Northern right whale dolphin	698	18	0
Pacific white-sided dolphin	521	23	0
Pygmy or Dwarf sperm whale	3	0	0
Risso's Dolphin	85	2	0
Short-beaked common dolphin	1,142	42	0
Short-finned pilot whale	2	0	0
Striped dolphin	38	1	0
California sea lion	281	0	0
Harbor seal	258	245	1
Northern elephant seal	288	0	0
Northern fur seal	1,277	1	0
Total	**128,583**	**528**	**1**

Expended Materials

Ordnance Related Materials

The amount of ordnance fired would increase approximately 110 percent in the Study Area under Alternative 2 as compared to the No Action Alternative. Similar to the No Action Alternative, only sperm whales would potentially be exposed to expended ordnance via ingestion from the bottom. Based on sperm whale habitat preferences and known feeding behaviors discussed above, it is extremely unlikely that they would encounter and ingest expended ordnance. However, ingestion of ordnance under Alternative 2 may affect the sperm whale. Ordnance ingestion under Alternative 2 would have no effect on the remaining ESA-listed species (sea otter, Steller sea lion, southern resident killer whale, blue whale, fin whale, humpback whale, North Pacific right whale, or sei whale) based on the feeding habits of these species. Ordnance related materials would not be expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, ordnance related materials would have minimal impact on marine mammals in territorial waters. Furthermore, ordnance related materials would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

Target Related Materials

Under Alternative 2, the number of targets used in the Study Area would increase by about 40 percent over the No Action. As discussed above for the No Action Alternative, species that feed on or near the bottom (which are the sperm whales and beaked whales) may encounter an expended target while feeding; however, the size of the target would prohibit any listed species from ingesting it. However, if target materials are fragmented into smaller pieces, there is a possibility for the sperm whale to ingest fragments while feeding on the sea floor. Therefore, Alternative 2 may affect the sperm whale. Ingestion of targets under Alternative 2 would have no effect on the other listed marine mammals (sea otter, Steller sea lion, southern resident killer whale, blue whale, fin whale, humpback whale, North Pacific right whale, or sei whale). Targets would not be expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, targets would have no significant impact on marine mammals in territorial waters. Furthermore, targets would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

Marine Markers

The number of marine markers used in the Study Area would increase under Alternative 2 from 296 to 312 per year. The probability of a marine mammal ingesting an expended marine marker would be extremely low based on the low concentration in the Study Area (0.002/nm^2/year). Marine marker ingestion under Alternative 2 may affect ESA-listed marine mammals. The use of marine markers is not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, there would be no significant impact to marine mammals from marine marker use during training exercises within territorial waters. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of marine markers during training exercises in non-territorial waters.

Sonobuoys

The number of passive and active sonobuoys would increase annually under Alternative 2 by approximately 2 percent more than Alternative 1 and 6 percent more than the No Action Alternative. Approximately 9,651 sonobuoys would be deployed in the Study Area annually. The same relative proportion of passive to active sonobuoys would be used. Approximately 80 percent of the sonobuoys would be passive SSQ-53 DIFAR. About nine percent of all sonobuoys would be active sonar emitters (SSQ-62 DICASS Active).

With regard to potential entanglement encounters between marine mammals and unrecovered sonobuoy and flare parachute assemblies expended during military activities, the entanglement effects would be potentially greater than those described for the No Action Alternative and Alternative 1 because of the greater number of sonobuoy and flare deployments (519 more sonobuoys than No Action and 228 more sonobuoys than Alternative 1). With Alternative 2 unrecovered materials would sink; the amount remaining on or near the sea surface would be low, and the density of such debris in the primary sonobuoy deployment area (W-237) would be the same as Alternative 1 at a very low concentration (0.4 sonobuoy parachute assemblies/nm^2/year). Entanglement impacts to marine mammals from this and other expended debris are unlikely.

Expended sonobuoys are a potential ingestion hazard for marine mammals while they are floating, while they are descending to the seafloor, or after they sink to the bottom. However, the probability of ingestion is extremely low based on the low number of passive sonobuoys expended per year (8,765) and the low concentration (0.07/nm^2/year). Sonobuoy ingestion under Alternative 2 may affect ESA-listed marine mammals. The use of passive sonobuoys is not expected to result in Level A or Level B harassment as defined by the MMPA. Effects of active sonobuoys are addressed as part of the sonar analysis. In accordance with NEPA, there would be no significant impact to marine mammals from passive sonobuoy use during training exercises within territorial waters. In accordance with EO 12114, there would be no significant harm to marine mammals resulting from use of passive sonobuoys during training exercises in non-territorial waters.

Critical Habitats

For the same reasons that were described for the No Action Alternative and Alternative 1, it is expected that none of the stressors associated with Alternative 2 will destroy or adversely modify critical habitats for either the southern resident killer whale or the Steller sea lion. Although Alternative 2 will increase the number of activities and the quantities of some stressors compared to the No Action Alternative and Alternative 1, the locations of training and testing activities will not change compared to No Action nor will the additional quantities of stressors associated with training and testing activities be large enough to affect or cause a noticeable change in the PCEs. Therefore, in accordance with ESA consultation provisions to assess potential effects of proposed actions to critical habitat, it is concluded that Navy activities of Alternative 2 will not destroy or adversely modify critical habitat for either the southern resident killer whale or the Steller sea lion.

3.9.3 Mitigation Measures

The Navy has implemented a comprehensive suite of mitigation measures reduce impacts to marine mammals that might result from Navy training activities in the NWTRC. The mitigation measures applicable to this proposed action are described in Chapter 5. In order for the NMFS and USFWS to make the findings necessary to issue a BE and a LOA under the MMPA, it may be necessary for NMFS and the USFWS to require additional mitigation or monitoring measures beyond those addressed in this EIS/OEIS. These measures could include measures considered, but eliminated in this EIS/OEIS, or as yet undeveloped measures. The public will have an opportunity, through the MMPA process, both to provide information to NMFS in the comment period following NMFS' Notice of Receipt of the application for an LOA, and to review any additional mitigation or monitoring measures that NMFS might propose in the comment period at the proposed rule stage. The final suite of measures developed as a result of the MMPA process would be identified and analyzed in the Final EIS/OEIS.

Effective training in the NWTRC dictates that ship, submarine, and aircraft participants utilize their sensors and exercise weapons to their optimum capabilities as required by the mission. Chapter 5 presents a comprehensive list of mitigation measures that would be utilized for training activities analyzed in the NWTRC EIS/OEIS in order to minimize potential for impacts on marine mammals and sea turtles in the NWTRC.

3.9.3.1 Alternative Mitigation Measures Considered but Eliminated

As described in Section 3.9, the vast majority of estimated sound exposures of marine mammals during proposed active sonar activities would not cause injury. Potential acoustic effects on marine mammals would be further reduced by the mitigation measures described in Chapter 5. Therefore, the Navy concludes the proposed action and mitigation measures would achieve the least practical adverse impact on species or stocks of marine mammals.

A determination of “least practicable adverse impacts” includes consideration of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity in consultation with the DoD. Therefore, several additional mitigation measures were analyzed and eliminated from further consideration. These are discussed in Section 5.2.1.5

3.9.4 Summary of Environmental Effects

Endangered Species Act

The Navy is consulting with NMFS under Section 7 of the ESA regarding its determination of effect for federally-listed marine mammals and critical habitat. Table 3.9-13 provides a summary of the Navy's determination of acoustic effects for federally-listed marine mammals that potentially occur in the Study Area.

The analysis presented above indicates that all seven ESA-listed species of marine mammals may be affected by one or more stressors resulting from Alternative 2 (Preferred Alternative) training activities. All species, except the sea otter and North Pacific right whale, may be affected by exposures to sonar emissions. The sea otter and North Pacific right whale were not included in the sonar exposure modeling because species density data to support exposure modeling was unavailable.

The Study Area contains designated critical habitats for the southern resident killer whale population in the Puget Sound and Straits of Juan de Fuca areas of northwest Washington and breeding rookeries for Steller sea lion at several locations along the coast of Oregon and northern/central California. The critical habitat analysis examined the potential effects of training and testing activities on the PCEs of critical habitat considered essential to the conservation of each species. None of the Navy activities were determined to either destroy or adversely modify critical habitat for either species. Therefore, it was concluded that training and testing activities under the proposed action would have no effects on critical habitat for either species.

This assessment focused on four aspects of the proposed NWTRC exercises — ship traffic, mid-frequency sonar, aircraft overflights, and underwater detonations. Potential risks associated with the ship traffic were assessed by estimating the probability of a ship striking a marine mammal. Potential risks associated with sonars that are likely to be employed during anti-submarine warfare exercises were assessed by treating the acoustic energy produced by those sonar as a pollutant introduced into the ocean environment. The sonar analysis evaluated the likelihood of listed species being exposed to sound pressure levels associated with mid-frequency sonar, which includes estimating the intensity, duration, and frequency of exposure. The analysis assumed that mid-frequency sonar posed no risk to listed species if they were not exposed to sound pressure levels from the mid-frequency sound sources. The analyses assumed that the potential consequences of exposure to mid-frequency sonar on individual animals would be a function of the intensity (measured in both sound pressure level in decibels and frequency), duration, and frequency of the animal’s exposure to the mid-frequency transmissions.

Potential risks associated with underwater explosions that are likely to be employed during BOMBEX and other training exercises were assessed by treating the impulse energy produced by underwater explosions as an energy force introduced into the ocean environment. The underwater explosion analysis evaluated the likelihood of listed species being exposed to sound pressure levels associated with underwater detonations, which includes estimating the intensity, duration, and frequency of exposure. The analysis assumed that underwater detonations posed no risk to marine mammal species if they were not exposed to sound pressure levels from the detonations.

Marine Mammal Protection Act

The analysis presented above indicates that several species of marine mammals could be exposed to impacts associated with underwater detonations and explosive ordnance use under Alternative 2 (Preferred Alternative) that could result in Level A or Level B harassment as defined by MMPA provisions that are applicable to the Navy. Underwater detonations and explosive ordnance exposure estimates for Alternative 2 are provided in Table 3.9-11. Sonar exposure estimates that could result in Level A or Level B harassment with Alternative 2 are provided in Table 3.9-12. Other stressors associated with Alternative 2 are not expected to result in Level A or Level B harassment. Accordingly, the Navy is working with NMFS through the MMPA permitting process to ensure compliance with the MMPA.

Table 3.9-13: Summary of the Navy's Determination of Effect for Federally Listed Marine Mammals that May Occur in the NWTRC Study Area – Preferred Alternative (Alternative 2)

Stressor	Blue Whale	Fin Whale	Humpback Whale	North Pacific Right Whale	Sei Whale	Sperm Whale	Southern Resident Killer Whale (SP/CH)[b/]	Steller Sea Lion (SP/CH)[b/]	Sea Otter
Vessel Movements									
Vessel Disturbance	MA[a/]	MA	MA	MA	MA	MA	MA/NE	MA/NE	MA
Vessel Collisions	MA	MA	MA	MA	MA	MA	NE/NE	NE/NE	NE
Aircraft Overflights									
Aircraft Disturbance	MA	MA	MA	MA	MA	MA	MA/NE	MA/NE	MA
Non-Explosive Practice Ordnance									
Weapons Firing Disturbance	NE	NE	NE	NE	NE	NE	NE/NE	NE/NE	NE
Non-Explosive Ordnance Strikes	NE	NE	NE	NE	NE	NE	NE/NE	NE/NE	NE
High Explosive Ordnance									
Underwater Detonation	MA	MA	NE	NA	NE	MA	NE	MA	NA
Explosive Ordnance	MA	MA	NE	NA	NE	MA	NE	MA	NA
Active Sonar									
Mid- and High-Frequency Sonar	MA	MA	MA	NA	MA	MA	MA	MA	NA
Expended Materials									
Ordnance Related Materials	NE	NE	NE	NE	NE	MA	NE/NE	NE/NE	NE
MK-58 Marine Markers	MA	MA	MA	MA	MA	MA	MA/NE	MA/NE	MA
Target Related Materials	NE	NE	NE	NE	NE	MA	NE/NE	NE/NE	NE
Sonobuoys	MA	MA	MA	MA	MA	MA	MA/NE	MA/NE	MA

a/ MA = May Affect; NE = No Effect; NA = species was not modeled because density estimates are unavailable
b/ SP/CH = Species effect/critical habitat effect determination made only for species with listed critical habitat

National Environmental Policy Act and Executive Order 12114

As summarized in Table 3.9-14, impacts on marine mammals in territorial waters under the No Action Alternative, Alternative 1, and Alternative 2 are provided in accordance with NEPA. Furthermore, impacts on marine mammals in non-territorial waters under the No Action Alternative, Alternative 1, and Alternative 2 are provided in accordance with EO 12114.

Table 3.9-14: Summary of Effects – Marine Mammals

Alternative and Stressor	Summary of Effects and Impact Conclusion NEPA (Territorial Waters, 0 to 12 nm) and Executive Order 12114 (Non-Territorial Waters, >12 nm)
No Action	
Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or ortality from vessel collisions.
Aircraft Overflights	Potential for short-term behavioral responses to overflights. No long-term population-level effects.
Non-Explosive Practice Ordnance	No effect based on extremely low probability of direct strikes.
High-Explosive Ordnance	Short-term behavioral responses or Temporary Threshold Shift (TTS) from ordnance use and underwater detonations. Modeling of underwater explosions indicated 170 annual exposures of potential behavioral harassment (76 pinnipeds, 94 cetaceans), 116 exposures of potential Level B harassment (56 pinnipeds, 60 cetaceans), 11 exposures of potential slight injury (5 pinnipeds, 6 cetaceans), and 1 exposure of potential severe injury to a harbor seal (pinniped).
Active Sonar	Short-term behavioral responses or TTS from sonar use. Except for one exposure to harbor seal (pinniped), sonar exposure modeling indicated no potential for Permanent Threshold Shift (PTS) from active sonar. Modeling indicated 108,807 annual exposures (1,875 pinnipeds, 106,932 cetaceans) that exceed the SPL dose response curve and potentially results in behavioral harassment and 443 annual exposures (207 pinnipeds, 236 cetaceans) that exceed the TTS threshold.
Expended Materials	Low potential for ingestion of ordnance related materials.
Alternative 1	
Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions. Slight increase compared to No Action.
Aircraft Overflights	Potential for short-term behavioral responses to overflights. Slight increase compared to No Action. No long-term population-level effects.
Non-Explosive Practice Munitions	No effect based on extremely low probability of direct strikes.
High-Explosive Ordnance	Short-term behavioral responses or TTS from ordnance use and underwater detonations. Modeling of underwater detonations and explosive ordnance use indicated 217 annual exposures of potential behavioral harassment (76 pinnipeds, 141 cetaceans), 144 exposures of potential Level B harassment (58 pinnipeds, 86 cetaceans), 14 exposures of potential slight injury (4 pinnipeds, 10 cetaceans), and 0 exposures of potential severe injury. Reductions in underwater EOD training would result in no effects to marine mammals from EOD activities.

Table 3.9-14: Summary of Effects – Marine Mammals (continued)

Alternative and Stressor	Summary of Effects and Impact Conclusion NEPA (Territorial Waters, 0 to 12 nm) and Executive Order 12114 (Non-Territorial Waters, >12 nm)
Alternative 1 (continued)	
Active Sonar	Short-term behavioral responses or TTS from sonar use. Except for one exposure to harbor seal (pinniped), sonar exposure modeling indicated no potential for PTS from active sonar. Modeling indicated 117,354 annual exposures (2,021 pinnipeds, 115,333 cetaceans) that exceed the SPL dose response curve and potentially results in behavioral harassment and 480 annual exposures (224 pinnipeds, 256 cetaceans) that exceed the TTS threshold.
Expended Materials	Low potential for ingestion of ordnance related materials. Slight increase compared to No Action.
Alternative 2 (Preferred Alternative)	
Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions. Slight increase compared to No Action.
Aircraft Overflights	Potential for short-term behavioral responses to overflights. Slight increase compared to No Action. No long-term population-level effects.
Non-Explosive Practice Munitions	No effect based on extremely low probability of direct strikes.
High-Explosive Ordnance	Short-term behavioral responses or TTS from ordnance use and underwater detonations. Modeling of offshore explosive ordnance use and underwater detonations indicated 262 annual exposures of potential behavioral harassment (84 pinnipeds, 178 cetaceans), 199 exposures of potential Level B harassment (89 pinnipeds, 110 cetaceans), 14 exposures of potential slight injury (4 pinnipeds, 10 cetaceans), and 1 exposure of potential severe injury. Reductions in underwater EOD training would result in no effects to marine mammals from EOD activities.
Active Sonar	Short-term behavioral responses or TTS from sonar use. Except for one exposure to harbor seal (pinniped), sonar exposure modeling indicated no potential for PTS from active sonar. Modeling indicated 117,615 annual exposures (2,217 pinnipeds, 126,366 cetaceans) that exceed the SPL dose response curve and potentially results in behavioral harassment and 480 annual exposures (246 pinnipeds, 282 cetaceans) that exceed the TTS threshold.
Expended Materials	Low potential for ingestion of ordnance related materials. Slight increase compared to No Action.

3.10 Birds

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3.10 BIRDS

The habitat found on land within the Northwest Training Range Complex (NWTRC) supports a wide diversity of resident and migratory birds that include neotropical migratory birds, waterfowl, shorebirds, and birds of prey (DoN 2006). This section describes the birds present in the NWTRC, presented in four broad categories: seabirds, shorebirds, waterfowl, and terrestrial species. In addition, it provides information on the Federally listed endangered or threatened bird species, and analyzes the impacts of proposed Navy activities to birds in the NWTRC. Issues of concern for birds are potential effects from aviation activities, vessel movements, ordnance strikes and explosions, and military expended materials.

Migratory birds are any species or family of birds that live, reproduce, or migrate within or across international borders at some point during their annual life cycle. In practice, the Migratory Bird Treaty Act (MBTA) protects all birds except those that are non-native and human introduced (including mute swans and pigeons) and those that are not referred to in any of the four treaties that underlie the MBTA (most notably, grouse, turkey [*Meleagris gallopavo*], quail, starlings [*Sturnus vulgaris*], and house sparrows [*Passer domesticus*]) (USFWS 2005). Seabirds, which are included in migratory birds protected by the MBTA (USFWS 1985), are birds whose normal habitat and food source is the sea, whether they utilize coastal waters (the nearshore), offshore waters (the continental shelf), or pelagic waters (the open sea) (Harrison 1983).

The inland waters of the Puget Sound, Hood Canal, Strait of Juan de Fuca, and Strait of Georgia comprise one of the world's largest estuaries (DoN 2006). Inland water shorelines of the estuary are generally rocky, with small beaches at the mouths of streams and rivers. Extensive mudflats associated with river deltas support seasonally large populations of shorebirds and waterfowl (DoN 2006). The coastline creates numerous bays and inlets, which provide sheltered waters for wintering waterfowl and seabirds, including ducks, gulls, and shorebirds.

From Grays Harbor south through Oregon and northern California, shorelines are generally beaches intersected by coastal headlands and rocky islands. These areas provide habitat for gulls, pelicans, and cormorants (DoN 2006). Off the coast, upwelling and other mixing zones provide nutrient "hotspots" where seabirds concentrate (Hickey 1995).

Along the shorelines, winter bird populations are generally three times higher than the summer populations, which mostly include gulls and alcids (Nysewander et al. 2005). Much of the inland shoreline interfaces with forest habitats that are important to nesting and roosting bald eagles (*Haliaeetus leucocephalus*), a prominent predatory bird throughout the inland water region.

Coastal habitats and productive offshore waters are important nesting and foraging areas for breeding and migrating birds. Effects of habitat degradation became noticeable on resources used by birds in the latter part of the 20th century. Habitat loss, coupled with pollution and related fisheries impacts, have reduced populations of several bird species to vulnerable levels.

3.10.1 Affected Environment

The birds of the NWTRC Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) Study Area are divided into four groups, based loosely on their geographic distribution and feeding habits (DOC 1993):

- Seabirds, such as alcids, shearwaters, and gulls. These feed in open waters ranging from the shoreline and estuaries to the open ocean. Some seabirds are strictly pelagic, while others prefer the nearshore environment.

- Shorebirds, such as herons, sandpipers, and other wading species. These species feed mainly along the intertidal and nearshore marine environment.
- Waterfowl, such as ducks and geese. These familiar species are found near shore on the open coast and in estuaries, but some also use inland freshwater habitats.
- Terrestrial species, such as hawks and raptors, woodpeckers, and perching birds. These birds occur in natural shrub, field, and forest settings, but some are commonly associated with developed areas and human-made structures.

In general, seabird activity is most concentrated along the Pacific Northwest (PACNW) coast, while shorebirds and waterfowl are found primarily in the bays and shallow waters of the southern coast (DOC 1993). Waterfowl (for example, ducks) and upland game birds (for example, mourning doves) can be hunted, but seasons and bag limits are established in Federal and/or State regulations. Terrestrial species occur from the shore inland; in habitats ranging from old-growth forests to highly disturbed agricultural and urban settings.

Table 3.10-1 identifies bird species known to occur in the NWTRC Study Area. Four of these are protected under the authority of the Endangered Species Act (ESA): two are Federally listed as endangered (short-tailed albatross [*Phoebastria albatrus*] and California brown pelican [*Pelecanus occidentalis californicus*]) and two are Federally listed as threatened (western snowy plover [*Charadrius alexandrinus nivosus*] and marbled murrelet [*Brachyramphus marmoratus*]). Most birds in the Study Area except starlings, house sparrows, and pigeons are protected under the Migratory Bird Treaty Act (MBTA). Bald eagles are afforded additional protection under the Bald and Golden Eagle Protection Act.

3.10.1.1 Birds and Their Habitats

Seabirds

The seabird colonies of the outer coast of Washington are among the largest in population in the continental United States (DOC 1993). More than 500,000 seabirds (juveniles included) are concentrated within Washington nesting colonies each year. Species include the black-legged kittiwake (*Rissa tridactyla*), rhinoceros auklet (*Cerorhinca monocerata*), and tufted puffin (*Fratercula cirrhata*). The nesting colonies along the outer coast of Washington contain more than 50 percent of contiguous U.S. west coast total populations of the fork-tailed storm-petrel (*Oceanodroma furcata*), Caspian tern (*Sterna caspia*), Cassin’s auklet (*Ptychoramphus aleuticus*), and tufted puffin.

Seabirds include those that are pelagic (generally foraging far offshore over the continental shelf and in oceanic waters) and those that feed in nearshore zones. Pelagic seabirds go ashore primarily to breed (DOC 1993). Pelagic species include the northern fulmar (*Fulmarus glacialis*), five species of shearwaters, black-footed albatross, arctic tern (*Sterna paradisaea*), pomarine jaeger (*Stercorarius pomarinus*), and fork-tailed and Leach’s storm-petrels (*Oceanodroma leucorhoa*). The sooty shearwater (*Puffinus griseus*) is by far the most numerous pelagic seabird in the Study Area (DOC 1993). Huge flocks estimated to approach a million birds have been observed at the entrance to the Strait of Juan de Fuca during summer months (Strickland and Chasan 1989). Nearshore seabirds feed within sight of land and include Pacific (*Gavia pacifica)* and red-throated loons (*Gavia stellata*), western grebes (*Aechmophorus occidentalis*), brown pelicans, several species of gulls and cormorants, common murres (*Uria aalge*), and red-necked phalaropes (*Phalaropus lobatus*).

Table 3.10-1: Representative Birds Known to Occur in the NWTRC Study Area

Common Name	Genus and species	Common Name	Genus and species
Aleutian tern	*Sterna aleutica*	Long-tailed jaeger	*Stercorarius longicaudus*
American goldfinch	*Carduelis tristis*	Mallard	*Anas platyrhynchos*
American kestrel	*Falco sparverius*	Manx shearwater	*Puffinus puffinus*
American wigeon	*Anas americana*	Marbled godwit	*Limosa fedoa*
American white pelican	*Pelecanus erythrorhynchos*	Marbled murrelet	*Brachyramphus marmoratus*
Ancient murrelet	*Synthliboramphus antiquus*	Merlin	*Falco columbarius*
Arctic loon	*Gavia arctica*	Mew gull	*Larus canus*
Arctic tern	*Sterna paradisaea*	Northern fulmar	*Fulmarus glacialis*
Ashy storm-petrel	*Oceanodroma homochroa*	Northern pintail	*Anas acuta*
Bald eagle	*Haliaeetus leucocephalus*	Northern rough-winged swallow	*Stelgidopteryx serripennis*
Barn swallow	*Hirundo rustica*	Northern shoveler	*Anas clypeata*
Barrow's goldeneye	*Bucephala islandica*	Northwestern crow	*Corvus caurinus*
Belted kingfisher	*Ceryle alcyon*	Olive-sided flycatcher	*Contopus cooperi*
Black guillemot	*Cepphus grylle*	Orange-crowned warbler	*Vermivora celata*
Black oystercatcher	*Haematopus bachmani*	Osprey	*Pandion haliaetus*
Black turnstone	*Arenaria melanocephala*	Pacific loon	*Gavia pacifica*
Black scoter	*Melanitta nigra*	Pacific-slope flycatcher	*Empidonax difficilis*
Black skimmer	*Rynchops niger*	Parakeet auklet	*Aethia psittacula*
Black-bellied plover	*Pluvialis squatarola*	Parasitic jaeger	*Stercorarius parasiticus*
Black-footed albatross	*Phoebastria nigripes*	Pelagic cormorant	*Phalacrocorax pelagicus*
Black-headed grosbeak	*Pheucticus melanocephalus*	Peregrine falcon	*Falco peregrinus*
Black-legged kittiwake	*Rissa tridactyla*	Pied-billed grebe	*Podilymbus podiceps*
Black-throated gray warbler	*Dendroica nigrescens*	Pigeon guillemot	*Cepphus columba*
Black-vented shearwater	*Puffinus opisthomelas*	Pink-footed shearwater	*Puffinus creatopus*
Bonaparte's gull	*Larus philadelphia*	Pomarine jaeger	*Stercorarius pomarinus*
Brant	*Branta bernicla*	Red knot	*Calidris canutus*
Brandt's cormorant	*Phalacrocorax penicillatus*	Red phalarope	*Phalaropus fulicaria*
Brown pelican	*Pelecanus occidentalis*	Red-breasted merganser	*Mergus serrator*
Bufflehead	*Bucephala albeola*	Red-faced cormorant	*Phalacrocorax urile*
Buller's shearwater	*Puffinus bulleri*	Red-necked phalarope	*Phalaropus lobatus*
California brown pelican	*Pelecanus occidentalis californicus*	Red-tailed hawk	*Buteo jamaicensis*
California gull	*Larus californicus*	Red-throated loon	*Gavia stellata*
Canada goose	*Branta canadensis*	Rhinoceros auklet	*Cerorhinca monocerata*
Canvasback	*Aythya valisineria*	Ring-billed gull	*Larus delawarensis*
Caspian tern	*Sterna caspia*	Rock sandpiper	*Calidris ptilocnemis*
Cassin's auklet	*Ptychoramphus aleuticus*	Royal tern	*Sterna maxima*
Cassin's vireo	*Vireo cassinii*	Ruddy duck	*Oxyura jamaicensis*
Common goldeneye	*Bucephala clangula*	Ruddy turnstone	*Arenaria interpres*
Common loon	*Gavia immer*	Rufous hummingbird	*Selasphorus rufus*
Common merganser	*Mergus merganser*	Sabine's gull	*Xema sabini*
Common murre	*Uria aalge*	Sanderling	*Calidris alba*

Table 3.10-1: Representative Birds Known to Occur in the NWTRC Study Area (cont'd)

Common Name	Genus and species	Common Name	Genus and species
Common raven	*Corvus corax*	Savannah sparrow	*Passerculus sandwichensis*
Common snipe	*Gallinago gallinago*	Semipalmated plover	*Charadrius semipalmatus*
Common tern	*Sterna hirundo*	Sharp-shinned hawk	*Accipiter striatus*
Cooper's hawk	*Accipiter cooperii*	Short-billed dowitcher	*Limnodromus griseus*
Craveri's murrelet	*Synthliboramphus craveri*	Short-tailed albatross	*Phoebastria albatrus*
Crested auklet	*Aethia cristatella*	Short-tailed shearwater	*Puffinus tenuirostris*
Double-crested cormorant	*Phalacrocorax auritus*	Snow goose	*Chen caerulescens*
Dunlin	*Calidris alpina*	Sooty shearwater	*Puffinus griseus*
Elegant tern	*Sterna elegans*	Spotted sandpiper	*Actitis macularia*
European starling	*Sturnus vulgaris*	Surfbird	*Aphriza virgata*
Flesh-footed shearwater	*Puffinus carneipes*	Surf scoter	*Melanitta perspicillata*
Fork-tailed storm-petrel	*Oceanodroma furcata*	Swainson's thrush	*Catharus ustulatus*
Forster's tern	*Sterna forsteri*	Thayer's gull	*Larus thayeri*
Great blue heron	*Ardea herodias*	Thick-billed murre	*Uria lomvia*
Greater scaup	*Aythya marila*	Townsend's warbler	*Dendroica townsendi*
Greater white-fronted goose	*Anser albifrons*	Trumpeter swan	*Cygnus buccinator*
Green-winged teal	*Anas crecca*	Tufted puffin	*Fratercula cirrhata*
Glaucous-winged gull	*Larus glaucescens*	Tundra swan	*Cygnus columbianus*
Gull-billed tern	*Sterna nilotica*	Wandering tattler	*Heteroscelus incanus*
Harlequin duck	*Histrionicus histrionicus*	Warbling vireo	*Vireo gilvus*
Heermann's gull	*Larus heermanni*	Western grebe	*Aechmophorus occidentalis*
Herring gull	*Larus argentatus*	Western gull	*Larus occidentalis*
Horned puffin	*Fratercula corniculata*	Western sandpiper	*Calidris mauri*
House wren	*Troglodytes aedon*	Western snowy plover	*Charadrius alexandrinus nivosus*
Kittlitz's murrelet	*Brachyramphus brevirostris*	Western tanager	*Piranga ludoviciana*
Killdeer	*Charadrius vociferus*	Whimbrel	*Numenius phaeopus*
Laysan albatross	*Phoebastria immutabilis*	Whiskered auklet	*Aethia pygmaea*
Leach's storm-petrel	*Oceanodroma leucorhoa*	White-winged scoter	*Melanitta fusca*
Least auklet	*Aethia pusilla*	Wilson's storm-petrel	*Oceanites oceanicus*
Least sandpiper	*Calidris minutilla*	Wilson's warbler	*Wilsonia pusilla*
Least storm-petrel	*Oceanodroma microsoma*	Xantus' murrelet	*Synthliboramphus hypoleucus*
Long-billed curlew	*Numenius americanus*	Yellow-billed loon	*Gavia adamsii*
Long-tailed duck	*Clangula hyemalis*		

(Note: Adapted from Dailey et al. 1993 and DoN 2007 with additions)

Coastal rocks, headlands, and islands along the outer coast are critical nesting and roosting sites for many seabird species (DOC 1993). Colony sites are important habitat for seabirds because reproductive success and continuation of species depend on these sites. Colonial seabird populations in the Pacific Washington coast are estimated to range from 108,530 breeding pairs (Strickland and Chasan 1989) to 240,000 individuals (Wahl 1984). Approximately 75 percent of the total estimated colonial seabird population in the Washington coastal area breeds between Point Grenville and Neah Bay. The shoreline south of Point Grenville has limited nesting habitat available for colonial seabirds, except for accreted sand islands in

Grays Harbor and Willapa Bay and the rock cliff face at the mouth of the Columbia River (Speich and Wahl 1989).

The Olympic coast is dominated by the more pelagic species and much higher numbers of nesters, while the southern coast is primarily nesting habitat for gulls and terns (DOC 1993). The dominant species of breeding seabirds in the Washington coastal area are Cassin's auklets, rhinoceros auklets, common murres, Leach's storm-petrels, glaucous-winged gulls (*Larus glaucescens*) and tufted puffins. Other species that breed on these coastal rocks and islands include terns, cormorants, black oystercatchers (*Haematopus bachmani*), ring-billed (*Larus delawarensis*) and western gulls (*Larus occidentalis*), pigeon guillemots (*Cepphus columba*), and ancient (*Synthliboramphus antiquus*) and marbled murrelets.

Destruction Island is the home of one of the seven major colonies (18,000 pairs) of rhinoceros auklets in the world, and one of only two major colonies of more than 20,000 birds along the entire west coast (SAB 1990). The rhinoceros auklet, fork-tailed storm petrel, Brandt's cormorant (*Phalacrocorax penicillatus*), and Caspian tern are all restricted to very few nesting sites (Speich and Wahl 1989).

Alcids are a distinctive family of seabirds present along the PACNW coast that includes the tufted puffin, rhinoceros auklet, Cassin's auklet, common murre, ancient and marbled murrelets, and pigeon guillemot (DOC 1993). They are long-lived colonial nesters that reproduce slowly and are found in shallower nearshore waters, especially in summer when birds are closely tied to nesting sites (DOC 1993). Large colonies of tufted puffins, rhinoceros auklets, Cassin's auklets, and common murres are present on the nearshore islands of the Olympic coast. Important breeding colony sites occur within the Study Area. Knowledge is limited regarding current population levels of alcids in this area.

Common murres are circumpolar and number in the millions worldwide. They are the dominant member of the breeding seabird community on the west coast. However, their populations have declined substantially in Washington and central California because of the combined effects of high mortality from gillnet fishing, oil spills, and El Niño events. Common murres are among the most colonial of seabirds (DOC 1993). They nest on open rock or dirt ledges at 18 locations along the Olympic outer coast and sometimes shift colony sites. These birds are strong fliers and forage long distances from their colonies. They dive to considerable depths to capture fish, crustaceans, and cephalopods. In late summer and fall, adult females of the Washington coastal population fly into Puget Sound to molt and winter (DOC 1993).

Shorebirds

Shorebirds do not swim, but rather wade or probe at the waters edge, feeding on organisms in shallow water or in the intertidal mud or sand (DOC 1993). Shorebirds such as western sandpipers (*Calidris mauri*), sanderlings (*C. alba*), dunlin (*C. alpina*), and semipalmated (*Charadrius semipalmatus*) and black-bellied plovers (*Pluvialis squatarola*) roost and forage along coastal beaches and bays during their annual migrations.

While most shorebirds tend to feed on sandy beaches or mudflats, several species prefer to forage on rock substrate and are consistently found on rocks and islands of the Olympic coastal region (DOC 1993). Representatives of this group include the ruddy turnstone (*Arenaria interpres*), black turnstone (*A. melanocephala*), wandering tattler (*Heteroscleus incanus*), surfbird (*Aphriza virgata*), and rock sandpiper (*Calidris ptilocnemis*). They pass through during migrations, but small numbers winter in rocky surf areas of the coast (Strickland and Chasan, 1989).

Unlike seabirds, most shorebirds are not associated with the marine environment during the breeding season but, in the PACNW, nest on coastal and interior wetlands (DOC 1993). A few species nest in small numbers in the vicinities of Grays Harbor and Willapa Bay, including the snowy plover, killdeer (*Charadrius vociferous*), semipalmated plover, and common snipe (*Gallinago gallinago*).

Shorebirds depend on critical staging sites along the coast during migrations (DOC 1993). Coastal bays and estuaries along the Washington outer coast, including Grays Harbor and Willapa Bay, are important feeding and resting areas for large concentrations of birds during migration and the winter season. These areas are the last estuaries at which many birds stop during their migration to Alaska. At least 12 species of shorebirds stage in the spring, with numbers of more than a million in the Grays Harbor area and 750,000 in Willapa Bay (DOC 1993). Approximately 30,000 shorebirds overwinter in Willapa Bay.

Waterfowl

Waterfowl are flat-billed birds that spend most of their lifecycle on the water (DOC 1993). Like shorebirds, waterfowl typically breed in freshwater habitats, but many species move to shoreline or nearshore habitats when breeding is complete. Many species of waterfowl stage and winter in Washington’s protected marine waters. Approximately 10,000 ducks and geese overwinter in Willapa Bay, with numbers swelling during migrations to more than 100,000 (DOC 1993). Approximately 20,000 waterfowl migrate through Grays Harbor (Atkinson, 1993 as cited in DOC 1993). Very small numbers of geese and ducks remain to nest in these two areas during the spring and summer. Species such as the harlequin duck (*Histrionicus histrionicus*), scoters (*Melanitta* sp.), bufflehead (*Bucephala albeola*), mergansers, goldeneyes, long-tailed duck (*Clangula hyemalis*), and scaup winter in the nearshore waters of the open coast (DOC 1993). Scoters are by far the most numerous species of sea ducks in nearshore waters.

Terrestrial Species of Birds

Neotropical migratory birds use nearly all of the vegetative habitats present in the terrestrial Study Area, including fresh and saltwater marshes, mudflats, meadows, grasslands, forests, and landscaped areas. Neotropical migrants include most songbirds and many other types of birds, including raptors, shorebirds, and waterfowl, that migrate from summer breeding areas in North America to wintering areas in the Central and South American tropics. Many of these species have experienced alarming declines in abundance in recent years, largely because of fragmentation and destruction of their habitats in North America and the tropics (DoN 1996a).

Within the Study Area, the coniferous and broadleaf forests and the freshwater marshes at Naval Air Station Whidbey Island (NASWI) are probably the most significant habitats for terrestrial birds (DoN 1996a). More than 200 species of birds are known to use habitat at NASWI. Herons and egrets also are common within the NWTRC. Birds of prey that occur in the area include numerous hawk species, bald eagles, ospreys (*Pandion haliaetus*), peregrine and other falcons. Bald eagle occurrence is discussed in Section 3.10.1.3.

The salt marshes at Seaplane Base provide very valuable habitat for a variety of raptors, waterfowl, and songbirds. Migratory waterfowl such as shovelers and gadwalls can be seen feeding in the marsh throughout the spring months. The extensive shrublands provide excellent habitat for perching birds, and beach and mud flat areas support a variety of shorebirds. Significant forest and freshwater marsh habitat for neotropical migratory birds exists at Seaplane Base. Conifer and broadleaf forest habitat for forest-nesting birds occurs in the Crescent Harbor area of Seaplane Base. The vegetation is dominated by 60 to 100 year old Douglas fir trees. A number of neotropical migratory birds breed primarily in conifer forest such as that occurring at Seaplane Base, and winter to the south. These migratory birds include olive-sided flycatcher (*Contopus cooperi*), Cassin’s vireo (*Vireo cassinii*), Townsend's warbler (*Dendroica townsendii*), and western tanager (*Piranga ludoviciana*). Those that are more likely to breed in broadleaf forests include black-headed grosbeak (*Pheucticus melanocephalus*), black-throated gray warbler (*Dendroica nigrescens*), and warbling vireo (*Vireo gilvus*). Species that may breed in either forested habitat include rufous hummingbird (*Salasphorus rufus*), Pacific-slope flycatcher (*Empidomax difficilis*), Swainson's thrush (*Catharus ustulatus*), house wren (*Troglodytes aedon*), orange-crowned warbler (*Vermivora celata*), and Wilson's warbler (*Wilsonia pusilla*) (DoN 1996a).

More than 30 species of water birds have been observed near Indian Island. These include a variety of gulls, cormorants, ducks, loons, murres, guillemots, plovers, grebes, mergansers, and scoters. Raptors that have been observed utilizing habitat in and around Indian Island include, the sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), osprey, merlin (*Falco columbarius*), bald eagle and the American kestrel (*Falco sparverius*) (DoN 2000a).

There are a variety of waterfowl that occur within Hood Canal where Naval Base Kitsap (NBK)-Bangor is located. Some of the seabird and waterfowl species using the marine and nearshore environment include harlequin duck, surf scoter, pigeon guillemots, common merganser, pied-billed grebe (*Podilymbus podiceps*), western grebe, Barrow’s (*Bucephala islandica*) and common goldeneye (*Bucephala clangula*), bufflehead, American widgeon (*Anas americana*), ruddy duck (*Oxyura jamaicensis*), double-crested cormorants (*Phalacrocorax auritus*), and ring-billed gull. Raptors that are present in the Hood Canal area include bald eagles, peregrine falcons, and osprey. Six potential great blue heron (*Ardea herodias*) rookeries have been located on NBK-Bangor. There are four active osprey nests that have fledged young for the last 15 years (DoN 2000a).

The coniferous forest at the north end of the Naval Outlying Landing Field (OLF) Coupeville has been identified by the Washington Department of Natural Resources (WDNR) as a significant habitat for neotropical migratory birds. This habitat is used as a breeding area by a number of neotropical migratory songbirds, including the olive-sided flycatcher, Cassin’s vireo, Townsend’s warbler, and western tanager (DoN 1996a).

Important Bird Areas

Birds are widely distributed, but they tend to congregate in areas referred to, and identified by Audubon, as Important Bird Areas (http://www.audubon.org/bird/iba/iba_intro.html). In the NWTRC, several Important Bird Areas have been identified; these areas are shown on Figure 3.10-1 and briefly described below.

Crescent Harbor Marshes

The Cresecent Harbor Important Bird Area, located three kilometers east of the city of Oak Harbor on Whidbey Island, includes the shoreline and marine waters to the 10-meter depth contour, and the adjacent uplands on the seaplane base at Whidbey Naval Air Station but excluding housing and operations areas. Fifty-five percent of the site is marine foraging area. Marine habitat also includes gravel and rock beaches, tidal channels, salt marsh, and mudflats; adjacent uplands contain open grasslands, fresh water ponds, and mature second-growth conifer forest. The marshes, shorelines, and marine waters support moderate concentrations of wintering waterfowl. The shorelines are habitat for black oystercatcher (*Haematopus bachmani*); surfbird (*Aphriza virgata*) and black turnstone (*Arenaria melanocephala*).

Deception Pass

The area includes the marine waters in Deception Pass State Park Deception Pass Bridge west past West Point to Deception Island and past Lighthouse Point to Northwest Island. The bridge crosses the narrowest point of Deception Pass, a rocky notch that separates Whidbey Island (Island County) and Fidalgo Island (Skagit County). The waters of Deception Pass are bounded by rocky shores and cliffs with a few beaches. During winter months, large numbers of diving birds, particularly loons, cormorants, grebes, mergansers and alcids, fly in to feed. Loons are present in some concentrations from mid-November to early April, with the largest numbers during December, January and February. In winter, rock outcrops are frequented by black oystercatchers (*Haematopus bachmani*). In summer, oystercatchers nest on at least one of the small islands. Pigeon guillemots (*Cepphus columba*) gather in the area each spring for pair-bonding, and they nest on the cliffs.

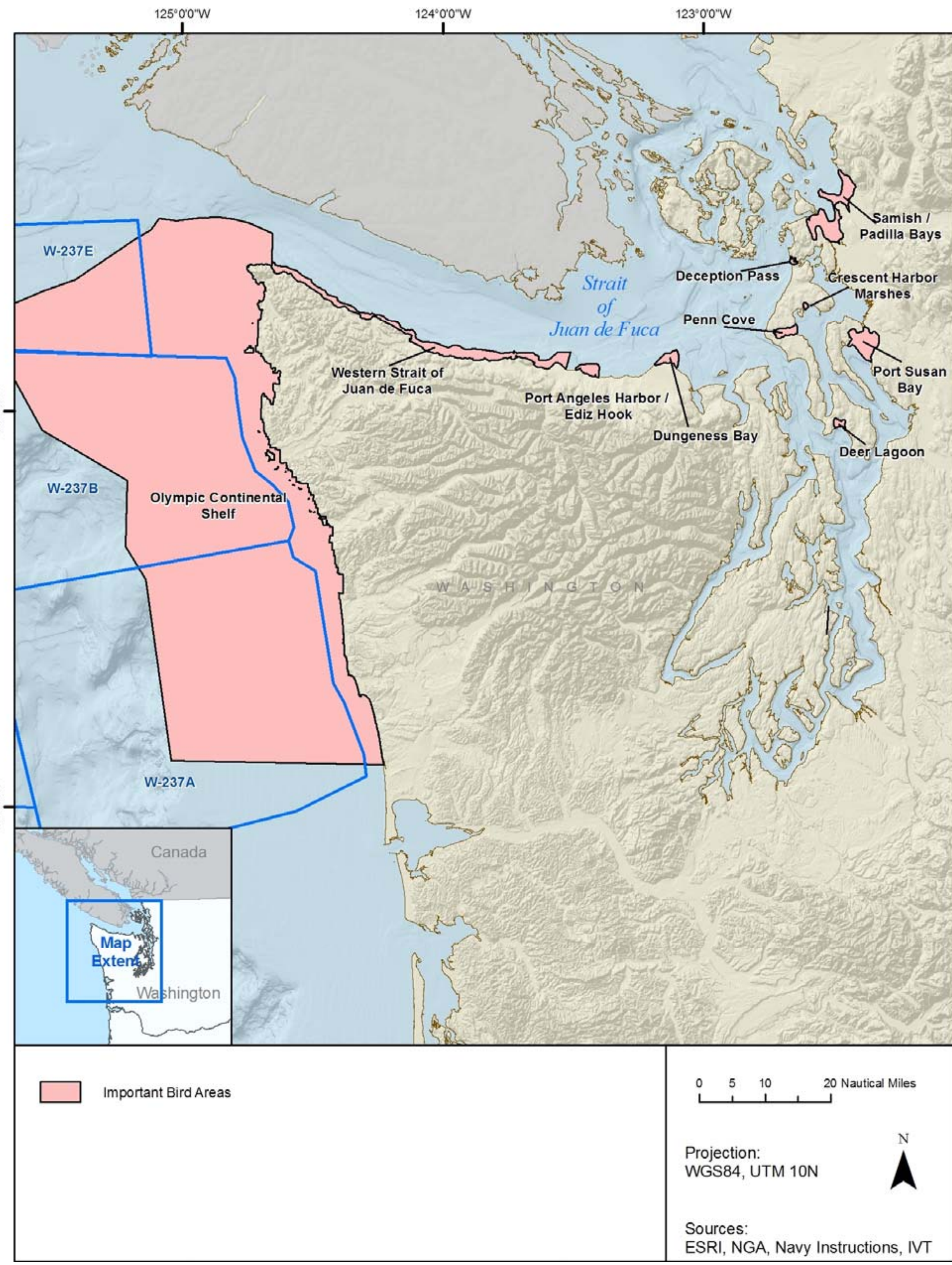

Figure 3.10-1: Important Bird Areas in the NWTRC Study Area

Deer Lagoon

Deer Lagoon, an estuarine marsh on Whidbey Island, is located near the island's south end, on the north shore of Useless Bay. The site includes an open lagoon with dikes on both east and west, and an open channel to salt water. The substrate is sand, silt, and mud. The wetlands in Deer Lagoon provide fresh water and salt water habitats in bay and tidal marshlands, brackish water pond, small islands, grass, and brushy uplands. Deer Lagoon is an important site on Whidbey Island in terms of use and importance to waterfowl. Concentrations of ducks, geese, and swans far exceed anything else found on the island.

Dungeness Bay

Located on the north shore of the Olympic Peninsula, this site includes intertidal and subtidal waters of Dungeness Bay, Dungeness Spit, the Dungeness River estuary, and adjacent wetlands. It comprises extensive sandflats and mudflats; some of the largest eelgrass beds in the Northwest; and a network of spits, sandbars, and small islands. Adjacent coastal wetlands contain fresh water and estuarine marshes and ponds maintained by a seasonally high water table. Dungeness Spit and adjacent intertidal areas lie within the Dungeness National Wildlife Refuge. Dungeness Bay is used by tens of thousands of shorebirds, gulls, and waterfowl during migration and winter. Subtidal eelgrass beds and associated fauna support significant populations of brant (*Branta bernicla*), diving ducks, seabirds, loons, grebes, and other diving birds.

Olympic Continental Shelf

This site includes the Olympic Coast National Marine Sanctuary, Washington Islands National Wildlife Refuge complex (Copalis, Quillayute Needles, and Flattery Rocks), and the coastal strip of Olympic National Park. Most of the site is open marine water. The western boundary approximates the edge of the continental shelf, out to the 100-fathom isobath, approximately 30 nautical miles (56 km) from the mainland. The coast undeveloped; most of the coastline is lined with sandy or gravelly pocket beaches, with intermittent rocky stretches containing abundant tidepools.

Penn Cove

Penn Cove is a sheltered, shallow bay on the east side of Whidbey Island, consisting primarily of marine waters and tidelands, tidal mudflats, and some estuarine habitat. The 19-kilometer shoreline includes sand and gravel beaches, rocky shore, and bluffs. Some of the beaches are spawning areas for surf smelt and sand lance. Penn Cove is a winter foraging area for aquatic birds. The site supports an assemblage of species associated with marine foraging areas, including ducks, loons, and grebes. The area is used by wintering black turnstones (*Arenaria melanocephala*), feeding and resting surfbirds (*Aphriza virgata*), peregrine falcons (*Falco peregrinus*), merlins (*Falco columbarius*), nesting bald eagles (*Haliaeetus leucocephalus*), and nesting great blue herons (*Ardea herodias*).

Port Angeles Harbor/Ediz Hook

This site includes Port Angeles Harbor, Ediz Hook, and shallow marine waters immediately north and west of Ediz Hook. Port Angeles Harbor is protected from the open marine waters by Ediz Hook, a 5 km-long spit of sand/gravel beach and rocky breakwater. The port is highly industrialized and modified by human influences. Despite the intense human use, the sheltered waters behind Ediz Hook are an essential roosting and foraging area for wintering and migrating waterfowl and other aquatic birds, especially during periods of severe weather. Floating logs and pilings are preferred roosting habitat for herons, gulls, shorebirds, and bald eagles. Gull numbers often reach into the thousands. The site regularly supports more than 100 wintering great blue herons (*Ardea herodias*). The Harbor supports wintering concentrations of Barrow’s (*Bucephala islandica*) and common goldeneyes (*Bucephala clangula*) and harlequin ducks (*Histrionicus histrionicus*). Waters immediately offshore outside the hook support feeding concentrations of alcids, gulls, and sea ducks throughout the year. The harbor supports large post-breeding dispersal flocks of Heermann's gulls (*Larus heermanni*) and migratory populations of Thayer's gulls (*Larus thayeri*).

Port Susan Bay

Located in northwest Snohomish County, this Important Bird Area comprises the northeast portion of Port Susan Bay, the mudflats of Livingston Bay, the Stillaguamish River Delta, and the surrounding farm fields. The extensive intertidal area consists of shallow water, with a shoreline characterized by tidally influenced mudflats and sloughs. Tidal mudflats provide habitat for shorebirds, mostly western sandpipers (*Calidris mauri*) and dunlin (*Calidris alpina*), both in winter and during spring and fall migrations. Flocks of wintering ducks, primarily northern pintail (*Anas acuta*), mallard (*Anas platyrhynchos*), American wigeon (*Anas americana*) and green-winged teal (*Anas crecca*), use the estuarine sloughs and sheltered shallow waters. In winter, trumpeter (*Cygnus buccinator*) and tundra swans (*Cygnus columbianus*) and large numbers of snow geese (*Chen caerulescens*) forage along the shoreline and also in the farm fields of the floodplain. Many raptor species frequent the tidal areas, marshy grasslands, and farm fields. The hedgerows and fields of this area provide important wintering habitat for sparrows.

Samish/Padilla Bays

The Samish/Padilla Bay areas are located near Anacortes. The nominated area contains extensive shallow bays (Similk, Fidalgo, Padilla and Samish) as well as associated mudflats and sloughs. The portion of the Swinomish Channel where the Samish River enters into the Samish Bay is also included, along with various tidal shoreline habitat and some small islands (Samish, Saddlebag and Hat Islands). The sheltered bays and sloughs provide wintering area for seabirds, ducks and geese and provide shelter and food for the large concentrations of seabirds. Padilla Bay contains eelgrass beds, making the bay an ideal wintering area for brant (*Branta bernicla*). The mudflats provide wintering and migratory habitat for shorebirds and the flatlands contain a high and diverse number of wintering raptors.

The Samish provides winter habitat for a variety of birds: mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), and American wigeon (*Anas americana*) winter along the area's coast. At high tide, dunlin and black-bellied plover (*Pluvialis squatarola*) move inland to feed and rest, returning to the muddy shorelines as the tide recedes. All of these are preyed upon by wintering hawks and falcons. Red-tailed (*Buteo jamaicensis*) and rough-legged hawks (*Buteo lagopus*) are abundant. Both adult and sub-adult bald eagles (*Haliaeetus leucocephalus*) are found in the area. On occasion, both Coopers (*Accipiter cooperii*) and sharp-shinned hawks (*Accipiter striatus*) perch and hunt in the trees planted around homes and other buildings.

Western Straight of Juan de Fuca

The boundaries of this site extend from Koitlah Point at the northwest corner of Neah Bay eastward to the mouth of Dry Creek, 3.5 km east of the mouth of the Elwha River. Total length is approximately 100 km (88 km straight-line distance), and width 1.5 km. These dimensions were chosen because they coincide with the length and width of transects used for monitoring marbled murrelets at sea under the Northwest Forest Plan. (Research has shown that 95% of the marbled murrelets (*Brachyramphus marmoratus*) on the at-sea transects occur within 1,500 meters of shore.) The entire site is within the nearshore ecological zone (i.e. < 30 meters depth) except on the stretches of coast between Tongue Point and Observatory Point, and between Slip Point and Pillar Point, where the offshore gradient is steeper, and depth exceeds 60 meters. The site generally extends to the high tide line, but also includes gull roosting sites at the mouths of major rivers. The western Strait of Juan de Fuca nearshore waters support breeding season marbled murrelets. The river deltas support large foraging and roosting flocks of gulls, most notably Heermann's gull (*Larus heermanni*) in late summer and Thayer's gull (*Larus thayeri*) in winter.

3.10.1.2 Federally Endangered or Threatened Species

As part of the EIS/OEIS process, Navy has prepared a Biological Evaluation (BE) for the NWTRC for use, as appropriate, in agency consultations. The BE provides detailed descriptions and analysis of the potential impacts to all threatened and endangered species and critical habitats protected under the ESA.

Information is presented below on Federally listed species known to occur within the Study Area. Federally listed species are the endangered short-tailed albatross (*Phoebastria albatrus*), endangered California brown pelican (*Pelecanus occidentalis californicus*), threatened western snowy plover (*Charadrius alexandrinus nivosus*), and threatened marbled murrelet (*Brachyramphus marmoratus*). Descriptions, habitat, and brief life histories of these listed species are included below:

Short-tailed Albatross

The short-tailed albatross is the largest of the three north Pacific albatrosses (Harrison 1984). Adult short-tailed albatrosses are distinguishable from other Pacific albatrosses by their entirely white back and large bubble-gum pink bill that is strongly hooked at the end (Roberson 2000).

The short-tailed albatross was listed as endangered throughout its range under the ESA in 2000 (USFWS 2000). There is no designated critical habitat under ESA for the short-tailed albatross. During the late 1800s, the world population of short-tailed albatrosses was severely reduced for their plumage. Short-tailed albatrosses nest on isolated, windswept, offshore islands owned and administered by Japan that have restricted human access. The population has been rebounding in recent years because several Pacific rookeries have been protected from human use. The world population of short-tailed albatross is currently estimated at approximately 1200 birds and is increasing (USFWS 2001b).

Short-tailed albatrosses have a lifespan of more than 40 years. Sexual maturity is reached at age seven or eight (Harrison 1990, USFWS 2001b). Nesting begins in October, with the hatching of the single egg in late December and January. Fledging occurs in late April to early June, and the colony is totally deserted by mid-July (Roberson 2000). This species disperses throughout the north Pacific when it is not breeding.

These birds are pelagic wanderers, traveling thousands of miles at sea during the non-breeding season (DoN 2006). Foraging occurs over open, offshore, ocean waters (DoN 2006). Most of their travel is concentrated along the continental shelf edge upwelling zones where they forage, utilizing shallow dives between 15 and 40 feet in depth, on squid, fish, shrimp and other crustaceans, and flying-fish eggs (USFWS 2005). Their at-sea distribution includes the entire Pacific north of about 20°N, but they tend to concentrate along the Aleutians in the Bering Sea (Piatt et al. 2006).

Historic records indicate frequent use of nearshore and coastal waters in the eastern north Pacific from California through Alaska (Committee on the Status of Endangered Wildlife in Canada [COSEWIC] 2002, USFWS 2001b). Current sightings in the eastern north Pacific are concentrated off the shores of Alaska and British Columbia. Sightings off the continental states are gradually increasing as the population rebounds (Unitt 2004). Sightings of short-tailed albatross have the potential to increase in frequency as the species continues recovering.

California Brown Pelican

The brown pelican is the smallest of the world's pelicans (USFWS 1985) and is one of only two pelican species found in North America. The California brown pelican is one of six recognized subspecies of brown pelican which was listed as endangered under the ESA in 1970. Major declines occurred in the 1960s from the effects of chlorinated hydrocarbons, including pesticides. The population was further impacted in the mid-1970s by reductions in numbers of their principle prey, the northern anchovy

(*Engraulis mordax*). Since that time, the brown pelican population has recovered dramatically (DoN 2006). There is no designated critical habitat for the California brown pelican (USFWS 1983).

Brown pelicans are diving birds that feed almost exclusively on fish, and dive from up to 60 ft in the air (Carl 1987). In the past, northern anchovies represented more than 90 percent of the diet of California brown pelicans (Anderson and Gress 1983). In recent years, however, Pacific sardine (*Sardinops sagax*) populations have been increasing and may now be common items in the California brown pelican diet. In the PACNW, Pacific herring (*Clupea pallasii*) and Pacific sand lance (*Ammodytes hexapterus*) also are frequent prey items (Burger et al. 1998).

California brown pelicans nest in colonies in Mexico and southern California, and wander north as far as British Columbia during the non-breeding period (Briggs et al. 1983). Most individuals return south to breeding colonies by January (Briggs et al. 1981, Briggs et al. 1983). Individuals roost and loaf on sandy beaches, offshore rocks, pilings, jetties, and breakwaters (Briggs et al. 1983), and large numbers can be found roosting during the winter season on sandy islands, protected from predators and winds, in Oregon and Washington. Areas of congregation during this season include Grays Harbor, Willapa Bay, and the mouth of the Columbia River (Schreiber and Schreiber 1982, Jaques and Strong 2003, Wahl et al. 2005).

After the breeding season, pelicans migrate north during the summer and early fall into northern California and the PACNW where they generally forage in the nearshore littoral zone and bay and river channels where prey are concentrated (Briggs et al. 1983). Pelicans are not strong divers and bob to the surface within seconds of submerging. Foraging offshore beyond the nearshore littoral zone is rare off Washington (Wahl and Tweit 2000).

In the Study Area, there are rare occurrences of the California brown pelican in inland marine waters of Washington, with most in the Strait of Juan de Fuca to Point No Point (Wahl et al. 2005). In northern California, large numbers of California brown pelicans can be found roosting between Trinidad and the Klamath River between July and October. In surveys conducted offshore from the mouth of Grays Harbor between 1972 and 1998, Wahl and Tweit (2000) recorded 32,533 brown pelicans, of which 97 percent were observed in channel or littoral waters (less than 65 ft deep). Nearly all the several thousand pelicans observed off Oregon and Washington by Briggs et al. (1992) were found in nearshore waters. Occurrence farther offshore during the late summer and fall appears to be rare off the PACNW.

Western Snowy Plover

The western snowy plover is a sparrow-sized shorebird with a gray-brown back marked with a white hind neck collar and white belly (Page et al. 1995). The western snowy plover was once widely distributed and abundant along the Washington, Oregon, and California coasts, but breeding populations have been reduced to about 2,000 birds (DoN 2006, USFWS 2001a). The USFWS (1993) listed the Pacific coast population as threatened in 1993. The primary agents causing declines have been habitat degradation by human disturbance (especially recreation), urban development, introduced beachgrass (*Ammophilia* spp.), and expanding predator populations (USFWS 2001a). The western snowy plover has designated critical habitat in the Study Area.

The Pacific coast population of the western snowy plover breeds in March and April. Nest sites are usually found on sandy or saline substrates with little or no vegetation or debris such as driftwood (Widrig 1980, Page and Stenzel 1981). Birds winter on coastal beaches, including sand spits, dune-backed beaches, beaches at river and creek mouths, and lagoon or estuarine saltpans (USFWS 2001a). Individuals also occasionally use bluff-backed beaches, dredged material disposal sites, salt pond levees, dry salt ponds, and river bars. Although western snowy plovers move up and down the west coast during the non-breeding season, they primarily winter on the same beaches used for breeding (Page et al. 1995). The waterlines of these beaches constitute their foraging habitat (Page et al. 1995).

In the PACNW, western snowy plovers generally feed in the wet sand or among surf-cast kelp, where they visually forage for flies, beetles, small clams and crabs, amphipods, seed shrimp (ostracods), and polychaetes (Page et al. 1995). During the winter, western snowy plovers often feed in loose flocks and roost in depressions or behind sheltering debris, such as driftwood or kelp.

The Pacific coast population of the western snowy plover extends from the mudflats and sandy beaches of Grays Harbor (Damon Point), Washington, south to Baja Sur, Mexico (DoN 2006). In the Study Area, the western snowy plover confines its habitat to the sandy beaches and mudflats of the Oregon, Washington, and California coasts (DoN 2006). This species does not occupy any of the marine or rocky shore areas found in the PACNW OPAREA.

- In Washington, western snowy plovers breed at Damon Point/Oyhut Wildlife Area, Midway Beach/Cape Shoalwater, and Leadbetter Point.
- In Oregon they nest at eight locations, including Baker Beach/Sutton Beach, Siltcoos Estuary, Oregon Dunes Overlook, Tahkenitch Estuary, Tenmile Estuary, Coos Bay North Spit, New River Spit, and Bandon State Natural Area (Stern et al. 2003).
- In northern California, nesting occurs at Eel River (gravel bars), Eel River Wildlife Area, and Clam Beach.
- During the winter, snowy plovers may be found at Midway Beach and Leadbetter Point in Washington, breeding sites in Oregon, and several sites in northern California.

Marbled Murrelet

The marbled murrelet is a small alcid with sooty brown to brownish-black upper parts, rusty margins on the back feathers, and reddish scapulars (Carter and Stein 1995). It is listed as threatened under the ESA, and has designated critical habitat in the NWTRC. Marbled murrelet populations have experienced significant population declines in the PACNW, primarily because of the removal of essential habitat by logging and coastal development (Wahl et al. 2005). Fisheries, especially gill-net fisheries, and oil spills have contributed to population declines.

The marbled murrelet occurs only in the north Pacific ranging from the Aleutian archipelago across southern Alaska and south as far as Santa Cruz County in central California (DoN 2006). They generally forage in nearshore waters within a mile of the shore (Kuletz and Marks 1997), commonly diving to depths between 10 to 100 ft to forage on small, schooling fish.

Marbled murrelets are unique among alcids in their use of old-growth forest stands near the coastline for nesting. Nesting occurs from the Aleutian Islands south through British Columbia, Washington, Oregon, and into central California. The species' wintering range is poorly documented, but includes most of the marine areas used in the breeding season (Nelson 1997). Demographic trend analyses suggest that the North American marbled murrelet population has been declining by four to seven percent per year (DoN 2006).

Offshore and Near Shore Occurrence

In the Study Area, marbled murrelets occur year-round in all inland marine waters of the Strait of Juan de Fuca, Puget Sound, and Strait of Georgia, and the entire nearshore outer coast from Cape Flattery, Washington, south to Humboldt County, California (Strong et al. 1995, Varoujean and Williams 1995). Surveys conducted between 1992 and 1999 indicated that marbled murrelets were distributed throughout the inland marine waters of Washington during the summer, with concentrations in the San Juan Islands, north Hood Canal, and south coast of the Strait of Juan de Fuca. By winter, there was a definite shift toward the more protective waters of the San Juan Islands, Hood Canal, Discovery Bay, Saratoga Passage, and Port Townsend, although some murrelets could be found throughout the summer range

(DoN 2006). Regional population monitoring conducted by the Pacific Northwest Research Division of the U.S. Forest Service (USFS) data indicate, in 2005, the average density of marbled murrelets in Conservation Zone 1 (inland waters of Puget Sound) is 11.78 per square mile (mi^2) ($4.55/km^2$) inshore areas and $2.33/mi^2$ ($0.90/km^2$) in offshore areas (USDA 2007).

Indian Island

Marbled murrelets occur within Port Townsend Bay, although according to surveys conducted by WDFW for the Puget Sound Ambient Monitoring Program (PSAMP) program, they are present in very low numbers:

- During boat surveys conducted in the area from 1993 to 1995, approximately two to four birds were sighted at one time in a few locations within Port Townsend Bay, particularly along the shoreline between the south end of Port Townsend Bay and Kala Point (WDFW 1999 as cited in DoN 2000a).
- PSAMP aerial surveys conducted from 1992 to 1999 indicated the presence of marbled murrelets throughout Port Townsend Bay during winter surveys. However, the maximum number of birds sighted in a given location was three to four birds.
- During the summer aerial surveys, the birds were sighted in many fewer locations in the Port Townsend area (one to two birds per sighting), including the north end of Indian Island and the mouth of Port Townsend Bay. However, they have been sighted infrequently on the north end of Indian Island (DoN 2000a).
- Based on annual U.S. Forest Service (USFS) surveys for marbled murrelets, in Stratum 2 of Conservation Zone 1 which includes the Indian Island area, NBK-Bangor, and the inner coastline of Whidbey Island that includes Crescent Harbor, the estimated density of birds was approximately $3.7/mi^2$ ($1.4/ km^2$) during the 2003 breeding season (Miller et al. 2006).

Naval Base Kitsap-Bangor

The following was taken from the DoN (2000a), biological assessment for explosive ordnance disposal activities. Similar to the other site locations, PSAMP boat surveys conducted in the vicinity of the Explosive Ordnance Disposal (EOD) training site located in Hood Canal indicated that marbled murrelets were present in low numbers in the area:

- Along the shoreline from Vinland to Lofall, north of the site, approximately 18.4 murrelets per mi2 (7.1/km2) were sited in 1993, and 3.6 murrelets per mi2 (1.4/km2) were sited in 1995 surveys.
- Along the shoreline from Vinland south to King Spit, no marbled murrelets were observed in the area in 1993 and 1995, and 2.1 birds per mi2 (0.8/km2) were observed in 1994.
- A few more birds (13 birds per mi2 (5.0/km2) in 1993) were observed south of King Spit to a point due east of Hazel Point on the Toandos Peninsula.
- More birds tended to be present in 1993 along the opposite shoreline of Hood Canal (along the eastern shoreline of the Toandos Peninsula).

Approximately 20.5 birds per mi^2 ($7.9/km^2$) were observed along the shoreline from Hazel Point to Brown Point and 46.1 birds per mi^2 ($17.8/ km^2$) were observed from Brown Point to the point south of Thorndyke Bay during 1993. However, few marbled murrelets were observed in this area during 1995 (2.8 birds per mi^2 ($1.1/km^2$) from Brown Point to Thorndyke Bay) (WDFW 1999). Marbled murrelets have also been identified on the canal adjacent to the Delta Pier (DoN 1999).

PSAMP aerial surveys were also conducted in Hood Canal near the EOD site from 1993 to 1999 (WDFW 2000). Few birds were sighted in summer aerial surveys in the action area (2.6-5.2 per mi^2 [1-2 per km^2]).

As stated above, in a 2003 survey during the breeding season, the USFS estimated the density of the birds to be approximately 3.7 per mi^2 (1.4/ km^2) in Stratum 2 of Conservation Zone 1 which includes NBK-Bangor (Miller et al. 2006). During the winter surveys, marbled murrelets were sighted more often, although not more than 8 birds were sighted at a given location (WDFW 2000).

Although marbled murrelets feed in the Hood Canal waters, nesting habitat is not present at NBK-Bangor (DoN 2001). There could be unidentified habitat in the Toandos Peninsula. However, WDFW Priority Habitats and Species (PHS) maps do not indicate the presence of marbled murrelet nests in the area (WDFW 1999).

Seaplane Base

Marbled murrelets have been observed around Whidbey Island throughout the year and have been observed foraging off of Polnell Point (DoN 1996a). Sightings of these birds have been infrequent at NASWI (DoN 1996a). Marbled murrelets were observed in Crescent Harbor in low numbers (one to eight birds) during PSAMP aerial surveys conducted from 1992 to 1999 (WDFW 2000). They were also observed in low numbers (one bird) during boat surveys conducted in Crescent Harbor during 1993 and 1994 (WDFW 1999).

There are no marbled murrelet nests near Crescent or Oak Harbors, although small patches of their nesting habitat type are present at NASWI (WDFW 1999, DoN 1996a). It is possible that these patches of mature forest areas may not be large enough to adequately support nesting murrelets.

3.10.1.3 Bald and Golden Eagle Protection Act Species

The bald eagle was first protected under the Federal Bald and Golden Eagle Protection Act of 1940 and was listed as threatened in the lower 48 states in 1978 under ESA. Bald eagle populations have since recovered and USFWS delisted the species in July 2007. Bald eagles are still protected under the Bald and Golden Eagle Protection Act and the MBTA. Recovery of the bald eagle has been especially dramatic in Washington State, where the number of occupied nests increased from 105 in 1980 to 840 in 2005. Bald eagle nesting territories are now found along much of the shorelines of Puget Sound. Washington State also supports the largest wintering population of bald eagles in the continental U.S. (Stinson et al 2001).

Nesting, foraging, and perching habitat for bald eagles is typically associated with water features such as rivers, lakes, and coastal shorelines where eagles prey upon fish, waterfowl, and seabirds. During the breeding season from January 1 to August 15, eagles establish and maintain territories. Nests are built in large dominant trees, primarily Douglas fir, within 3,000 ft (914 m) of open water. Bald eagle nesting territories average 2.6 mi^2 (6.7 km^2) in areas within the Puget Sound region. They are usually seen foraging in open areas having wide views. Perch sites may be used for a number of activities including hunting, consumption of prey, and resting. Foraging and roosting habitat in winter is typically the same as the nesting season. During the winter, bald eagles often congregate in the evening in communal roosts that are chosen for a favorable microclimate that protects eagles from harsh weather (Stinson et al. 2001). Bald eagles are present in the NWTRC all year.

Indian Island

According to the U.S. Navy (DoN 2005), eight active bald eagle nest territories have been identified on Indian Island. Six active bald eagle nest territories identified on Indian Island in 1996 included: Bishop Point, Boggy Spit, Crane Point, Scow Bay, Administration Building, and Walan Point (DoN 1997). The eagle nests were primarily within stands of second growth coniferous trees while other nests were found in stands containing old growth trees or deciduous trees. Based on WDFW priority species habitat maps, there are additional areas that appear to occur within these various areas that may be alternate nest sites (DoN 2000a). Suitable habitat exists on the island to support additional bald eagle territories, particularly along the western shoreline. The eagles that nest along the western shoreline likely forage in the vicinity of the training activities site at Indian Island. Migrant bald eagles also overwinter on the island (DoN 1997).

According to the WDFW priority species habitat maps, at least three bald eagle territories are present on Marristone Island, east of Indian Island. A number of bald eagle territories also occur on the Quimper Peninsula to the west of Port Townsend Bay. One territory is present along the western shoreline of Port Townsend Bay, north of Chimacum Creek (DoN 2000a). Two others are located on the west side of the peninsula near Discovery Bay, another is at the south end of Discovery Bay, and a fourth is on the west side of Discovery Bay on the Miller Peninsula (DoN 2000a).

Naval Base Kitsap-Bangor

According to the DoN (2000a), there are no bald eagle territories or nests at NBK-Bangor, although there are at least four bald eagle territories on the Toandos Peninsula. Bald eagles also nest on the Bolton Peninsula along the Dabob Bay shoreline, and along the Quilcene Bay shoreline to the west of Dabob Bay and Hood Canal. There are also bald eagle territories south of the action area near Dyes Inlet and along Hood Canal near Seabeck (WDFW 1999). Bald eagles have been observed feeding, roosting, and bathing within NBK-Bangor boundaries, and thus likely forage near training sites (DoN 2001).

Seaplane Base

According to WDFW priority species habitat maps, a number of bald eagle territories are present within Seaplane Base. Bald eagles occasionally hunt near NASWI, and nest on Polnell Point at the eastern end of Crescent Harbor, at the north end of Crescent Harbor (west of Penfold Pond), and on Maylor's Peninsula (DoN 2000a). Several nests have been located east of Crescent Harbor near Strawberry Point, and along the eastern Whidbey Island shoreline to the north of the point. A number of nests have been located along the western shoreline of Whidbey Island, to the northwest of Crescent and Oak Harbors. It is believed that eagles nesting at these various locations frequently forage in Oak and Crescent Harbors. The eagles also use a number of trees at Seaplane Base for perching and roosting (DoN 2000a).

The Integrated Natural Resources Management Plan (INRMP) for NASWI summarized a study conducted in 1995 by EDAW Inc., in collaboration with natural resource managers at NASWI, on bald eagle movement and habitat use at NASWI. The study found that a pair of eagles nesting on Polnell Point primarily used the coastal habitats within 1.1 miles of the nest tree. Another pair of eagles built a nest on the Maylor Peninsula, but did not produce any young during 1995. This pair of eagles generally used a two-mile stretch of shoreline along Crescent Harbor between Forbes Point and the Oak Harbor marina. Another pair of eagles was observed during the 1995 breeding season along the eastern half of Crescent Harbor over a three mile stretch of shoreline. This pair did not breed in 1995 (DoN 1996a).

3.10.1.4 Hearing in Birds

While little is known about the general hearing or underwater hearing capabilities of birds, research suggests an in-air maximum auditory sensitivity between 1 and 5 kilohertz (kHz) for most bird species (NMFS 2003). It is possible that birds are likely to hear some mid-frequency sound in air. However, there is little published literature on the effects of underwater sound on diving birds. A review of available literature shows that most research focused on effects of pile-driving and seismic surveys. During such studies, neither airguns nor explosives caused harm unless birds were near the detonation site (Turnpenny and Nedwell 1994).

The NMFS issued an environmental assessment in 2003 to determine whether to issue a scientific research permit for "takes" by "level B harassment" in accordance with the Marine Mammal Protection Act of 1972. As part of the environmental documentation, birds were analyzed for potential effects associated with exposure to active sonar. The operating frequency of the system was greater than 20 kHz, with a maximum source level at or less than 220 decibels (dB) at a reference pressure of 1 microPascal at 1 meter (re 1 µPa-m) in individual pulses less than one second for a duty cycle (time on over total time) of less than 10 percent. For example, in an 8-hour day, maximum sonar use would be less than 48 minutes (NMFS 2003). Although the potential hearing capability of birds was outside the proposed high frequency of the operating system, it was concluded that effects were unlikely. Even if some species were able to hear the signal, there is no evidence that birds use underwater sound. In addition, birds would not be an effective receptor because they are submerged only for short periods and birds at the surface can rapidly fly away from disturbance and annoying sounds.

3.10.2 Current Requirements and Practices

Some of the standard operating procedures and best management practices implemented by the Navy for resource protection that would reduce potential effects to birds are identified below. See Chapter 5 for details.

- Avoidance of birds and their nesting and roosting habitats provides the greatest degree of protection from potential impacts within the NWTRC Study Area. For example, pursuant to Navy instruction, measures to evaluate and reduce or eliminate bird/aircraft strike hazards to aircraft, aircrews, and birds are implemented.
- Guidance involving land or water detonations contains instructions to personnel to observe the surrounding area within 600 yards (yds) for 30 minutes prior to detonation. If diving birds (or marine mammals or sea turtles) are seen, the activity must be relocated to an unoccupied area or postponed until animals leave the area.

The Navy implements measures to avoid, minimize, or compensate for its effects on biological resources including listed species within the NWTRC. The following, which has been taken from the NASWI Bald Eagle Management Plan (DoN 1996b), describes measures taken by NASWI's Environmental Affairs Department to minimize unnecessary disturbance to bald eagles during critical time periods. The USFWS indicates that critical nesting period for eagles is from 1 January through 15 August, while critical wintering period is 15 November through 15 March.

- Measure DS-1: Prohibit all access and human activities on a year-round basis within a 100 m primary zone surrounding nests.
- Measure DS-2: Prohibit all human activity, including blasting and low level aircraft operations, within each of the identified 400 m secondary nest zones between 1 January and 31 August. The Polnell Point nest site should remain off limits to unauthorized personnel by way of the existing fence and gate.
- Measure DS-6: Inform NASWI's Operations Department of the location of all nest sites on NASWI and on Whidbey Island and instruct them to maintain at least 1,000 ft above ground level (AGL) and 0.5 mi clearance from the sites. Any changes in course rules (local flight rules) will be coordinated through the NASWI's Environmental Affairs Department.
- Measure DS-8: Limit use of the military survival training area to essential training activities during the 1 December to 1 March time period.

3.10.3 Environmental Consequences

3.10.3.1 Approach to Analysis

Regulatory Framework

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) of 1918 (16 U.S.C. 703 et seq.) and the Migratory Bird Conservation Act (16 U.S.C. 715–715d, 715e, 715f–715r) of 18 Feb 29, (45 Stat. 1222) are the primary legislation in the United States established to conserve migratory birds. These statutes implement the United States' commitment to four bilateral treaties, or conventions, for the protection of a shared migratory bird resource. Current treaties are with the countries of Great Britain, Mexico, Canada, Japan, and the Soviet Union. The MBTA prohibits the taking, killing, or possessing of migratory birds or the parts, nests, or eggs of such birds, unless permitted by regulation. The species of birds protected by the MBTA appears in Title 50, Section 10.13 of the Code of Federal Regulations (50 C.F.R. 10.13) and represents almost all avian families found in North America. In general, there are only three species that are not protected by the MBTA and they include the rock pigeon (*Columba livia*), European starling, and house sparrow. On December 2, 2003, the President signed the 2003 National Defense Authorization Act. The Act provides that the Secretary of the Interior shall exercise his/her authority under the MBTA to prescribe regulations to exempt the Armed Forces from the incidental taking of migratory birds during military readiness activities authorized by the Secretary of Defense. Take under the MBTA is defined to be unlawful at any time, by any means or in any manner, to pursue, hunt, take, capture, kill, attempt to take, capture, or kill, possess, offer for sale, sell, offer to barter, barter, offer to purchase, purchase, deliver for shipment, ship, export, import, cause to be shipped, exported, or imported, deliver for transportation, transport or cause to be transported, carry or cause to be carried, or receive for shipment, transportation, carriage, or export, any migratory bird, any part, nest, or eggs of any such bird, or any product, whether or not manufactured, which consists, or is composed in whole or part, of any such bird or any part, nest, or egg thereof, included in the terms of the conventions between the United States and Great Britain for the protection of migratory birds concluded August 16, 1916 (39 Stat. 1702), the United States and Mexico for the protection of migratory birds and game mammals concluded February 7, 1936, the United States and the Government of Japan for the protection of migratory birds and birds in danger of extinction, and their environment concluded March 4, 1972 and the convention between the United States and the Union of Soviet Socialist Republics for the conservation of migratory birds and their environments concluded November 19, 1976.

Congress defined military readiness activities as all training and operations of the Armed Forces that relate to combat and the adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat use. Congress further provided that military readiness activities do not include: (A) the routine operation of installation operating support functions, such as administrative offices, military exchanges, commissaries, water treatment facilities, storage facilities, schools, housing, motor pools, laundries, morale, welfare, and recreation activities, shops, and mess halls: (B) the operation of industrial activities; or (C) the construction of demolition of facilities used for a purpose described in (A) and (B).

The final rule authorizing the Department of Defense to take migratory birds during military readiness activities was published in the Federal Register on February 28, 2007. The regulation can be found at 50 C.F.R. Part 21. The regulation provides that the Armed Forces must confer and cooperate with the USFWS on the development and implementation of conservation measures to minimize or mitigate adverse effects of a military readiness activity if it determines that such activity may have a "significant adverse effect" on a population of a migratory bird species.

The requirement to confer with the USFWS is triggered by a determination that the military readiness activity in question will have a "significant adverse effect" on a population of migratory bird species. An activity has a significant adverse effect if, over a reasonable period of time, it diminishes the capacity of a population of a migratory bird species to maintain genetic diversity, to reproduce, and to function effectively in its native ecosystem. A population is defined as “a group of distinct, coexisting, same species, whose breeding site fidelity, migration routes, and wintering areas are temporally and spatially stable, sufficient distinct geographically (at some point of the year), and adequately described so that the population can be effectively monitored to discern changes in its status.

Migratory bird conservation relative to non-military readiness activities is addressed separately in a Memorandum of Understanding developed in accordance with Executive Order (EO) 13186, signed January 10, 2001, “Responsibilities of Federal Agencies to Protect Migratory Birds”. The Memorandum of Understanding between Department of Defense (DoD) and the USFWS was signed on July 31 2006. DoD responsibilities discussed in the Memorandum of Understanding include, but are not limited to:

(1) Obtaining permits for import and export, banding, scientific collection, taxidermy, special purposes, falconry, raptor propagation, and depredation activities;

(2) Encouraging incorporation of comprehensive migratory bird management objectives in the planning of Department of Defense planning documents;

(3) Incorporating conservation measures addressed in Regional or State Bird Conservation Plans in Integrated Natural Resource Management Plans;

(4) Managing military lands and activities other than military readiness in a manner that supports migratory bird conservation;

(5) Avoiding or minimizing impacts to migratory birds, including incidental take and the pollution or detrimental alteration of the environments used by migratory birds;

(6) Developing, striving to implement, and periodically evaluating conservation measures for management actions to avoid or minimize incidental take of migratory birds, and, if necessary, conferring with the Service on revisions to these conservation measures.

Virtually all bird species found within the NWTRC Study Area are covered by the MBTA (exceptions are noted in 3.10.1). Four of the species covered under the MBTA are also Federally listed as threatened or endangered and have additional protection under the ESA, as discussed in Section 3.10.1.2.

Endangered Species Act of 1973

This EIS/OEIS analyzes potential effects to birds in the context of the ESA, the National Environmental Policy Act (NEPA), and Executive Order (EO) 12114. For purposes of ESA compliance, effects of the action were analyzed to make the Navy's determination of effect for listed species (that is, no effect or may affect). The definitions used in making the determination of effect under Section 7 of the ESA are based on the U.S. Fish and Wildlife Service (USFWS) and NMFS *Endangered Species Consultation Handbook* (USFWS 1998).

“No effect” is the appropriate conclusion when a listed species will not be affected, either because the species will not be present or because the project does not have any elements with the potential to affect the species. “No effect” does not include a small effect or an effect that is unlikely to occur.

If effects are insignificant (in size) or discountable (extremely unlikely), a “may affect” determination is appropriate. Insignificant effects relate to the magnitude or extent of the impact (that is, they must be small and would not rise to the level of a take of a species). Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur. These factors were also considered in determining the significance of effects under the NEPA and EO 12114.

Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (16 USC 668-668c), enacted in 1940 and amended several times since, prohibits anyone without a permit issued by the Secretary of the Interior from “taking” bald eagles, including their parts, nests, or eggs. The Bald and Golden Eagle Protection Act defines “take” as “pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb.”

Study Area

The Study Area for birds includes the marine, coastal, and terrestrial environments of the NWTRC.

Data Sources

A systematic review of relevant literature and data was conducted of both published and unpublished sources. The following types of documents were used in the assessment: journals, books, periodicals, bulletins, DoD operations reports, theses, dissertations, endangered species recovery plans, species management plans, and other technical reports published by government agencies, private businesses, and consulting firms. Site-specific DoD INRMP (i.e, NASWI INRMP [DoN 1996a] and NBK-Bangor INRMP [DoN 2001]) and compliance documents were referenced during the search for geographic location data on the occurrence of resources within the NWTRC. The scientific literature was also consulted during the search for geographic location data (geographic coordinates) on the occurrence of birds within the Study Area.

Assessment Methods

Potential stressors to birds include:

- Vessel movements (disturbance and collisions) in the nearshore and offshore environments;
- Vehicle and equipment use;
- Aircraft overflights (disturbance and collisions) throughout the Study Area, including those flights within the Okanagon and Roosevelt military operating areas (MOAs) that allow flights below 3,000 ft AGL (in the Okanagon MOA, an operating floor of 300 ft AGL has been established, but is rarely used);
- Weapons firing/ordnance use (disturbance and strikes) throughout the Study Area;
- Underwater explosions and detonations in the nearshore and offshore environments;
- On land demolitions; and
- Expended materials (contact, ingestion, and entanglement) throughout the Study Area.

As previously discussed in Section 3.10.2.1, military readiness activities are exempt from the take prohibitions of the MBTA provided they do not result in a significant adverse effect on a population of a migratory bird species. The migratory bird species that are protected under ESA and the Bald and Golden Eagle Protection Act are discussed in the analyses that follow. Additionally, a BE has been prepared for the NWTRC; the BE provides detailed species descriptions and analysis of potential impacts to all threatened or endangered species and critical habitats protected under the ESA. Navy has initiated agency consultations in accordance with Section 7 of the ESA.

The potential effects of these stressors on birds are addressed in the sections that follow, with the following exceptions:

An assessment was not conducted on the effects of sonar on birds. A study documented by NMFS (2003) concluded that effects to birds from sonar were unlikely. Although some species may be able to hear sonar, several factors were identified in that section that would make effects improbable. Those factors, plus the low level of sonar use within the NWTRC (approximately 100 hours each year during training and vessels transit) would result in a low likelihood of seabird exposure. Therefore, sonar use is not addressed further.

Underwater demolition has been dismissed from evaluation of terrestrial birds. Explosions that occur in the Study Area are underwater (or at water surface) detonations that are associated with mine neutralization activities. The typical ordnance used is C-4. The distance from the nearest shoreline to detonations in Crescent Harbor and Port Townsend Bay (west side of Indian Island), is between 1,100 and 7,200 ft (300 to 2,195 m); underwater detonations are at depths between 50 and 60 ft (15 to 18 m). Detonations occur offshore of Floral Point at NBK-Bangor approximately 600 ft (183 m) offshore; underwater detonations occur in 30 ft (9 m) deep water. Given the distance from shore there would be no effects to shoreline wetland vegetation or wildlife species using the terrestrial environment (DoN 2000a).

As discussed in Section 3.2 – Air Quality and Section 3.4 – Water Resources, some air and water pollutants would be released into the environment as a result of the proposed action. The analyses presented in Sections 3.2 and 3.4 indicate that any increases in air or water pollutant concentrations resulting from Navy training in the Study Area would be negligible and localized, and impacts to air and water quality would be minor. Based on these analyses, air and water quality changes would have no effect or negligible effects on birds. Accordingly, the effects of air and water quality changes on birds are not addressed further in this EIS/OEIS.

3.10.3.2 No Action Alternative

Under the No Action Alternative, levels of activities would remain unchanged from current conditions. Birds would have the potential to be affected by vessel movement, vehicle and equipment use, aircraft overflights, weapons firing, ordnance use, explosions and detonations, on land demolitions, and expended materials. Effects of the No Action Alternative on birds, with additional attention to Federally protected species, are addressed below.

Vessel Movements

Ship movements on the ocean surface have the potential to affect birds by disturbing or striking individual animals. The probability of ship and seabird interactions occurring in the NWTRC Study Area depends on several factors, including the presence and density of birds; numbers, types, and speeds of vessels; duration and spatial extent of activities; and protective measures implemented by the Navy.

Currently, the number of Navy vessels operating in the NWTRC Study Area varies based on training schedules. Most activities involve one vessel, and usually are no more than two vessels per operation. During a year of activities, 6,940 steaming hours occur in the NWTRC, with 4,320 of those in transit, and 2,610 during training activities. Although Navy vessels are capable of much higher speeds, training activities routinely dictate slower rates of travel – typically ranging from 10 to 14 knots.

Vessel movements occur intermittently and vary in duration, from hours to days. These activities are widely dispersed throughout the NWTRC Study Area, which encompasses 122,400 square nautical miles (nm^2) of surface/subsurface ocean. Under the No Action Alternative, the Navy would log about 289 total steaming days within the Study Area during a typical year. This would represent approximately 0.06 hours (or 3 minutes) of steaming per nm^2 (less than 1 minute per km^2). Vessels would transit in the vicinity of the Important Bird Areas discussed in Section 3.10.1. Navy vessel transit in these areas would be a small portion of the current commercial and recreational vessel traffic in these Important Bird Areas, therefore would not introduce a measurable impact to birds.

Birds respond to moving vessels in various ways. Some species, such as gulls and albatross, commonly follow vessels (Hamilton 1958, Hyrenbach 2001, Hyrenbach 2006), while other species, such as plovers and curlews, seem to avoid vessels (Borberg et al., 2005, Hyrenbach, 2006). Vessel movements could elicit short-term behavioral or physiological responses, such as alert response, startle response, or fleeing the immediate area. However, the general health of individual birds is not compromised. (See additional discussion of these responses below under aircraft overflights).

Direct collisions with vessels or a vessel's rigging, such as wires, poles, or masts, could result in bird injury or mortality. Bird/vessel collisions are probably rare events during daylight hours, but the possibility of collisions could increase at night, especially during inclement weather. Birds can become disoriented at night in the presence of artificial light (Black 2005), and lighting on vessels may attract some birds (Hunter et al. 2006), increasing the potential for harmful encounters.

Based on the low density of Navy vessels and high mobility of birds, the probability of bird/vessel collisions is low. Navy mitigation measures (see Chapter 5), which include avoidance of seabird colonies and habitats where birds may concentrate, would further reduce the probability of bird/vessel collisions.

Vessel movements could result in short-term behavioral responses and low potential for injury/mortality from collisions. No long-term population level effects would result. Vessel movements under the No Action Alternative would not adversely affect populations of migratory birds and their habitat, as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, vessel movements in territorial waters would have minimal impact on birds. In accordance with EO 12114, harm to birds from vessel movements in non-territorial waters would be unlikely.

Vehicle and Equipment Use

The No Action Alternative includes land-based training activities involving personnel and/or vehicles associated with EOD; Intelligence, Surveillance, and Reconnaissance (ISR); Naval Special Warfare (NSW); and insertion and extraction activities. EOD activities involve six personnel and occasionally involve use of a small truck. These activites occur within Seaplane Base and NBK-Bangor Detonation Training Ranges (DTRs) which are previously disturbed areas cleared of vegetation. Activities are performed within a structure designed to contain a blast. ISR training activities occur, on occasion, at Seaplane Base in the survival area and involve crews of 11 personnel. Insertion and extraction activities involve delivery and withdrawal of personnel and equipment using helicopters (personnel use parachutes) within designated areas. NSW training on Indian Island would occur in off-road and trail areas, but would be limited to foot traffic. Land based activities are in the vicinity of identified Important Bird Areas, as shown in Figure 3.10-1. The Proposed Action would utilize existing training areas; no new areas would be disturbed.

Land based training activities would result in short-term effects to birds due to the presence of personnel and noise generated by training activities. Birds present in areas where exercises are taking place would be disturbed from feeding, nesting, or resting while training activities were occurring. There may be short-term displacement because of the presence of people but effects would be short-term and behaviors would be expected to return to normal after personnel had left the area. The exercises are not expected to result in chronic stress to birds based on the short duration of the exercises. There would be no change in bird populations as a result of these training activities.

Vehicle and equipment use could result in short-term behavioral responses; no long-term population level effects would result. Vehicle and equipment use under the No Action Alternative would not adversely affect populations of migratory birds and their habitat, as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, vehicle and equipment use would have minimal impacts on birds.

Aircraft Overflights

Aircraft Disturbance

Various types of fixed-wing aircraft and helicopters are used in training exercises throughout the Study Area. As such, birds could be exposed to airborne noise associated with these aircraft. Numerous studies have documented that birds respond to anthropogenic noise, including aircraft overflights, weapons firing, and explosions (National Park Service 1994, Larkin 1996, Plumpton, 2006). The manner in which birds respond to noise depends on several factors, including life-history characteristics of the species, characteristics of the noise source, loudness, onset rate, distance from the noise source, presence or absence of associated visual stimuli, and previous exposure.

Researchers have documented a variety of behavioral responses of birds to noise, such as alert behavior, startle response, flying or swimming away, diving into the water, and increased vocalizations. While they are difficult to measure in the field, some of these behavioral responses are likely accompanied by physiological responses, such as increased heart rate, or stress. Chronic stress can compromise the general health of birds, but stress does not necessarily result in negative consequences to individual birds or to populations (National Park Service 1994, Larkin 1996). For example, the reported behavioral and physiological responses of birds to noise exposure are within the range of normal adaptive responses to external stimuli, such as predation, that birds face on a regular basis. Unless they are repeatedly exposed to loud noises or simultaneously exposed to a combination of stressors, individuals may return to normal behavior and physiology almost immediately after exposure. Studies also have shown that birds can become habituated to noise following frequent exposure and cease to respond behaviorally to the noise (National Park Service 1994, Larkin 1996, Plumpton 2006).

Both fixed-wing aircraft and helicopters are used in training activities within the Study Area. Aircraft that are used below 3,000 ft (914 m) Above Ground Level (AGL) have the potential to affect birds. Helicopters used for insertion/extraction exercises including SAR actions at Seaplane Base survival area occur at less than 500 ft (152 m) AGL. Sometimes helicopters hover about 20 ft (6 m) above ground or land as described above. Air combat maneuver (ACM) flights that could affect terrestrial species occur within the Okanogan and Roosevelt MOAs, which are located in north-central Washington near the U.S.-Canadian border. ACM include basic flight maneuvers where aircraft engage in offensive and defensive maneuvering against each other. In Okanogan MOA segments B and C and Roosevelt MOA section B, the lower limit flight altitude is 300 ft (91 m); however the preponderance of air activities occur at high altitudes. The majority of flights involve EA-6B aircraft; however F/A-18 and F-16 aircraft are also used but at much lower frequency (see Section 2.3.1.1).

Under the No Action alternative, 6,855 overflights would occur above the NWTRC annually. Of these, 84 would be helicopter flights. Most overflights would occur over marine environments, at elevations in excess of 3,000 feet above mean sea level (MSL), and beyond 3 nautical miles (nm) from shore, however, flights in Military Operating Areas (MOAs) are in the vicinity of identified Important Bird Areas. The Proposed Action would utilize existing training areas; no new areas would be disturbed. Bird exposure to aircraft noise would be brief as aircraft quickly passed overhead. Exposures would be intermittent based on the mobility of birds in proximity to overflights, and repeated exposure of individual birds over a short period of time (hours or days) would be unlikely. It is quite possible that birds in the terrestrial environment would not respond to overflight noise based on the relatively high flight altitudes (above 3,000 ft) and relatively low sound exposure levels (less than 85 A-weighted dB for C-130 aircraft) for the majority of overflight activities.

Most documented responses of birds have been to low-level aircraft overflights occurring below 3,000 ft (National Park Service, 1994). Unlike the situation at a busy commercial airport or military landing field, repeated exposure of individual birds or groups of birds is unlikely within the NWTRC Study Area based on the dispersed nature of the overflights. If birds were to respond to an overflight, the responses would be limited to short-term behavioral or physiological reactions and the general health of individual birds would not be compromised.

Unlike fixed-wing aircraft, helicopter training activities often occur at low altitudes (75 to 100 ft), which increases the likelihood that birds would respond to helicopter overflights. In addition, some studies have suggested that birds respond more to noise from helicopters than that from fixed-wing aircraft (Larkin 1996, Plumpton 2006). Noise from low-altitude helicopter overflights would be expected to elicit short-term behavioral or physiological responses in exposed birds. Repeated exposure of individual birds or groups of birds would be unlikely, based on the mobility of birds in proximity to overflights. The general health of individual birds would not be compromised.

Aircraft noise from the No Action Alternative could elicit short-term behavioral or physiological responses in exposed birds, but the general health of individual birds would not be compromised. Temporal and spatial variability of training activities, in combination with temporal and seasonal distributions of bird species minimizes the potential for effects. Compared to current conditions, aircraft noise under the No Action Alternative would not adversely affect populations of migratory birds and their habitat, as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, aircraft noise would have minimal impacts on birds. In accordance with EO 12114, aircraft noise over non-territorial waters would not cause considerable harm to birds.

Aircraft Collisions

Aircraft strikes on birds are a major concern for the Navy because they can cause harm to aircrews, damage equipment, and produce bird mortality. However, the numbers of bird deaths that occur annually from all Navy activities are insignificant from a bird population standpoint. From 2002 through 2004, an annual average of 596 known wildlife/aircraft strike events occurred Navy-wide, and most of these involved birds (Navy Safety Center [NSC] 2004).

While bird strikes can occur anywhere aircraft are operated, Navy data indicate that they occur most often over land or close to shore. The potential for bird strikes to occur in offshore areas is relatively low because activities are widely dispersed and at relatively high altitudes (above 3,000 feet for fixed-wing aircraft) where bird densities are low. Table 3.10-2 summarizes Navy-wide bird strikes from 2002 through 2004, and is presented to show the types of birds affected by aircraft collisions. During this NCC Safety Center 2004).

Table 3.10-2: Summary of Naval Aircraft Bird Strikes 2002 to 2004

Type of Bird	Total Collisions Reported	% of Total
Songbirds	191	32%
Seabirds	131	22%
Raptors	103	17%
Waterfowl	42	7%
Waders	9	2%
Shorebirds	104	18%
Gamebirds	13	2%
Total	593	100%

The No Action Alternative would not result in any changes from current conditions in the numbers or durations of aircraft flights in the Study Area. Individual birds may be injured or killed by aircraft strikes, however, there would not be long-term population level effects. Aircraft strikes under the No Action

Alternative would not adversely affect migratory bird populations and their habitat, as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, aircraft strikes would have minimal impact on birds. In accordance with EO 12114, aircraft strikes over non-territorial waters would not cause considerable harm to birds.

Ordnance Use

Current Navy training activities in the NWTRC Study Area include firing a variety of weapons and employing non-explosive training rounds and explosive rounds. These include bombs, missiles, naval gun shells, cannon shells, small-caliber ammunition, and grenades. Under the No Action Alternative, the total number of expended ordnance in the Study Area would be approximately 85,700 pieces per year. Assuming all ordnance would be expended throughout the OPAREA in an even distribution, the concentration of expended rounds would be 0.7 per nm^2 (2.4 per km^2). Important Bird Areas within the vicinity NWTRC are primarily located in nearshore and intertidal areas. As discussed in Section 3.10.1, portions of the Olympic Continental Shelf Important Bird Area are located in the OPAREA. Birds in this area would potentially be affected by ordnance use. Seabirds in this area would be mobile throughout the area, foraging for food.

Birds in the vicinity of ordnance use would be vulnerable to an ordnance strike. Birds exposed to ordnance strike could suffer sub-lethal injury or death. Avoidance measures are implemented prior to and during these activities to minimize impacts to birds (see Section 3.10.2). Further, the large area over which training activities would occur in the No Action Alternative, combined with the small size of birds and their ability to flee disturbance would make direct strikes unlikely. While a few individual birds may inadvertently be affected, ordnance strikes would have no effect on species or community populations.

Individual birds may be injured or killed by ordnance, however, there would not be long-term population level effects. Ordnance strikes under the No Action Alternative would not adversely affect migratory bird populations and their habitat, as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, ordnance use would have minimal impact on birds. In accordance with EO 12114, ordnance use in non-territorial waters would not cause considerable harm to birds.

Underwater Detonations and Explosions

Explosions that occur in the Study Area are associated with training exercises that use explosive ordnance, including bombs (BOMBEX), missiles (MISSILEX), sink exercises (SINKEX) and naval gun shells (GUNEX, 5-inch high explosive rounds), as well as underwater detonations associated with EOD training. Explosive ordnance is used in offshore areas of the NWTRC, and underwater detonation is limited to a few specific training areas: Crescent Harbor Underwater EOD range, Floral Point Underwater EOD Range, and Indian Island Underwater EOD Range. (see Chapter 2 for a summary of activities by training area).

As shown in Table 2-9, under the No Action Alternative, approximately 108 bombs, 10 missiles, and 9,132 sonobuoys (includes 124 explosive sonobuoys) would be used in the OPAREA training area each year. This would produce a very low density of offshore explosions per year in the Study Area of 0.002 explosions per nm^2. Birds exposed to underwater explosions would suffer temporary effects, sub-lethal or lethal injuries, or direct mortality, in proportion to the proximity to the explosion and size of the detonation. Underwater detonations at NWTRC are single explosion events; therefore, birds attracted to debris created from a detonation would not be subjected to the hazard associated with a subsequent detonation. As previously discussed, Important Bird Areas where large numbers of birds congregate are located in nearshore and intertidal areas. Offshore explosives use is a considerable distance from areas where most birds would be expected, therefore impacts to birds from offshore explosions are possible, but have a low potential for occurrence.

Underwater detonations that occur in the Study Area are associated with mine neutralization activities. The majority of underwater detonation training would occur at Crescent Harbor (88 percent) with infrequent training at Indian Island (6 percent) and Floral Point (6 percent) at Bangor. The typical ordnance used is C4. The distance from the nearest shoreline to underwater detonation sites in Crescent Harbor and Port Townsend Bay (west side of Indian Island), is between 1,100 and 7,200 ft (300 to 2,195 m) at depths between 50 and 60 ft (15 to 18 m). Detonations occur offshore of Floral Point at NBK-Bangor approximately 600 ft (183 m) offshore in 30 ft (9 m) deep water (DoN 2000a). As described in Section 3.10.1, there are Important Bird Areas in the vicinity of these training areas. The Proposed Action would utilize existing training areas; no new areas would be disturbed.

As discussed in Chapter 2, the No Action Alternative represents baseline conditions. With respect to EOD activities, the No Action Alternative represents approximately 60 annual EOD activities in nearshore environments. Fifty-five of these would use charges containing 2.5 pounds or less of explosive; one would use 5 pounds and four would use 20 pounds of explosive. In April 2008, the Navy made the decision to relocate EOD Mobile Unit Eleven (EODMU Eleven) forces out of the NWTRC Study Area to a new homebase in Imperial Beach, CA. This move is planned to be completed in the fall of 2009. Two EOD Shore Detachments (Bangor and Northwest) will remain in the NWTRC. As a result of the EODMU Eleven relocation, mine warfare underwater detonation training will significantly decrease from a yearly maximum of 60 underwater detonations as analyzed in the No Action Alternative (the baseline) to no more than four annual underwater detonations as analyzed in Alternatives 1 and 2.

Navy resource protection measures implemented prior to EOD activities would provide a high level of protection for birds during underwater detonations (see Section 3.10.2). However, birds that may be present in proximity to these events could be disturbed and relocate, or they could be injured or killed (NMFS 2002).

Birds exposed to explosions could suffer temporary effects, sub-lethal injury, or mortality. Explosions and detonations under the No Action Alternative would not adversely affect migratory bird populations and their habitat, as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, injury to individual birds from explosions and underwater detonations is possible, however, population-level effects are not anticipated. In accordance with EO 12114, harm to individual birds from explosions and underwater detonations in non-territorial waters is possible, however, population-level harm is not anticipated.

Land Demolitions

Studies generally indicate that birds hear in-air sounds over a very limited range between 1 and 5 kHz but specific species hearing can extend to higher and lower frequencies (Beason 2003). The sensitivity of birds to disturbance may also vary during different stages of the nesting cycle. Noise may be more likely to cause nest abandonment during incubation of eggs than during brooding of chicks because birds have invested less time and energy and have a greater chance of re-nesting (Knight and Temple 1986). In a similar manner, a bird may be more likely to defend its nest later in the season because it already has invested more time and energy in reproduction and care (Grubb and Bowerman 1997, VanderWerf et al. 2000).

The effects of land demolitions on birds would be short-term and minor. Birds may be displaced and there may be temporary increases in stress levels, however, behavior and use of habitat would return shortly after the training is complete. Stewart (1982) had shown that birds exposed to up to 146 dBA within 325 ft flushed but then returned within minutes of the disturbance. Mitigation measures are implemented prior to and during these activities to minimize impacts to birds (see Section 3.10.2). Most Important Bird Areas in the vicinity of the NWTRC are in nearshore and intertidal areas. There are no Important Bird Areas identified by Audubon near the land demolition areas. Since the areas where birds are most likely to congregate is not on or near the land demolition areas, the vast number of bird species discussed previously in Section 3.10.1 would not be expected to be affected by land demolition activities. Land demolitions under the No Action Alternative would not adversely affect populations of migratory birds and their habitat, as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, land demolitions would have minimal impacts on birds.

Expended Materials

The Navy expends a variety of materials during training exercises in the NWTRC Study Area. The types and quantities of expended materials used, and information regarding fate and transport of these materials within the marine environment, are discussed in Section 3.3 (Hazardous Materials) and Section 3.4 (Water Resources). The analyses in these sections determined that most expended materials rapidly sink to the sea floor, become encrusted by natural processes, and become incorporated into the sea floor, with no substantial accumulations in any particular area and no measurable negative effects to water quality or marine benthic communities. Nonetheless, birds could be exposed to some expended materials via contact and ingestion.

Birds of all sizes and species are known to ingest a wide variety of marine debris, which they might mistake for prey. Plastic bags and plastic sheeting are most commonly swallowed by birds but balloons, Styrofoam beads, monofilament fishing line, and tar are also known to be ingested (Lutz 1990, Bjorndal et al 1994, Tomas 2002).

Marine debris can pass through the digestive tract and be voided naturally without causing harm, or it can cause sub-lethal or lethal effects. Sub-lethal effects include nutrient dilution, which occurs when non-nutritive debris displaces nutritious food in the gut, leading to slow growth or reduced reproductive success (McCauley and Bjorndal, 1999).

Lutz (1990) found that hungry birds will actively seek and consume marine debris if other food is not available. In most cases, this debris passed through the gut within a few days, but latex was found to take up to 4 months to clear the intestinal system. While ingestion of marine debris has been linked to bird mortalities, sub-lethal effects are more common (Bjorndal et al 1994, Tomas 2002, McCauley and Bjorndal 1999).

Ordnance and Ordnance-Related Materials

Expended materials resulting from ordnance use include remnants and shrapnel from explosive rounds and non-explosive training rounds. These solid materials, many of which have a high metal content, quickly drop through the water column to the sea floor where they could be available for ingestion by benthic foraging birds. Ingestion of expended ordnance does not occur in the water column because ordnance-related materials quickly sink.

The probability of birds ingesting expended ordnance depends on factors such as the location of the spent material, size of the material, likelihood the material would be mistaken for prey, and extent of benthic foraging that occurs in the impact area. Some materials, such as non-explosive training bombs, would be too large to be ingested by a bird, but other materials such as small-caliber ammunition and shrapnel are small enough to be swallowed. While the literature indicates that commonly ingested items such as drifting balloons or plastic bags might be mistaken for jellyfish or other prey, there are cases of animals ingesting items such as plastic caps that do not resemble prey (Barreiros 2001). It is possible that persistent expended ordnance could be colonized by benthic organisms (such as clams and oysters) and then mistaken by birds for prey, or that expended ordnance could be accidentally ingested by birds while they were foraging for natural prey items.

Under the No Action Alternative, the total number of expended ordnance in the Study Area would be approximately 85,700 pieces per year. Rounds would be expended in the OPAREA, a 122,400 square nautical mile (nm^2 [420,000 square kilometer (km^2)]) offshore training area. Assuming all ordnance was expended in the OPAREA and an even distribution, the concentration of expended rounds would be 0.7 per nm^2 (0.2 per km^2).

It is highly unlikely that benthic foraging by birds would occur in areas of ordnance use, or that ingestion of expended ordnance would affect birds. Most benthic foraging by birds occurs in nearshore areas (Lutcavage et al. 1997). Except for EOD detonations in nearshore environments, all ordnance use would occur in areas more than 3 nm offshore where water depths in excess of 3,000 ft would exclude benthic foraging.

Ordnance-related materials under the No Action Alternative would not adversely affect migratory bird populations and their habitat, as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, ordnance-related materials would have minimal impact on birds. In accordance with EO 12114, harm to birds from ordnance-related materials would be unlikely in non-territorial waters.

Target-Related Materials

A variety of at-sea targets are used in the OPAREA, ranging from high-technology, remotely operated airborne and surface targets (such as airborne drones) to low-technology, floating, at-sea targets (such as inflatable targets) and airborne, towed banners. Many of the targets are designed to be recovered for reuse and are not destroyed during training. The expendable targets used in the Study Area include the Expendable Mobile ASW Training Target (EMATT) and MK-58 marine marker. These units are 2 and 3 feet in length, respectively, sink to the bottom intact, and present no ingestion hazard to birds.

MK-58 marine markers produce chemical flames and surface smoke and are used in training exercises to mark an ocean surface position to simulate divers, ships, and points of contact. The smoke dissipates in the air and has little or no effect on birds. The marker burns similarly to a flare, producing a flame until all combustible components have been consumed. Approximately 208 MK-58 marine markers would be used in the Study Area under the No Action Alternative. Based on the large size of the Study Area, low number of markers used, and abilities of birds to readily disperse from disturbance, it is very unlikely that birds would be measurably affected by use of marine markers.

Target and marine maker use under the No Action Alternative would not adversely affect migratory bird populations and their habitat, as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, targets and marine markers would have minimal impacts on birds. In accordance with EO 12114, harm to birds from targets and marine markers would be unlikely in non-territorial waters.

Entanglement

Debris such as parachute lines or shrouds may be encountered by birds in the waters of the NWTRC. Entanglement in persistent marine debris causes mortality in birds in the eastern Pacific Ocean. Birds that become entangled could drown, starve to death, lose a limb, or attract predators with their struggling. There is a potential for birds to become entangled in expended materials that are on or near the surface. Materials that are expended in training exercises, including sonobuoys and markers usually sink shortly after they are deployed. As a result, the potential for entanglement in these materials is low.

Under the No Action Alternative, approximately 9,132 sonobuoy parachutes are deployed and not recovered. These parachutes deliver sonobuoys and a variety of targets and markers during training exercises. Assuming all parachutes were expended throughout the OPAREA over an even distribution, the concentration of entanglement hazards would be 0.07 per nm^2 per year (0.02 per km^2). Given the low concentration of entanglement hazards, the potential for bird entanglement in Navy debris would be low.

Entanglement hazards under the No Action Alternative would not adversely affect migratory bird populations as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, marine debris would have minimal impacts on birds. In accordance with EO 12114, harm to birds from marine debris would be unlikely in non-territorial waters.

Threatened and Endangered Species and Critical Habitat

Within the NWTRC, endangered species include the short-tailed albatross and California brown pelican; threatened species include the western snowy plover and marbled murrelet. The western snowy plover and marbled murrelet also have designated critical habitat within the NWTRC.

On November 7, 2008, USWFS issued a Biological Opinion (USFWS 2008) for Navy EOD Operations, Puget Sound. The Biological Opinion applies to Navy's ongoing EOD training conducted from the date of the Biological Opinion through December 31, 2009. The Navy has determined that EOD training through December 31, 2009 will include six underwater detonations (each limited to 2.5 lb charge) and two surface or floating mine detonations (each limited to 2.5 lb charge), and will only occur at Crescent Harbor. The Biological Opinion determined that these EOD training activities would result in the following:

- incidental take in the form of harm (through mortalitiy or sublethal injury) to no more than four marbled murrelets from elevated underwater sound pressure levels resulting from the six underwater detonations in November 2008 and February and July 2009.
- incidental take in the form of harm (through damage to ears) to all murrelets within approximately 69.7 nm2 (239 km2) of the detonation site from elevated underwater sound pressure levels resulting from the six underwater detonations in November 2008 and February and July 2009.
- incidental take in the form of harassment (through significant disruption of normal breeding, foraging, and sheltering behaviors) to all murrelets within approximately 69.7 nm2 (239 km2) of the detonation site from elevated underwater and above water sound pressure levels from the six underwater and two floating mine training exercises taking place between November 2008 and December 2009.

The Biological Opinion concluded that this level of anticipated take is not likely to result in jeopardy to the marbled murrelet species. USFWS also stated that "…no reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of murrelets. Measures that are designed to minimize impacts to murrelets have been incorporated by the Navy…" The terms and conditions included in USFWS' Biological Opinion require Navy to monitor and report the impacts of the incidental take.

The findings of USFWS' Biological Opinion have been used in the analysis for this EIS/OEIS. Utilizing criteria and analysis methodology as presented for non-listed species, vessel movements, aircraft overflight, ordnance use, underwater detonations and military expended materials (entanglement) may affect individual short-tailed albatross; however, these activities would not have community or population level effects. Vessel movements, aircraft overflights and underwater detonations may affect individual marbled murrelets and individual California brown pelicans, but the activities would not have community or population level effects. Aircraft overflights and underwater detonations may affect individual western snowy plovers, but would not have community or population level effects. Proposed NWTRC activities would not destroy or adversely modify critical habitat for the marbled murrelet or the western snowy plover.

The No Action Alternative may affect threatened and endangered species in the NTWRC. Implementation of the No Action Alternative would not destroy or adversely modify critical bird habitat in the NWTRC. As part of the EIS/OEIS process, Navy has prepared a BE for the NWTRC for use, as appropriate, in agency consultations. The BE provides detailed descriptions and analysis of the potential impacts to all threatened and endangered species and critical habitats protected under the ESA. Navy has initiated agency consultations in accordance with Section 7 of the ESA.

Bald and Golden Eagle Protection Act

As discussed in Section 3.10.1.3, bald eagles are common in areas of the NWTRC. A study of bald eagles determined that military activity disturbed birds to a limited extent, but the activity was not disruptive enough to preclude heavy usage of the Study Area by eagles (Stalmaster 1987). According to the NASWI Bald Eagle Management Plan (1996b), there is little indication that activities at NASWI have resulted in negative effects on bald eagles.

Vessel movements would have no impact on bald eagles, based on low Navy vessel density, transitory occurrence of bald eagles in nearshore and offshore areas, and the ability of bald eagles to avoid Navy vessels.

According to the USFWS, critical nesting period for eagles is 1 January through 15 August, and critical wintering period is 15 November through 15 March. The Navy implements measures to avoid and minimize unnecessary disturbance to bald eagles during critical time periods. Navy prohibits all access and human activities within a 100 m primary zone surrounding bald eagle nests; prohibits all human activity within each of the identified 400 m secondary nest zones between 1 January and 31 August; aircraft maintain at least 1,000 ft (152 m) above nest sites; and use of the military survival training area is limited to essential training activities during the 1 December to 1 March time period.

Because of the controlled and infrequent nature of Navy training activities, and the short-time frame that aircraft are present in an area, eagles would resume normal use of an area once the disturbance had ceased. As such, aircraft overflights would have minor impacts on bald eagles.

Current Navy training activities in the NWTRC Study Area include firing a variety of non-explosive training rounds and explosive rounds. Direct ordnance strikes from firing weapons are possible, but unlikely. Rounds are fired at targets; human activity such as vessel movement, aircraft overflights, and target setting could cause birds to flee a target area prior to the onset of firing, thus avoiding harm. Ordnance use may affect bald eagles, however, Navy mitigation measures minimize disturbance to of bald eagles.

Underwater explosions and detonations that occur in the Study Area may result in a minor and temporary startling effect to bald eagles. Explosions could kill prey sources (i.e., fish) for bald eagles, however, fish killed by blasts would not measurably alter food supply. In addition, precautionary measures are implemented to ensure that detonation does not occur when eagles or other birds are present. Expended materials are not expected to affect the bald eagle.

Vehicle and equipment use and personnel presence involved in NWTRC land based training would not affect bald eagles. Research has indicated that bald eagles are often more disturbed by pedestrians than vehicles, machinery, or generalized noise (DoN 2000a). Given the small number of personnel and the controlled, infrequent training events, it is unlikely that eagles would be displaced. Eagles would avoid the area while personnel and equipment were present for training activities but would resume normal activities once training had ceased. Insertion and extraction activities would not be conducted in areas of nesting eagles, particularly during critical time periods.

Land demolition training at the established DTRs would not adversely affect bald eagles. Given the distance of the detonations from the nests at Seaplane Base, the USFWS determined that EOD activities would not adversely affect the bald eagle (DoN 1996b). Eagle use in the vicinity of the EOD DTR is low (DoN 1996b). Given the potential for eagles to become habituated to noise there would be no long-term effect from land demolitions on eagle populations at Seaplane Base. Due to the infrequency of land demolitions that occur at NBK-Bangor and the low use of the site by eagles, there would be no long-term population level effect of land demolition on bald eagles. Eagles that may be in the vicinity when demolitions are occurring would avoid the area and displace to suitable adjacent habitat for feeding; they would be expected to return to normal use of the area once training activities ceased.

The No Action Alternative would not adversely affect the bald eagle as defined by the Bald and Golden Eagle Protection Act, or MBTA regulations applicable to military readiness activities. In accordance with the NEPA, the No Action Alternative would have minimal impacts on the bald eagle on land or in territorial waters. In accordance with EO 12114, harm to bald eagles from the No Action Alternative would be unlikely in non-territorial waters.

The No Action Alternative is not expected to disturb, or result in take of, bald eagles as defined by the Bald and Golden Eagle Protection Act.

Migratory Bird Treaty Act

The No Action Alternative would not diminish the capacity of a population of a migratory bird species to maintain genetic diversity, to reproduce, and to function effectively in its native ecosystem. The proposed action would not adversely affect migratory bird populations. As a result and in accordance with 50 CFR Part 21, the Navy is not required to confer with the USFWS on the development and implementation of conservation measures to minimize or mitigate adverse effects to migratory birds that are not listed under the ESA.

3.10.3.3 Alternative 1

Potential impacts to birds resulting from implementation of Alternative 1 are similar to those previously described for the No Action Alternative. As discussed in Chapter 2, some activities in the NWTRC Study Area would increase under Alternative 1 relative to the baseline No Action Alternative.

Vessel Movements

As discussed for the No Action Alternative, the number of Navy vessels operating in the NWTRC Study Area would vary based on training schedules. Under Alternative 1, steaming hours would increase by four percent over current conditions to 7,228 hours. Vessel movements would be widely dispersed throughout the NWTRC Study Area, with approximately 0.06 hours of steaming per nm^2. The small increase in steaming hours would not measurably increase potential effects to birds from disturbance or vessel collision. Impacts would be the same as those described for the No Action Alternative.

Vessel movements under Alternative 1 would not adversely effect migratory bird populations as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, vessel movements in territorial waters would have minimal impact on birds. In accordance with EO 12114, harm to birds from vessel movements in non-territorial waters would be unlikely.

Aircraft Overflights

Aircraft Disturbance

Under Alternative 1, overflights above the NWTRC would increase by 18 percent over the No Action Alternative level, to 8,077 overflights annually. The vast majority of these would be below 3,000 feet; 93 would be helicopter flights. As discussed for the No Action Alternative, most flights would over marine environments, at elevations in excess of 3,000 ft, and beyond 3 nm. Most sound exposure levels would be lower than 97 dBA because a majority of the overflights would occur above 3,000 ft. Impacts to birds from aircraft disturbance would be the same as those described for the No Action Alternative. Under Alternative 1, aircraft overflight noise would elicit short-term behavioral responses in exposed birds, but the general health of individual birds would not be compromised.

As discussed for the No Action Alternative, relatively few navy aircraft strike birds each year. The potential for bird strikes to occur offshore is low because activities are widely dispersed and altitudes above 3,000 ft where bird densities are low. The proposed increase in aircraft overflights would not measurably change impacts from those described for the No Action Alternative. Few, if any, birds would be struck by Navy aircraft under Alternative 1.

Aircraft overflights under Alternative 1 would not adversely effect migratory bird populations as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, aircraft overflights would have minimal impact on birds. In accordance with EO 12114, harm to birds from aircraft overflights in non-territorial waters would be unlikely.

Ordnance Use

Under Alternative 1, approximately 106,000 pieces of ordnance would be fired. Assuming an even distribution of exercises, this would result in 0.85 pieces of ordnance per nm^2 (0.25 per km^2). As described for the No Action Alternative, the potential for birds to be struck by ordnance is low, given the ability of birds to flee from disturbance, and low concentration of dispersed rounds. Individual birds may be affected, but ordnance strikes would have no effect on species or community populations. Avoidance measures are implemented prior to and during these activities to minimize impacts to birds (see Section 3.10.2).

Under Alternative 1, the potential for birds to be injured or killed by ordnance exists, but likelihood of this occurring is very low. Ordnance use would not adversely effect migratory bird populations as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, ordnance use would have minimal impact on birds. In accordance with EO 12114, harm to birds from ordnance use in non-territorial waters would be unlikely.

Underwater Explosions and Detonations

As shown in Table 2-9, underwater explosions that occur in the offshore areas of the NWTRC are associated with explosive ordnance use. Under Alternative 1, approximately 144 bombs, 35 missiles, and 9,422 sonobuoys (includes 136 explosive sonobuoys) would be used in the OPAREA training area each year. This would produce a very low density of offshore explosions per year in the Study Area of less than 0.003 explosions per nm^2. Birds exposed to underwater explosions would suffer temporary effects, sub-lethal or lethal injuries, or direct mortality, in proportion to the proximity to the explosion and size of the detonation. Underwater detonations at NWTRC are single explosion events; therefore, birds attracted to debris created from a detonation would not be subjected to the hazard associated with a subsequent detonation. As previously discussed, Important Bird Areas where large numbers of birds congregate are located in nearshore and intertidal areas. Since offshore explosives use is a considerable distance from areas where most birds would be expected, impacts to birds from explosions are possible, but have a low potential for occurrence.

Under Alternative 1, the number of underwater detonations and net explosive weight of underwater detonations would decrease by more than 90 percent from baseline conditions. Under Alternative 1, two detonations (2.5-lb net explosive weight each) would occur per year at Crescent Harbor; one detonation (2.5-lb net explosive weight) would occur at Floral Point; and one detonation (2.5-lb net explosive weight) would occur at Indian Island. Detonations would occur either at water surface, or underwater at depth. As described for the No Action Alternative, birds in proximity to these events could be affected, but the rate of occurrence of these effects would be reduced considerably from baseline conditions. Avoidance measures are implemented prior to and during these activities to minimize impacts to birds (see Section 3.10.2).

Birds exposed to explosions could suffer temporary effects, sub-lethal injury or mortality. Under Alternative 1, the potential for birds to be injured by explosions exists, the chance of this occurrence is reduced considerably since the number of detonations is reduced by more than 90 percent from baseline conditions. Under Alternative 1, underwater explosions and detonations would not adversely effect migratory bird populations as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, injury to individual birds from underwater explosions and detonations in territorial waters is possible, however, population-level effects are not anticipated. In accordance with EO 12114, harm to individual birds from underwater explosions and detonations in non-territorial waters is possible, however, population-level harm is not anticipated.

Land Demolitions

Under Alternative 1, the effects of land demolitions on birds would be short-term and minor. Birds may be displaced and there may be temporary increases in stress levels, however, behavior and use of habitat would return shortly after the training is complete. Mitigation measures are implemented prior to and during these activities to minimize impacts to birds (see Section 3.10.2). Most Important Bird Areas in the vicinity of the NWTRC are in nearshore and intertidal areas. There are no Important Bird Areas identified by Audubon near the land demolition areas. Since the areas where birds are most likely to congregate is not on or near the land demolition areas, the vast number of bird species discussed previously in Section 3.10.1 would not be expected to be affected by land demolition activities. Land demolitions under Alternative 1 would not adversely affect populations of migratory birds and their habitat, as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, land demolitions would have minimal impacts on birds.

Expended Materials

Under Alternative 1, the total number of expended ordnance in the Study Area would be approximately 106,000 pieces per year. Assuming an even distribution throughout the OPAREA, the concentration of expended rounds would be approximately 0.78 pieces per nm^2 (0.25 per km^2). It is highly unlikely that benthic foraging by birds occurs in the area where ordnance would be found in the benthic environment. With the exception of EOD detonations in nearshore environments, all ordnance use would occur in areas more than three nm offshore where water depths in excess of 3,000 ft. Under Alternative 1, ingestion of expended ordnance may affect birds, but this affect would be discountable.

Use of targets and marine markers would increase by 15 percent under Alternative 1 to a total of 532. As discussed for the No Action Alternative, the expendable targets used in the Study Area are the EMATT and the MK-58 Marine Marker. The modest change in use of these materials would not measurably change the impacts to birds over existing conditions. Thus, effects would be the same as those described for the no Action Alternative.

Under Alternative 1, approximately 9,422 sonobuoy parachutes would be deployed and not recovered. Assuming an even distribution, the concentration of entanglement hazards would be 0.08 per nm^2 (0.02 per km^2). As described for the No Action Alternative, given the infrequent occurrence of birds in the Study Area and the low concentration of entanglement hazards, the potential for bird entanglement in Navy debris would be low.

Expended materials under the Alternative 1 would not adversely effect migratory bird populations as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, expended materials would have minimal impact on birds. In accordance with EO 12114, harm to birds from expended materials in non-territorial waters would be unlikely.

Threatened and Endangered Species and Critical Habitat

Within the NWTRC, endangered species include the short-tailed albatross and California brown pelican; threatened species include the western snowy plover and marbled murrelet. The western snowy plover and marbled murrelet also have designated critical habitat within the NWTRC.

Under Alternative 1, underwater detonations would be similar to those assessed by USFWS for their 2008 Biological Opinion for Navy EOD Operations, Puget Sound (USFWS 2008). As discussed for the No Action Alternative, the Biological Opinion determined that the EOD training activities would result in incidental take (in the form of harm through mortality or sublethal injury) to no more than four marbled murrelets, incidental take (in the form of harm through damage to ears) to all murrelets within approximately 69.7 nm^2 (239 km^2) of the detonation site, and incidental take (in the form of harassment through significant disruption of normal breeding, foraging, and sheltering behaviors) to all murrelets within approximately 69.7 nm^2 (239 km^2) of the detonation site. The Biological Opinion concluded that this level of anticipated take is not likely to result in jeopardy to the marbled murrelet species. USFWS also stated that "…no reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of murrelets. Measures that are designed to minimize impacts to murrelets have been incorporated by the Navy…" The terms and conditions included in USFWS' Biological Opinion require Navy to monitor and report the impacts of the incidental take.

Utilizing criteria and analysis methodology as presented for non-listed species, vessel movements, aircraft overflight, ordnance use, underwater detonations and military expended materials (entanglement) under Alternative 1 may affect individual short-tailed albatross; however, these activities would not have community or population level effects. Vessel movements, aircraft overflights and underwater detonations may affect individual marbled murrelets and individual California brown pelicans, but the activities would not have community or population level effects. Aircraft overflights and underwater detonations may affect individual western snowy plovers, but would not have community or population level effects. Proposed NWTRC activities would not destroy or adversely modify critical habitat for the marbled murrelet or the western snowy plover.

Implementation of Alternative 1 may affect threatened and endangered species in the NWTRC. Implementation of Alternative 1 would not destroy or adversely modify critical bird habitat in the NWTRC. As part of the EIS/OEIS process, Navy has prepared a BE for the NWTRC for use, as appropriate, in agency consultations. The BE provides detailed descriptions and analysis of the potential impacts to all threatened and endangered species and critical habitats protected under the ESA. Navy has initiated agency consultations in accordance with Section 7 of the ESA.

Bald and Golden Eagle Protection Act

Impacts to bald eagles resulting from implementation of Alternative 1 would be similar to those described for the No Action Alternative. Vessel movements would have no impact on bald eagles, based on low Navy vessel density, transitory occurrence of bald eagles in nearshore and offshore areas, and the ability of bald eagles to avoid Navy vessels.

Because of the controlled and infrequent nature of Navy training activities, the limited number of flights under 3,000 ft, and the short-time frame that aircraft are present in an area, if eagles were to be disturbed by occasional aircraft, they would resume normal use of an area once the disturbance had ceased. As such, aircraft overflights under Alternative 1 would have minor impacts on bald eagles.

As with the No Action Alternative, under Alternative 1, direct ordnance strikes from firing weapons are possible, but unlikely. Ordnance use may affect on bald eagles, however, Navy mitigation measures minimize disturbance to bald eagles. Underwater explosions and detonations that occur in the Study Area may result in a minor and temporary startling effect to bald eagles. Explosions and detonations may kill eagle prey, however would not measurably alter food supply. Precautionary measures are implemented to ensure that detonation does not occur when eagles are present. Expended materials are not expected to affect the bald eagle.

Under Alternative 1, vehicle and equipment use and personnel presence involved in NWTRC land based training would not affect bald eagles. Given the small number of personnel and the controlled, infrequent training events, it is unlikely that eagles would be displaced. Eagles would avoid the area while personnel and equipment were present for training activities but would resume normal activities once training had ceased. Insertion and extraction activities would not be conducted in areas of nesting eagles, particularly during critical time periods.

Land demolition training at the established DTRs under Alternative 1 would not adversely affect bald eagles. Eagles that may be in the vicinity when demolitions are occurring would avoid the area and displace to suitable adjacent habitat for feeding. They would be expected to return to normal use of the area once training activities ceased.

Implementation of Alternative 1 would not adversely affect the bald eagle as defined by the Bald and Golden Eagle Protection Act, or MBTA regulations applicable to military readiness activities. In accordance with the NEPA, Alternative 1 would have minimal impacts on the bald eagle on land or in territorial waters. In accordance with EO 12114, harm to bald eagles from the Alternative 1 would be unlikely in non-territorial waters.

Alternative 1 is not expected to disturb, or result in take of, bald eagles as defined by the Bald and Golden Eagle Protection Act.

Migratory Bird Treaty Act

Implementation of Alternative 1 would not diminish the capacity of a population of a migratory bird species to maintain genetic diversity, to reproduce, and to function effectively in its native ecosystem. The proposed action would not adversely affect migratory bird populations. As a result and in accordance with 50 CFR Part 21, the Navy is not required to confer with the USFWS on the development and implementation of conservation measures to minimize or mitigate adverse effects to migratory birds that are not listed under the ESA.

3.10.3.4 Alternative 2

Potential impacts to birds resulting from implementation of Alternative 2 are similar to those previously described for the No Action Alternative, and Alternative 1. As discussed in Chapter 2, some activities in the NWTRC Study Area would increase under Alternative 2 relative to the baseline No Action Alternative.

Vessel Movements

The ten percent increase in steaming hours over current conditions would result in about 318 total steaming days within the Study Area during a typical year (approximately 0.06 hours of steaming per nm^2). Impacts to birds from vessel movement would, therefore, be the same as those described for the No Action Alternative and Alternative 1.

Vessel movements under Alternative 2 would not adversely effect migratory bird populations as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, vessel movements in territorial waters would have minimal impact on birds. In accordance with EO 12114, harm to birds from vessel movements in non-territorial waters would be unlikely.

Aircraft Overflights

Aircraft overflights would increase by approximately 54 percent to 10,582 per year under Alternative 2. Of these, 93 would be helicopter flights. As described for the other alternatives, most flights would occur beyond three nm at elevations in excess of 3,000 ft MSL.

As discussed in the analyses for the No Action Alternative and Alternative 1, bird responses to noise from aircraft overflights would be limited to short-term behavioral or physiological reactions and the general health of individual birds would not be compromised. Aircraft noise effects of Alternative 2 would be the same as the described for the other alternatives.

As described for the No Action Alternative and Alternative 1, the potential for bird strikes to occur in offshore areas is relatively low because activities are widely dispersed and at relatively high altitudes where bird densities are low. Few, if any, aircraft strikes are expected to occur in the NWTRC Study Area.

Aircraft overflights under Alternative 2 would not adversely effect migratory bird populations as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, aircraft overflights would have minimal impact on birds. In accordance with EO 12114, harm to birds from aircraft overflights in non-territorial waters would be unlikely.

Ordnance Use

As described for the other alternatives, birds could be vulnerable to ordnance strikes. Under Alternative 2, the increase in ordnance use would result in 1.5 pieces of ordnance used per nm^2 of the offshore areas. However, the potential for birds to experience strike would remain quite low. Avoidance measures are implemented prior to and during these activities to minimize impacts to birds (see Section 3.10.2). The large area of ordnance use, small size of the birds, and ability of birds to readily flee would make direct strikes unlikely. Individual birds may be affected, but ordnance strikes would have no effect on species or community populations.

Ordnance strikes under Alternative 2 would not adversely effect migratory bird populations as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, ordnance use would have minimal impact on birds. In accordance with EO 12114, harm to birds from ordnance use in non-territorial waters would be unlikely.

Underwater Explosions and Detonations

Underwater explosions that occur in the offshore areas of the NWTRC are associated with explosive ordnance use. As shown in Table 2-9, under Alternative 2, approximately 144 bombs, 57 missiles, and 9,651 sonobuoys (includes 149 explosive sonobuoys) would be used in the OPAREA training area each year. This would produce a very low density of offshore explosions per year in the Study Area of less than 0.003 explosions per nm^2. Birds exposed to underwater explosions would suffer temporary effects, sub-lethal or lethal injuries, or direct mortality, in proportion to the proximity to the explosion and size of the detonation. Underwater detonations at NWTRC are single explosion events; therefore, birds attracted to debris created from a detonation would not be subjected to the hazard associated with a subsequent detonation. As previously discussed, Important Bird Areas where large numbers of birds congregate are located in nearshore and intertidal areas. Since offshore explosives use is a considerable distance from areas where most birds would be expected, impacts to birds from explosions are possible, but have a low potential for occurrence.

Under Alternative 2, the number of underwater detonations and net explosive weight of underwater detonations would decrease by more than 90 percent from baseline conditions. Under Alternative 2, two detonations (2.5-lb net explosive weight each) would occur per year at Crescent Harbor; one detonation (2.5-lb net explosive weight) would occur at Floral Point; and one detonation (2.5-lb net explosive weight) would occur at Indian Island. Detonations would occur either at water surface, or underwater at depth. Birds in proximity to these events could be disturbed and relocate, or be injured or killed. The rate of occurrence of these effects would be reduced considerably from baseline conditions. Navy avoidance measures (see Section 3.10.2) implemented prior to EOD activities would provide a high level of protection for birds during underwater detonations, and the likelihood of birds being affected is expected to be quite low.

Birds exposed to explosions could suffer temporary effects, sub-lethal injury or mortality. Under Alternative 2, the potential for birds to be injured by explosions exists, however, the chance of this occurrence is reduced considerably since the number of detonations is reduced by more than 90 percent from baseline conditions. Underwater explosions and detonations under Alternative 2 would not adversely effect migratory bird populations as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, injury to individual birds from underwater explosions and detonations in territorial waters is possible, however population-level effects are not anticipated. In accordance with EO 12114, harm to individual birds from underwater explosions and detonations in non-territorial waters is possible, however, population-level harm is not anticipated.

Land Demolitions

Under Alternative 2, the effects of land demolitions on birds would be short-term and minor. Birds may be displaced and there may be temporary increases in stress levels, however, behavior and use of habitat would return shortly after the training is complete. Mitigation measures are implemented prior to and during these activities to minimize impacts to birds (see Section 3.10.2). Most Important Bird Areas in the vicinity of the NWTRC are in nearshore and intertidal areas. There are no Important Bird Areas identified by Audubon near the land demolition areas. Since the areas where birds are most likely to congregate is not on or near the land demolition areas, the vast number of bird species discussed previously in Section 3.10.1 would not be expected to be affected by land demolition activities. Land demolitions under Alternative 2 would not adversely affect populations of migratory birds and their habitat, as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, land demolitions would have minimal impacts on birds.

Expended Materials

Under Alternative 2, the total number of expended ordnance in the Study Area would be approximately 183,700 pieces per year. Assuming all ordnance would be expended in offshore areas and an even distribution, the concentration of expended rounds would be 1.5 per nm^2 (0.4 per km^2).

As described for the other alternatives, with the exception of EOD detonations in nearshore environments, all ordnance use would occur in areas more than 3 nm offshore where water depths in excess of 3,000 feet, excluding seabird benthic foraging. Although a small potential for expended materials to be ingested by birds may exist, the low concentration of expended rounds and the great depth to benthic habitats in the training area would make this occurrence highly unlikely.

Under Alternative 2, approximately 724 at-sea targets and marine markers would potentially be used in the OPAREA. As described for the other alternatives, many of the targets are designed to be recovered for reuse, but the EMATT and the MK-58 Marine Marker would be expended. These units are 2 and 3 ft in length, respectively, sink to the bottom intact, and present no ingestion hazard to birds.

Under Alternative 2, 220 marine markers would be used in the Study Area under, as compared to 208 under the No Action. Effects would thus, be the same as those described above – it would be very unlikely that birds would be measurably affected by use of marine markers. Target and marine marker use under the Alternative 2 may affect birds, but the effects would be small because of the low number of targets and markers used.

Under Alternative 2, approximately 9,651 sonobuoy parachutes would be deployed in offshore areas and not recovered. Assuming an even distribution, the concentration of entanglement hazards would be 0.08 per nm^2 (0.02 per km^2). Given the low concentration of hazards, the potential for bird entanglement in Navy debris would be low. Under Alternative 2, birds may be affected by entanglement in Navy debris, but the effects would be small because of the infrequent occurrence of birds and low concentration of debris.

Expended materials would not adversely effect migratory bird populations as defined by MBTA regulations applicable to military readiness activities. In accordance with the NEPA, expended materials would have minimal impact on birds. In accordance with EO 12114, harm to birds from expended materials in non-territorial waters would be unlikely.

Threatened and Endangered Species and Critical Habitat

Within the NWTRC, endangered species include the short-tailed albatross and California brown pelican; threatened species include the western snowy plover and marbled murrelet. The western snowy plover and marbled murrelet also have designated critical habitat within the NWTRC.

Under Alternative 2, underwater detonations would be similar to those assessed by USFWS for their 2008 Biological Opinion for Navy EOD Operations, Puget Sound (USFWS 2008). As discussed for the No Action Alternative and Alternative 1, the Biological Opinion determined that the EOD training activities would result in incidental take (in the form of harm through mortality or sublethal injury) to no more than four marbled murrelets, incidental take (in the form of harm through damage to ears) to all murrelets within approximately 69.7 nm^2 (239 km^2) of the detonation site, and incidental take (in the form of harassment through significant disruption of normal breeding, foraging, and sheltering behaviors) to all murrelets within approximately 69.7 nm^2 (239 km^2) of the detonation site. The Biological Opinion concluded that this level of anticipated take is not likely to result in jeopardy to the marbled murrelet species. USFWS also stated that "…no reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of murrelets. Measures that are designed to minimize impacts to murrelets have been incorporated by the Navy…" The terms and conditions included in USFWS' Biological Opinion require Navy to monitor and report the impacts of the incidental take.

Under Alternative 2 (Preferred Alternative) at the NWTRC and utilizing criteria and analysis methodology as presented for non-listed species, vessel movements, aircraft overflight, ordnance use, underwater detonations and military expended materials (entanglement) may affect individual short-tailed albatross; however, these activities would not have community or population level effects. Vessel movements, aircraft overflights and underwater detonations may affect individual marbled murrelets and individual California brown pelicans, but the activities would not have community or population level effects. Aircraft overflights and underwater detonations may affect individual western snowy plovers, but would not have community or population level effects. Proposed NWTRC activities would not destroy or adversely modify critical habitat for the marbled murrelet or the western snowy plover.

Implementation of Alternative 2 may affect threatened and endangered species in the NWTRC. Implementation of Alternative 2 would not destroy or adversely modify critical bird habitat in the NWTRC. As part of the EIS/OEIS process, Navy has prepared a BE for the NWTRC for use, as appropriate, in agency consultations. The BE provides detailed descriptions and analysis of the potential impacts to all threatened and endangered species and critical habitats protected under the ESA. Navy has initiated agency consultations in accordance with Section 7 of the ESA.

Bald and Golden Eagle Protection Act

Impacts to bald eagles resulting from implementation of Alternative 2 would be similar to those described for the No Action Alternative and Alternative 1.

Vessel movements would have no impact on bald eagles, based on low Navy vessel density, transitory occurrence of bald eagles in nearshore and offshore areas, and the ability of bald eagles to avoid Navy vessels.

Because of the controlled and infrequent nature of Navy training activities, the limited number of flights under 3,000 ft, and the short-time frame that aircraft are present in an area, if eagles were to be disturbed by occasional aircraft, they would resume normal use of an area once the disturbance had ceased. As such, aircraft overflights under Alternative 2 would have minor impacts on bald eagles.

As with the No Action Alternative and Alternative 1, under Alternative 2 direct ordnance strikes from firing weapons possible, but unlikely. Ordnance use may affect bald eagles, however Navy mitigation measures minimize disturbance of bald eagles. Underwater explosions and detonations that occur in the Study Area may result in a minor and temporary startling effect to bald eagles. Explosions could kill prey, however would not measurably alter food supply. Precautionary measures are implemented to ensure that detonation does not occur when eagles are present. Expended materials are not expected to affect the bald eagle.

Under Alternative 2, vehicle and equipment use and personnel presence involved in NWTRC land based training would not affect bald eagles. Given the small number of personnel and the controlled, infrequent training events, it is unlikely that eagles would be displaced. Eagles would avoid the area while personnel and equipment were present for training activities but would resume normal activities once training had ceased. Insertion and extraction activities would not be conducted in areas of nesting eagles, particularly during critical time periods.

Land demolition training at the established DTRs under Alternative 2 would not adversely affect bald eagles. Eagles that may be in the vicinity when demolitions are occurring would avoid the area and displace to suitable adjacent habitat for feeding. They would be expected to return to normal use of the area once training activities ceased.

Implementation of Alternative 2 would not adversely affect the bald eagle as defined by the Bald and Golden Eagle Protection Act, or MBTA regulations applicable to military readiness activities. In accordance with the NEPA, Alternative 2 would have minimal impacts on the bald eagle on land or in territorial waters. In accordance with EO 12114, harm to bald eagles from the Alternative 2 would be unlikely in non-territorial waters.

Alternative 2 is not expected to disturb, or result in take of, bald eagles as defined by the Bald and Golden Eagle Protection Act.

Migratory Bird Treaty Act

Implementation of Alternative 2 would not diminish the capacity of a population of a migratory bird species to maintain genetic diversity, to reproduce, and to function effectively in its native ecosystem. The proposed action would not adversely affect migratory bird populations. As a result and in accordance with 50 CFR Part 21, the Navy is not required to confer with the USFWS on the development and implementation of conservation measures to minimize or mitigate adverse effects to migratory birds that are not listed under the ESA.

3.10.4 Mitigation Measures

As summarized in Section 3.10.3, the actions proposed in this EIS/OEIS could affect some individual birds within the Study Area, but community or population level effects would not be expected under any of the alternatives. Current protective measures would continue to be implemented by the Navy, and no additional mitigation measures would be needed to protect birds or their habitats.

In an effort to reduce potential impacts to marbled murrelets, the Navy will conduct sea bird surveys. The Navy currently surveys for all seabirds and marine mammals that may be within the designated impact zone, the same “go, no go” status will be applicable to murrelets, as well.

3.10.5 Summary of Effects by Alternative

The NWTRC encompasses important foraging and breeding habitats for birds. Migratory birds utilize the productive offshore waters associated with the Pacific coast upwelling to forage during wintering and migratory movements. Coastal developments, loss of habitat, commercial fishing, and introduced species have caused populations of many seabird species to decline in recent decades. Navy activities in the NWTRC would not be expected to increase effects to bird populations. Based on the analysis of the proposed alternatives, it is thought that effects to protected and migratory birds would be minimal. The sheer size of the Range Complex, as well as the temporal and spatial variability of activities, in combination with temporal and seasonal distributions of seabird species poses minimal effect potential to seabird populations. Table 3.10-3 summarizes effects of the alternatives.

Under the No Action Alternative, Alternative 1, or Alternative 2 (Preferred Alternative) at the NWTRC, vessel movements, aircraft overflight, ordnance use, underwater detonations and military expended materials (entanglement) may affect individual short-tailed albatross; however, these activities would not have community or population level effects. Vessel movements, aircraft overflights and underwater detonations may affect individual marbled murrelets and individual California brown pelicans, but the activities would not have community or population level effects. Aircraft overflights and underwater detonations may affect individual western snowy plovers, but would not have community or population level effects. Proposed No Action Alternative, Alternative 1, or Alternative 2 (Preferred Alternative) NWTRC activities would not destroy or adversely modify critical habitat for the marbled murrelet or the western snowy plover.

Implementation of the No Action Alternative, Alternative 1, or Alternative 2 (Preferred Alternative) would not adversely affect the bald eagle as defined by the Bald and Golden Eagle Protection Act, or MBTA regulations applicable to military readiness activities. In accordance with the NEPA, the No Action Alternative, Alternative 1, or Alternative 2 would have minimal impacts on the bald eagle on land or in territorial waters. In accordance with EO 12114, harm to bald eagles from the No Action Alternative, Alternative 1, or Alternative 2 would be unlikely in non-territorial waters. The No Action Alternative, Alternative 1, or Alternative 2 is not expected to disturb, or result in take of, bald eagles as defined by the Bald and Golden Eagle Protection Act.

Table 3.10-3: Summary of Effects – Birds

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	Vessel movements could result in short-term behavioral responses and low potential for injury/mortality from collisions. No long-term population-level effects. Short-term behavioral response to overflights. Low potential for bird injury/mortality from aircraft strikes. No long-term or population-level effects. Minor, short-term, and localized disturbance due to land based training and land demolition activities. No long-term or population-level effects. Low potential for direct and indirect effects to birds from ordnance use. No long-term or population-level effects. Low potential for direct and indirect effects to birds from underwater detonations and explosives use. No long-term or population-level effects. Low potential for ingestion or entanglement impacts to birds resulting from military expended materials. No long-term or population-level effects. No adverse impacts to migratory birds or bald eagles. Not expected to disturb, or result in take of, bald eagles as defined by the Bald and Golden Eagle Protection Act. May affect threatened and endangered birds; would not destroy or adversely modify critical bird habitat.	Vessel movements could result in short-term behavioral responses and low potential for injury/mortality from collisions. No long-term population-level effects. Short-term behavioral response to overflights in non-territorial water areas. Low potential for harm to birds from aircraft strikes. Low potential for harm to birds from ordnance use in non-territorial water areas. Low potential for harm to birds from explosives use in non-territorial water areas. Low potential for harm from military expended materials in non-territorial water areas. No adverse impacts or harm to migratory birds or bald eagles in non-territorial water areas. Not expected to disturb, or result in take of, bald eagles in non-territorial water areas. May affect threatened and endangered birds in non-territorial water areas; would not destroy or adversely modify critical bird habitat.

Table 3.10-3: Summary of Effects – Birds (cont'd)

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
Alternative 1	Vessel movements could result in short-term behavioral responses and low potential for injury/mortality from collisions. No long-term population-level effects. Short-term behavioral response to overflights. Low potential for bird injury/mortality from aircraft strikes. No long-term or population-level effects. Minor, short-term, and localized disturbance due to land based training and land demolition activities. No long-term or population-level effects. Low potential for direct and indirect effects to birds from ordnance use. No long-term or population-level effects. Low potential for direct and indirect effects to birds from underwater detonations and explosives use. No long-term or population-level effects. Low potential for ingestion or entanglement impacts to birds resulting from military expended materials. No long-term or population-level effects. No significant adverse effects to migratory birds or bald eagles. Not expected to disturb, or result in take of, bald eagles as defined by the Bald and Golden Eagle Protection Act. May affect threatened and endangered birds; would not destroy or adversely modify critical bird habitat. Impacts slightly higher than the No Action Alternative.	Vessel movements could result in short-term behavioral responses and low potential for injury/mortality from collisions. No long-term population-level effects. Short-term behavioral response to overflights in non-territorial water areas. Low potential for harm to birds from aircraft strikes. Low potential for harm to birds from ordnance use in non-territorial water areas. Low potential for harm to birds from explosives use in non-territorial water areas. Low potential for harm from military expended materials in non-territorial water areas. No adverse impacts or harm to migratory birds or bald eagles in non-territorial water areas. Not expected to disturb, or result in take of, bald eagles in non-territorial water areas. May affect threatened and endangered birds in non-territorial water areas; would not destroy or adversely modify critical bird habitat. Potential for harm is slightly higher than the No Action Alternative.

Table 3.10-3: Summary of Effects – Birds (cont'd)

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
Alternative 2 (Preferred Alternative)	Vessel movements could result in short-term behavioral responses and low potential for injury/mortality from collisions. No long-term population-level effects. Short-term behavioral response to overflights. Low potential for bird injury/mortality from aircraft strikes. No long-term or population-level effects. Minor, short-term, and localized disturbance due to land based training and land demolition activities. No long-term or population-level effects. Low potential for direct and indirect effects to birds from ordnance use. No long-term or population-level effects. Low potential for direct and indirect effects to birds from underwater detonations and explosives use. No long-term or population-level effects. Low potential for ingestion or entanglement impacts to birds resulting from military expended materials. No long-term or population-level effects. No adverse impacts to migratory birds or bald eagles. Not expected to disturb, or result in take of, bald eagles as defined by the Bald and Golden Eagle Protection Act. May affect threatened and endangered birds; would not destroy or adversely modify critical bird habitat. Impacts slightly higher than Alternative 1.	Vessel movements could result in short-term behavioral responses and low potential for injury/mortality from collisions. No long-term population-level effects. Short-term behavioral response to overflights in non-territorial water areas. Low potential for harm to birds from aircraft strikes. Low potential for harm to birds from ordnance use in non-territorial water areas. Low potential for harm to birds from explosives use in non-territorial water areas. Low potential for harm from military expended materials in non-territorial water areas. No adverse impacts or harm to migratory birds or bald eagles in non-territorial water areas. Not expected to disturb, or result in take of, bald eagles in non-territorial water areas. May affect threatened and endangered birds in non-territorial water areas; would not destroy or adversely modify critical bird habitat. Potential for harm is slightly higher than Alternative 1.

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3.11 Terrestrial Biological Resources

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3.11 TERRESTRIAL BIOLOGICAL RESOURCES

This section addresses the terrestrial plant and animal life within the Northwest Training Range Complex (NWTRC) that may be affected by proposed actions. These biological resources include: vegetation (including wetlands), wildlife, threatened and endangered species, and sediments and soils. For this report, the discussion of terrestrial biological resources does not include avian species found onshore. Avian species found in the operating areas (OPAREAs) are addressed in Section 3.10. Marine mammals, including species such as seals or sea lions that haul out or breed on the island, are addressed in Section 3.9.

Terrestrial areas within the NWTRC that may be affected by activities include the eastern portion of the Naval Air Station Whidbey Island (NASWI) Seaplane Base, Indian Island, Naval Outlying Landing Field (OLF) Coupeville, and Naval Base Kitsap (NBK)-Bangor. Activities within these areas may affect resources that occur on land and in near-shore areas.

Other NWTRC areas include the Olympic Military Operating Areas (MOAs) over the Olympic Peninsula, Okanogan and Roosevelt MOAs over north-central and northeastern Washington, respectively, as well as Admiralty Bay Range/Restricted Airspace (R)-6701. These MOAs and ranges are the sites of air activities and training. Low-altitude aircraft flights (*i.e.* below 3,000 feet [ft] or 914 meters [m]) that occur within Okanagan MOA segments B and C and Roosevelt MOA section B, as described in Chapter 2, may affect wildlife and have been included in the analysis of effects. There are no activities of the proposed actions in other MOAs that would affect land-based biological resources at these locations, and thus, terrestrial biological resources at these sties will not be analyzed in this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS).

Activities under the Proposed Action that may affect the terrestrial resources discussed in this section are those that are most likely to result in land disturbance, such as explosions, troop training, and materials expended during training. These potential impacts are discussed in more detail in Section 3.11.2, Environmental Consequences.

3.11.1 Affected Environment

3.11.1.1 Vegetation

Plant Community Types

The plant community types found in the Study Area are based on the classification defined in the NASWI Integrated Natural Resources Management Plan (INRMP) (DoN 1996) and the NBK-Bangor INRMP (DoN 2001). This section provides a general description of the community types and is followed by a description of the vegetation communities found in specific target locations where activities may occur that would affect terrestrial plant communities. This site-specific information was gained from a variety of source materials which are cited as appropriate.

Douglas Fir Forest. This community typically occurs on dry, well-drained soil and is dominated by Douglas fir (*Pseudotsuga menziesii*) and, in some areas, Pacific madrone (*Arbutus menziesii*). These stands have a broadleaf evergreen understory of salal (*Gaultheria shallon*), evergreen huckleberry (*Vaccinium ovatum*), Pacific rhododendron (*Rhododendron macrophryllum*), and Oregon grape (*Berberis nervosa*). Sword fern (*Polystichum munitum*) is one of the most common species occurring in the herbaceous layer. Less common species in this community are lodgepole pine (*Pinus contorta*), western white pine (*Pinus monticola*), western hemlock (*Tsuga heterophylla*), red alder (*Alnus rubra*), ocean spray (*Holodiscus discolor*), clustered wild rose (*Rosa pisocarpa*), red elderberry (*Sambucus racemosa*), and snowberry (*Symphoricarpos albus*). Significant stands of Douglas fir forest are found on the Seaplane Base and OLF Coupeville.

Mixed Forest. This vegetation type typically occurs on moister soils than the Douglas fir forest type. Dominant tree species include Douglas fir, western hemlock, western red cedar (*Thuja plicata*), and red alder, with an understory of red huckleberry (*Vaccinium parvifolium*), salal, Oregon grape, red elderberry, and several fern species. Other common associates include Sitka spruce (*Picea sitchensis*), big leaf maple (*Acer macrophyllum*), grand fir (*Abies grandis*), cascara (*Rhamnus purshiana*), bitter cherry (*Prunus emarginata*), and red-osier dogwood (*Cornus stolonifera*). While Douglas fir is dominant in some mixed forest stands, this cover type can be differentiated from the Douglas fir forest type by the co-dominance of hemlock, cedar, and/or deciduous broadleaf tree species.

Alder Forest. Red alder stands occur in moist to wet areas on poorly drained organic soils, often over an impervious clay layer. These are usually monotypic stands of alder with salmonberry (*Rebus spectabilis*), thimbleberry (*Rubes parviflorus*) and lady fern (*Athyrrium filix femina*) in the understory. Where a disturbance has occurred in forests that were dominated by Douglas fir and western hemlock, red alder replaces the dominant trees as a successional species. These successional areas often contain minor amounts of young Douglas fir, western hemlock, and western red cedar. Sword fern is present in these communities as well. The occurrence of red alder stands at Seaplane Base and OLF Coupeville is due either to relatively high soil moisture or to some kind of past disturbance, such as logging.

Willow Stand. Willow communities occur in moist to wet soils around lakes, ponds, marshes, and waterways. The stands are dominated by willows (*Salix* spp.) and black cottonwood (*Populus trichocarpa*) and may include dense thickets of Douglas spiraea, also known as hardhack (*Spiraea douglasii*). Herbaceous associates include common cattail (*Typha latifolia*), skunk cabbage (*Lysichitum americanum*), and curly dock (*Rumex crispus*). Hard-stemmed bulrush (*Scirpus acutus*) and various rushes, sedges, and grasses are also common to this vegetation type. These occur on NASWI at the Seaplane Base.

Orchard. Orchards are small stands of old, domestic fruit trees, mostly apple and pear that are overgrown with various shrubs and invasive grass species. Dominant shrubs in the orchards include wild rose and snowberry. Small patches of orchard occur on Seaplane Base, OLF Coupeville, and NBK-Bangor.

Scrub-shrub. This is a classification for areas that have received significant disturbance and are revegetating with both native and nonnative shrubs. Tree seedlings may be present but shrubs less than 20 ft (6 m) in height are the dominant plant form. Scrub-shrub areas are dominated by wild rose, snowberry, Himalayan blackberry (*Rubus discolor*), Douglas spiraea, Scotch broom (*Cytisus scoparius*), and other shrub species. Scrub-shrub wetlands may be dominated by Pacific ninebark (*Physocarpus capitatus*), red alder seedlings, willow shrubs and saplings, and Douglas spiraea. This vegetation type occurs in Seaplane Base, Indian Island, OLF Coupeville, and NBK-Bangor.

Grassland and Cultivated Field. Open fields and agricultural lease areas comprise a large component of the vegetative cover of station lands on Seaplane Base and OLF Coupeville. This cover type includes a variety of native and exotic grasses, grains, annual crops, and annual weeds. Common species include Canada thistle (*Cirsium arvense*), clover (*Trifolium* spp.), plantain (*Plantago* spp.), ryegrass (*Lolium* spp.), orchard grass (*Dactylis glomerata*), velvet grass (*Holcus lanatus*), western fescue (*Festuca occidentalis*), bentgrass (*Agrostis* spp.), quackgrass (*Agropvron repens*), and bluegrass (*Poa* spp.). Cole crops, field mustard (*Brassica campestris*), and timothy (*Phleum pratense*) are especially common in the cultivated fields.

Disturbed Area. This category includes areas that have been recently disturbed or that receive ongoing disturbance, apart from regular landscape maintenance. Disturbed areas typically have extensive patches of bare soil and may or may not be dominated by vegetation. Bare soil is interspersed with seral herbs and weedy exotic species. Common plant species include lambsquarters (*Chenopodium album*), sheep sorrel

(*Rumex acetosella*), curly dock, field mustard, buttercup (*Ranunculus* spp.), clover, tansy ragwort (*Senecio jacohaea*), Canada thistle, a variety of other forbs and the following grass species: red top (*Agrostis alha*), quack grass, velvet grass, Kentucky bluegrass (*Poa pratensis*), and orchard grass.

Landscaped Area. The vegetation of landscaped areas consists of a mix of native and non-native species resulting from a variety of landscape practices. Planted trees and shrubs and maintained turfgrass areas are typical.

3.11.1.2 Threatened, Endangered, and Sensitive Plant Species

Seaplane Base

According to the NASWI INRMP (DoN 1996), the golden Indian paintbrush (*Castilleja levisecta*) is a federally-listed threatened species known to occur at Seaplane Base. Further information on this species can be found in a separate report entitled, *Significant Biological and Natural Features of Naval Air Station Whidbey Island, Island County, Washington* (WDNR 1995). Golden paintbrush occurs in open grasslands at elevations below 328 ft (100 m) around the periphery of the Puget Trough with most populations occurring on glacially derived soils (Federal Register Vol.62, No.112, 1997). Based on species distribution information provided in the INRMP (see Figure 8-5 of the INRMP), golden Indian paintbrush is known to occur at Forbes Point on Seaplane Base. Only ten known populations remain in the world, eight of which occur in Washington State (WDNR 1995). Of the eight known sites in Washington, five are located on Whidbey Island. Observations conducted in 1995 indicate that the distribution of the plant on Seaplane Base is decreasing, although no conclusions have been drawn as to trends in population size. Golden Indian paintbrush is very sensitive to disturbance. At Forbes Point, the primary threats to the population at Forbes Point are native and non-native competing vegetation (DoN 1996). Ongoing DoN management efforts include maintaining a fence around the population and hand-pulling competing shrubs from the area.

3.11.1.3 Wetlands

Wetlands in the NWTRC are important ecosystems which serve valuable purposes. Wetlands have ecosystem values related to erosion, maintaining water quality, cycling nutrients, and providing habitat for aquatic and terrestrial animals. They also have value related to human use of the environment including water supply, flood control, fisheries, aesthetics, and recreation. The primary functions of wetlands in the NWTRC are associated with providing fish and wildlife habitat, providing recreational opportunity, flood attenuation, and water quality enhancement (DoN 1996). Wetlands discussed in this section found within the NWTRC that may be affected include freshwater (palustrine) and saltwater (estuarine) wetlands.

Freshwater Marsh. Freshwater marshes are typically saturated, seasonally flooded, or semi-permanently flooded. These areas contain a wide variety of emergent herbaceous and graminoid (i.e., grass-like; e.g., sedges, rushes, grasses) wetland plant species. Plant associations in freshwater marshes vary depending on the hydrologic regime, shade, and soil type. Some of the most frequently occurring species in emergent wetlands in the affected area include lady fern (*Athyrium filix-femina*), curly dock, skunk cabbage, marsh willow herb (*Epilobium watsonii*), water parsley (*Oenanthe sarmentosa*), climbing nightshade (*Solanum dulcamara*), floating-leaved pondweed (*Potamogeton natans*), common cattail, hardstem bulrush, soft rush (*Juncus effusus*), reed canarygrass (*Phalaris arundinacea*), burreed (*Sparganium* spp.), and tufted hairgrass (*Deschampsia caespitosa*). Freshwater marshes occur at Seaplane Base and NBK-Bangor. Freshwater marshes are classified under the United States Fish and Wildlife Service (USFWS) (Cowardin et al. 1979) as palustrine, emergent, and persistent (PEM1) and palustrine scrub-scrub broadleafed deciduous (PSS1) (DoN 1996).

Freshwater Wet Meadow. Wet meadows include those wetlands that are temporarily flooded and are dominated by a variety of herbs and graminoid species. Where many freshwater marshes may remain inundated or saturated throughout the year, the surface soils in wet meadows often dry up during summer months. Common plants in wet meadows may include curly dock, creeping buttercup (*Ranunculus repens*), cow parsnip (*Heracleum lanatum*), reed canarygrass, soft rush, and dagger-leaf rush (*Juncus ensifolius*). Wet meadows are found at Seaplane Base, Indian Island, and NBK-Bangor. These are classified under the USFWS (Cowardin et al. 1979) as palustrine, emergent, and persistent (PEM1) (DoN 1996).

Salt Marsh. Salt marsh is typically divided into two subtypes, high and low, based on the elevation and relative salinity. The plant communities vary with these factors. Dominant species in high salt marsh areas include redtop (*Agrostis alha*), Pacific silverweed (*Potentilla pacifica*), seaside arrowgrass (*Triglochin maritimum*), Lyngby's sedge (*Carex lyngbyei*), Baltic rush (*Juncus balticus*), springbank clover (*Trifolium wormsskjoldii*), meadow barley (*Hordeum branchyantherum*), and Douglas aster (*Aster subspicatus*). Low salt marsh areas are dominated by pickleweed (*Salicornia virginica*), seashore saltgrass (*Distichlis spicata*), seaside arrowgrass, orache or saltweed (*Atriplex patula*), sea plantain (*Plantago maritima*), saltmarsh sandspurry (*Spergularia marina*), and fleshy jaumea (*Jaumea carnosa*). Areas of salt marsh occur at Seaplane Base, Indian Island and NBK-Bangor. These are classified under the USFWS (Cowardin et al. 1979) as estuarine, intertidal, emergent (E2EM1) or unconsolidated shore (E2US). These wetlands are regularly or irregularly flooded by the tides depending upon their elevation (DoN 1996).

Mudflats. These areas are classified under the USFWS as estuarine, intertidal and subtidal, unconsolidated shore (E2US and E1UB) (DoN 1996). They are largely lacking in vegetation, although some areas support extensive eelgrass flats, and are often strewn with driftwood along the high tide line. This habitat type is important primarily to marine invertebrates, marine fishes, waterfowl, some raptors, and shorebirds.

Deciduous Forested Wetlands. These wetland areas consist of wetland plants with an important component in large deciduous trees, usually red alder. The trees provide shade, keeping water temperatures cool, and supplying a rich organic food source as they shed their leaves. As water levels rise and fall, some trees are killed as their root zones are inundated with water. The trees quickly rot, providing homes for cavity nesters, food for insect foragers, and after they have fallen into the wetland, additional organic matter from which the other existing wetland plants feed. These wetland types are found at Seaplane Base and NBK-Bangor. They are classified under the USFWS classification as palustrine forested broadleaf (PFO1) (DoN 2001).

Coniferous Forested Wetlands. These wetlands have Douglas-fir and lodgepole pine in close proximity to their edge. The waters are usually somewhat acidic and brackish in color. Acidic plants, such as hardhack, reed canary grass, and water lilies are indicators of the wetland community. Again, the trees are an important component as they provide a temperature regulation as well as providing necessary large woody debris as they decay and fall to the surrounding area. These wetland types are found at NBK-Bangor. They are classified under the USFWS classification as palustrine forested needle-leafed evergreen (PFO4) (DoN 2001).

Shrub Dominated Wetlands. These wetlands are peat bogs in origin, containing hardhack, serviceberry, skunk cabbage, and cattails. They are open and provide easy access for waterfowl species. Because of the lack of canopy cover, they are warmer than other types of wetlands and provide habitat for the more water dependent life cycles of reptile and amphibian species. These wetland types are found at Seaplane Base and NBK-Bangor. They are classified under the USFWS classification as palustrine scrub-scrub broadleafed deciduous (PSS1) (DoN 2001).

3.11.1.4 Wildlife

A variety of wildlife is found within the Study Area including fish, marine and terrestrial animals, and bird populations. This section addresses terrestrial animals which inhabit and use the terrestrial environment, with the exception of birds. Fish, marine animals, and birds found in the OPAREA are discussed in sections 3.7 (Fish), 3.9 (Marine Mammals), and 3.10 (Birds), respectively.

This section describes the wildlife potentially found in the terrestrial environment of the NWTRC that may be affected by proposed actions. The reader is referred to the NASWI INRMP (DoN 1996) and the NBK-Bangor INRMP (DoN 2001) for detailed descriptions of habitat use by these various wildlife species. There are no federally-listed threatened or endangered wildlife species found within the terrestrial portion of the Study Area.

Mammals. Many small mammals are found within the Study Area that include multiple species of moles (*Scapanus* spp.), voles (*Microtus* spp.), and mice (*Peromyscus maniculatus*, *Mus musculus*, and *Zapus trinotatus*). Rabbits (*Sylvilagus bachmani*), raccoons (*Procyon lotor*), skunks (*Mephitis mephitis*), weasels and ferrets (*Mustela* spp.), bats (*Lasurus* spp. and *Lasionycteris* spp.) and blacktail deer (*Odocoileus hemionus*) are also common. Larger carnivorous species that are present include black bears (*Ursus americanus*), coyotes (*Canis latrans*), bobcats (*Lynx rufus*), and cougars (*Felis concolor*). Aquatic environments within the NWTRC, both freshwater and estuarine, support animals such as beavers (*Aplodontia rufa* and *Castor canadensis*), river otters (*Lutra canadensis*), and muskrat (*Ondatra zibethicus*).

Amphibians and Reptiles. Freshwater marshes and meadows are suitable habitat for amphibians found within the NWTRC. Amphibians that could potentially occur within the NWTRC include salamanders, newts, frogs, including the Pacific treefrog (*Hyla regilla*), and the western toad (*Bufo boreas*). Red alder stands particularly near water, found around meadows or along streams, have been identified as important habitat for amphibians. Red alder stands with some component of Douglas fir and western red cedar are considered an even more valuable habitat because of the complexity of the habitat, and the higher potential for large downed woody debris (DoN 1996).

Reptiles use freshwater habitats, grasslands, forested areas, and agricultural fields. Reptiles that may potentially occur include three species of garter snakes (*Thamnophis* spp.), and the northern alligator lizard (*Elgaria coerulea*).

3.11.2 Environmental Consequences

3.11.2.1 Approach to Analysis

The approach is based on information concerning the environmental resources discussed in Section 3.11.1, and a systematic evaluation of the components of each activity that may affect these resources. The analysis for terrestrial natural resources is organized by specific activity and/or stressors associated with that activity, rather than warfare area. However, where the effect of the stressor differs by area, this will be clearly described.

Study Area

The analysis presented for the natural resources in the terrestrial environment is focused on those areas where activities and training will occur that would affect resources on land and in the nearshore environment. These environments within the NWTRC include the eastern portion of NASWI Seaplane Base, Indian Island, OLF Coupeville, NBK-Bangor, Okanogan MOA segment B & C, and Roosevelt MOA segment B.

Data Sources

A systematic review of relevant literature and data was conducted to complete the analysis for terrestrial natural resources in the study area. Candidate sources consisted of published and unpublished documents including journals, books, periodicals, bulletins, theses and dissertations, Internet sites, natural resource management plans, previous National Environmental Policy Act (NEPA) documents for facilities and activities in the study area, Department of Defense (DoD) operations reports, and other technical reports published by government agencies, private businesses, and consulting firms. Site-specific DoD INRMPs and compliance documents were primarily referenced during the search for geographic location data on the occurrence of resources within the study area.

Methods

This EIS/OEIS analyzes potential effects to land based natural resources from range activities in the context of the NEPA. Factors considered in the evaluation of significant effects include the extent to which an alternative could change the capacity of a population of a terrestrial species to maintain genetic diversity, reproduce, and function effectively in its native ecosystem. The analysis of effects on terrestrial biological resources was done qualitatively based on resource management plans specific to the NWTRC, previous compliance that has been conducted for actions taken within the NWTRC that are related to activities addressed in this EIS/OEIS, and published literature.

The golden Indian paintbrush is a federally-listed threatened species that occurs on the western portion of Seaplane Base in the area of Forbes Point as discussed in the “Affected Environment” section. The actions and activities being evaluated under all of the alternatives would occur approximately four miles to the west of the known population of golden Indian paintbrush and would not be affected by any alternative. Therefore, this species will not be evaluated further.

Warfare Areas and Associated Environmental Stressors

Of the potential environmental stressors considered in the analysis, the following stressors were carried forward for detailed analysis:

- Vehicle and equipment use
- Vehicle and personnel movements
- Ordnance and pyrotechnic use
- Low-altitude aircraft overflights
- On land demolition
- Materials expended during demolition

Underwater demolition has been dismissed from evaluation of terrestrial biological resources. Underwater detonations that occur in the Study Area are associated with mine neutralization activities and typically use C-4. The majority of underwater detonation training would occur at Crescent Harbor (88 percent) with infrequent training at Indian Island (6 percent) and Floral Point (6 percent) at Bangor. In Crescent Harbor and in Port Townsend Bay on the west side of Indian Island, the distance from the nearest shoreline to where detonations take place is between 1,100 ft and 7,200 ft (355 to 2,195 ms) at depths between 50 and 60 ft (15 to 18 m). Detonations occur offshore of Floral Point at NBK-Bangor approximately 600 ft (200 m) offshore in 30 ft (9 m) deep water. Given the depth at which demolition occurs and the distance from shore there, would be no effects to shoreline wetland vegetation or wildlife species using the terrestrial environment (DoN 2000).

3.11.2.2 No Action Alternative

Impacts on Terrestrial Vegetation and Wetlands

Land-based Training

The No Action Alternative includes land-based training activities involving personnel and/or vehicles associated with Explosive Ordnance Disposal (EOD), Intelligence, Surveillance, and reconnaissance (ISR), Naval Special Warfare (NSW), insertion/extraction, and search and rescue (SAR) activities. EOD activities involve six personnel and occasionally involve use of a small truck. These activities occur within the Demolition Training Range (DTR) Seaplane Base and DTR Bangor which are previously disturbed areas cleared of vegetation and within a structure designed to contain a blast. ISR training activities occasionally occur at Seaplane Base Survival Area and involve crews of 11 personnel. Insertion/extraction, including SAR activities, involves delivery and withdrawal of personnel and equipment using helicopters and parachute at designated areas within the bases. At Seaplane Base Survival Area, helicopter rope suspension training (HRST) activities occur monthly and involve approximately eight participants. Participants maneuver briefly within the designated landing area and no vehicles are used. Approximately 31 parachute training activities occur annually at OLF Coupeville at designated drop zones and involve placing personnel into an area undetected. Search and rescue training occurs 40 times per year at the Seaplane Base Survival Area. During SAR exercises, personnel may disembark from a helicopter within the survival area, "rescue" the personnel to be recovered, and return to the helicopter to be removed from the area. The land-based portion of the exercise is limited to foot traffic, typically on established trails, roads, or other open areas, and does not involve vehicles. Naval Special Warfare (NSW) training on Indian Island would also be limited to foot traffic but would occur off roads and trails. These covert activities generally consist of four to six people walking through an area, and activities occur for two to three weeks twice a year.

Vehicle and equipment use and foot traffic associated with the continued use of the existing EOD DTR at Seaplane Base and Bangor by personnel would have a no effect on vegetation. These sites have been and continue to be used for demolition training and vegetation has been cleared from the areas. EOD DTR activities would have no effect on vegetation. ISR training activities that occur at Seaplane Base Survival Area would have negligible impacts on vegetation from trampling and crushing of ground-cover and shrub layer vegetation as personnel move through the training areas. The ISR activities occur occasionally with crews of 11 personnel moving through approximately 420 acres (1.5 square kilometers [km^2]) of conifer and broadleaf forest habitat; this habitat is more resilient to the low level disturbance of these activities because of the height and structure of the vegetation in the habitat.

Naval Special Warfare training on Indian Island could affect terrestrial vegetation because of off-road foot traffic. Land vehicles will not be used as part of the Special Forces training that will take place on Indian Island. NSW activities involving off-road foot traffic generally would consist of four to six people covertly walking over an area. These activities would occur for two to three weeks twice a year. Because the covert nature of these Special Forces activities requires special training and a light footprint, effects on vegetation would be comparatively minimal.

Insertion/extraction activities at OLF Coupeville and Seaplane Base, with additional SAR activities occurring at Seaplane Base Survival Area, occur predominantly in defined drop zones or insertion points. In these designated areas, vegetation would be impacted because of crushing, trampling, and uprooting. In areas such as grasslands and scrub-shrub habitats vegetation could experience long-term effects as soils become compacted and vegetation is removed. Given the low frequency of these actions and relatively low number of personnel participating, impacts would be minor.

There would be no effect on wetlands as land-based training exercises would be conducted to avoid wetlands.

Land Demolition

Demolition practice on land takes place in the existing DTR Seaplane Base and DTR Bangor, where little vegetation is present. Typical explosives used include C-4 demolition blocks, detonation (DETA) sheet, detonation cord, and electric blasting caps. Because of the long-term use of the DTRs and repeated disturbances in these areas, little vegetation is present and the areas are considered disturbed. There would be no effect to vegetation in these areas.

Impacts on Wildlife

Land Based Training

For EOD activities at established DTR Seaplane Base and DTR Bangor, the presence of personnel, vehicles, and equipment use to conduct training would have no effect on wildlife as these areas are disturbed from prior use and provide poor quality habitat for wildlife. The other land based training activities would have minor, short-term effects on wildlife due to the presence of personnel and noise generated by training activities. These effects would be predominantly localized to small areas where training was occurring such as the insertion/extraction actions. Due to the dispersed nature of NSW training on Indian Island and ISR activities at Seaplane Base Survival Area, the effects on wildlife would be more widespread. NSW, however, are designed to be convert and undetectable, further reducing wildlife disturbance. In general, wildlife present in areas where exercises are taking place would be disturbed from feeding, nesting, or resting while activities were occurring. Some may leave the area to more suitable adjacent, available habitats. These exercises are not expected to result in chronic stress to wildlife based on the low number of activities that occur per year, the short duration of the exercises, and the low number of vehicles and/or personnel involved in the exercises described in Chapter 2. There would be no change in populations of animals because of vehicle traffic and/or presence of personnel associated with these training activities.

EOD Mobile Unit (MU) and the occasional ISR training exercise would also involve the use of blank small arms ammunitions (a projectile is not fired when blanks are used, but noise is generated), inert grenades, and some pyrotechnics (e.g. signal smoke, flash-bangs, signal flares) may be authorized depending on fire danger level. In addition, there is patrolling with vehicles, including tracked vehicles. The noises generated from these activities are highly localized to the area of disturbance. Flares release heat and light and are designed to burn completely. Wildlife in the area could be exposed to light generated by the flares, but no effects are expected based on the short burn time and infrequent use. Wildlife in the immediate vicinity of the target would respond to the sound of blank ammunition, but any effects would be minor and short-term.

Land Demolition

Demolition practice on land takes place in the existing DTR Seaplane Base and DTR Bangor. Typical explosives used include C-4 demolition blocks with a Net Explosive Weight (NEW) training limit of 2.5 lbs at NBK-Bangor and 2.0 lbs at Seaplane Base. As noted above, the activities occur in areas that have been previously cleared of vegetation and occur within a structure designed to contain the blast. Given the disturbed nature and lack of habitat availability of the DTRs, wildlife effects are focused on those areas outside of the DTRs. In general, the effects of explosions correspond to the distance of the animal from the explosion, ranging from lethal injury to short-term behavioral responses to noise. Behavioral responses to noise may range from minor responses such as head-raising and body-shifting, more disturbed mammals may move short distances, and higher level behaviors such as panic and escape would result from more severe disturbances (NPS 1994).

Impacts on wildlife as a result of increased sound levels are difficult to quantify because the evaluation of sound in the environment is generally linked to human reaction (annoyance level), and the literature base for evaluating how sound may affect wildlife is extremely limited. Although the reaction/response of wildlife to sound in the environment is difficult to measure and characterize, noise can be defined as sound that may be harmful or disturbing to the health and activity of wildlife or sound that can degrade the quality of the habitat. Additionally, what may be considered an adverse effect on one particular species, or individual, may not necessarily translate into the same type of effect on another species or individual.

Wildlife on the outer edges of the zone of influence could exhibit a short-term behavioral response while EOD activities were occurring. Given the more frequent use of the DTR Seaplane Base, approximately 6 training activities per month, and the level of human presence and activity that occurs in this disturbed habitat, animals in this environment may be more habituated to the training activities and would not react or illicit minor responses because of the presence of EOD personnel. At the DTR Bangor the number of detonations is much less, approximately six per year. The wildlife in the vicinity may elicit a stronger physiological response such as fleeing and avoidance of the area as the activity is infrequent.

Animals in areas adjacent to the DTRs may be disturbed by noise resulting from detonations with greater startle response in individuals closest to the area of detonation. The Environmental Protection Agency (EPA) (1971) has indicated that a noise level of 85 dB is required to startle birds. In the prior environmental assessment for the activities at Seaplane Base (DoN 1993), it was shown that noise from 0.5 lb detonations 2,200 ft (670 m) away from the DTR at the northeast boundary fence would be 118 dBP (decibels Peak) and 102 dB 6,000 ft (1,829 m) to the west across grassland habitat. Based on the current use of 2.0 lb shots at this site, it would be expected that the noise level would be higher at this same distance. The noise from detonations would therefore be expected to cause temporary displacement and startling of wildlife in these habitats. However, wildlife would be expected to return to the habitat or to normal behaviors after activity ceases. Studies have also shown that animals can become habituated to noise following frequent exposure and cease to respond behaviorally to the noise (Larkin 1996, NPS 1994, Plumpton 2006).

Given the extended period of time that EOD activities have occurred (15 years) at Seaplane Base, the more frequent nature of the activity at this site, and the high background ambient noise levels as discussed in Section 3.5, noise as a result of land-demolition in the existing DTR would not be expected to act as an independent stressor to wildlife. At NBK-Bangor, the area is predominantly open grasslands. With the use of 2.5 lb explosives in this open environment, the zone of influence would be greater than at Seaplane Base as there is no buffer to noise and the NEW is greater. Thus, land demolitions at NBK-Bangor would travel further, affecting wildlife over a greater area. Overall, the effects of land demolition on wildlife would be short-term and minor. Wildlife may be displaced and there may be temporary increases in stress levels; however, animal behaviors and use of habitat would return shortly after the training had ceased.

Aircraft Overflights

Both fixed-wing aircraft and helicopters are used in training activities within the study area. Aircraft that are used below 3,000 ft (914 m) Above Ground Level (AGL) have the potential to affect wildlife. Helicopter use for insertion/extraction exercises, including SAR actions at Seaplane Base Survival Area, occur at less than 500 ft (152 m) AGL. Sometimes helicopters hover about 20 ft (6 m) above ground as described above. Air combat maneuver (ACM) flights that could affect terrestrial wildlife occur within the Okanogan and Roosevelt MOAs, which are located in north-central Washington near the U.S.-Canadian border. ACM include basic flight maneuvers where aircraft engage in offensive and defensive maneuvering against each other. In Okanogan MOA segments B and C and Roosevelt MOA section B, the lower limit flight altitude is 300 ft (91 m); however, the preponderance of air activities occur at high altitudes. The majority of flights involve EA-6B aircraft, but F/A-18 and F-16 aircraft are also used at much lower frequency (see Section 2.3.1.1). The average time for this exercise is about one hour, with typically two aircraft participating in the exercise.

The No Action Alternative would include some relatively low-altitude aircraft overflights (*i.e.*, less than 3,000 ft or 914 m AGL). As a result, wildlife occurring in some parts of the Study Area could be exposed to noise and visual cues associated with aircraft overflights. Wildlife could also be exposed to downdrafts from helicopters.

Numerous studies have documented that wild animals respond to human-made noise, including low-altitude aircraft overflights (Larkin 1996, NPS 1994, Plumpton 2006). The manner in which animals respond to overflights depends on several factors including life-history characteristics of the species, characteristics of the noise source, loudness, onset rate, distance from the noise source, presence/absence of associated visual stimuli, and previous exposure. A primary concern is that low-altitude overflights may cause physiological and/or behavioral responses that reduce the animals' fitness or ability to survive. Researchers have documented a range of behavioral responses to overflights, ranging from indifference to extreme panic. Behavioral responses could interfere with raising young, habitat use, and physiological energy budgets. Most studies have focused on ungulates and birds, while little or no research has been conducted on carnivorous mammals, small mammals, reptiles, and amphibians (NPS 1994). While difficult to measure in the field, some behavioral responses are likely accompanied by physiological responses, such as increased heart rate, or stress. Chronic stress can compromise the general health of animals, but stress is not necessarily indicative of negative consequences to individuals or to populations (Larkin 1996, NPS 1994, Bowles *et al*. 1990 in Larkin 1996). Unless repeatedly exposed to loud noises or simultaneously exposed to synergistic stressors, it is possible that individuals would return to homeostasis almost immediately after exposure and the individual's overall metabolism and energy budgets would not be affected. Studies have also shown that animals can become habituated to noise following frequent exposure and cease to respond behaviorally to the noise (Larkin 1996, NPS 1994, Plumpton 2006).

Fixed-wing aircraft overflights under the No Action Alternative would result in short-term, localized increases in noise levels within the Study Area. Biological receptors on the ground and directly under the flight track could be exposed to the noise levels as described in Section 3.5 (Acoustics). Exposure levels would decrease with increasing distance from the flight track centerline. As discussed in Section 3.5, as aircraft in flight gain altitude, the received noise level drops, often becoming indistinguishable from the background noise. The duration of exposure to fixed-wing aircraft noise would be very brief (seconds) as an aircraft passes overhead. Exposures would be infrequent based on the low number of sorties and the short duration of the exercises (about one hour).

Helicopter overflights under the No Action Alternative takes place within existing higher noise contours as described in section 3.5.3.2. At Seaplane Base, daytime helicopter use would be either indistinguishable from the background jet noise or masked by louder jet noise. A hovering SH-60 helicopter produces sounds levels of approximately 90 dBA at 50 ft (15 m) and sound levels would decrease by about 6 dBA for each doubling of the distance from the helicopter. Unlike fixed-wing aircraft, helicopter training activities can occur at less than 500 ft (152 m) AGL and helicopters may hover. Some studies suggest that animals respond more to helicopter overflights than to fixed-wing aircraft overflights (Larkin 1996, Plumpton 2006). Areas exposed to helicopter noise, visual cues, and downdraft would be limited to areas within Seaplane Base Survival Area. The duration of exposure to helicopter noise could be longer than that described for fixed-wing aircraft because helicopters typically fly at slower airspeeds and spend more time over a given area. The typical duration for helicopter use for HRST and SAR activities is five hours. Nonetheless, exposures would be infrequent based on the low number of exercises (67 per year).

Wildlife exposed to low-altitude aircraft overflights under the No Action Alternative could exhibit short-term behavioral and/or physiological responses, but not to the extent where the general health of individuals or populations would be compromised. Aircraft overflights are not expected to result in chronic stress based on the short duration and infrequency of exposure.

The insertion/extraction activities at OLF Coupeville involve parachute insertion with aircraft that are more than 3,000 ft (914 m) above the ground. As discussed in Section 3.5, as aircraft in flight gain altitude, the received noise levels drop, often becoming indistinguishable from the ambient noise. The approximate ground level noise levels from a C-130 aircraft at 2,000 ft is 77.2 dB and at 5,000 ft it is 66.3 dB (USAF 1999). Based on the relatively high flight altitudes and relatively low sound exposure levels, there would be no effect of noise from C-130 aircraft on terrestrial wildlife.

3.11.2.3 Alternative 1

Impacts on Terrestrial Vegetation and Wetlands

Land Based Training

The No Action Alternative includes land-based training activities involving personnel and/or vehicles associated with EOD, ISR, NSW, insertion/extraction, and SAR activities. Under Alternative 1, the number of Navy training and testing activities would increase as discussed in Chapter 2. As in the No Action Alternative, continued vehicle and equipment use and foot traffic at the existing DTR Seaplane Base and DTR Bangor would have a negligible effect on vegetation because of the disturbed nature of the areas in which these activities occur. ISR and EODMU training activities that occur at Seaplane Base Survival Area would have minor impacts on vegetation from trampling and crushing of ground-cover and shrub layer vegetation as personnel and light vehicular traffic move through the training area.

Impacts of NSW training at Indian Island on terrestrial vegetation would be the same as the No Action Alternative. Foot traffic in undisturbed areas has the potential to cause damage to individual plants from trampling or crushing in localized areas. However, there would not be any loss of populations and areas of trampling would be expected to recover in a short time period.

Insertion/extraction activities at OLF Coupeville and Seaplane Base and SAR activities at Seaplane Base Survival Area would increase slightly under Alternative 1, as described in Chapter 2. The effects on vegetation would be the same as described under the No Action Alternative and there would be no significant impacts.

There would be no effect on wetlands as land-based training exercises would be conducted to avoid wetlands.

Land Demolition

Under Alternative 1, activities involving or potentially involving explosives would increase, as discussed in Chapter 2. Because of the long-term and repeated disturbances in the DTR areas of Seaplane Base and NBK-Bangor, little vegetation is present and the areas are considered disturbed. No adverse impacts to vegetation are therefore anticipated.

Impacts on Wildlife

Land Based Training

Under Alternative 1, the vehicle and equipment use and foot traffic associated with an increase of EOD training activities at the DTR Seaplane Base and DTR Bangor, as described in Chapter 2, would have a negligible effect on wildlife because of the disturbed and poor quality habitat the areas provide. Animals that are present would either be habituated to the human and vehicle presence or would avoid the area when activities were occurring.

EODMU and ISR training activities at Seaplane Base Survival Area would have short-term minor adverse effects from the presence of personnel and noise and disturbance generated during activities. These exercises are not expected to result in chronic stress to wildlife based on the low number of activities that occur per year, the short duration of the exercises, and the low number of vehicles and/or personnel involved in the exercises. There would be no change in populations of animals because of vehicle use, presence of personnel, or use of ordnance and pyrotechnics associated with these training activities.

Impacts of NSW training at Indian Island on wildlife and wildlife habitat under Alternative 1 would be the same as the No Action Alternative as training activities would be occurring at the same level. Because the covert nature of these activities have a light footprint, cause little noise disruption, and involve a small number of personnel, the effects of this training would result in temporary displacement of individuals and would disrupt foraging and/or resting behaviors for very brief periods. As these activities are short-term and infrequent, there would not be any population level effects.

Insertion/extraction activities occur on land at OLF Coupeville and Seaplane Base and SAR activities at Seaplane Base Survival Area would increase slightly under Alternative 1, as described in Chapter 2. Personnel movements for insertion/extraction and SAR activities would not prohibit the use of habitats by wildlife once the disturbance ceased. As with NSW training events, wildlife behaviors would be disturbed temporarily, but would be expected to return to normal once the disruption from personnel movements had passed or shortly thereafter. There would be no significant impact to wildlife or wildlife habitat as a result of personnel ground movements associated with insertion/extraction training activities.

Land Demolition

Under Alternative 1 there would be additional training activities conducted each year involving land demolitions, as described in Chapter 2. The type of ordnance used would not change from the No Action Alternative. Because of the long-term and repeated disturbances in the DTR Seaplane Base and DTR Bangor, these areas are considered to be of poor quality as wildlife habitat and there would be little effect to wildlife within the DTR themselves. The effects of detonations on habitats and wildlife use in areas adjacent to the DTRs would be the same as under the No Action Alternative. The effects on wildlife from detonations at the DTRs would be temporary displacement and increased stress. Animal behaviors and use of habitat would return to baseline or normal conditions shortly after the training had ceased. No significant adverse impacts to wildlife are anticipated.

Aircraft Overflights

There would be a minimal increase in insertion/extraction training and SAR activities at Seaplane Base where helicopters would be used for land based training. The number of inland ACM at Okanogan and Roosevelt MOAs would increase under Alternative 1, as described in Chapter 2. The impacts of aircraft disturbance would be the same as the No Action Alternative. Wildlife exposed to low-altitude aircraft overflights under Alternative 1 could exhibit short-term behavioral and/or physiological responses, but not to the extent where the general health of individuals or populations would be compromised. Aircraft overflights are not expected to result in chronic stress based on the short duration and relative infrequency of exposure.

3.11.2.4 Alternative 2

Impacts on Terrestrial Vegetation and Wetlands

Land Based Training

The No Action Alternative includes land-based training activities involving personnel and/or vehicles associated with EOD, ISR, NSW, insertion/extraction, and SAR activities. Under Alternative 2, the number of Navy training and testing activities would increase, as discussed in Chapter 2. As in the No Action Alternative, continued vehicle and equipment use and foot traffic at the existing DTR Seaplane Base and DTR Bangor would have a negligible effect on vegetation because of the disturbed nature of the areas in which these activities occur. ISR and EODMU training activities that occur at Seaplane Base Survival Area would have minor impacts on vegetation from trampling and crushing of ground-cover and shrub layer vegetation from personnel movements and light vehicular traffic in the training area.

Impacts of NSW training at Indian Island on terrestrial vegetation would be the same as the No Action Alternative. Foot traffic in undisturbed areas has the potential to cause damage to individual plants from trampling or crushing in localized areas however there would not be any loss of populations and areas of trampling would be expected to recover in a short time period.

Insertion/extraction activities at OLF Coupeville and Seaplane Base and SAR activities at Seaplane Base Survival Area would increase slightly under Alternative 2, as described in Chapter 2. The effects on vegetation would be the same as described under the No Action Alternative and there would be no significant impacts.

There would be no effect on wetlands as land-based training exercises would be conducted to avoid wetlands.

Land Demolition

Under Alternative 2, activities involving or potentially involving explosives would increase, as discussed in Chapter 2. Because of the long-term and repeated disturbances in the DTR areas of Seaplane Base and NBK-Bangor, little vegetation is present and the areas are considered disturbed. No adverse impacts to vegetation are therefore anticipated.

Impacts on Wildlife

Land Based Training

Under Alternative 2, the vehicle and equipment use and foot traffic associated with an increase of EOD training activities at the DTR Seaplane Base and DTR Bangor, as described in Chapter 2, would have a negligible effect on wildlife because of the disturbed and poor quality habitat the areas provide. Animals that are present would either be habituated to the human and vehicular presence or would avoid the area when activities were occurring.

EODMU and ISR training activities at Seaplane Base Survival Area would have short-term minor adverse effects from the presence of personnel and noise and disturbance generated during activities. These exercises are not expected to result in chronic stress to wildlife based on the low number of activities that occur per year, the short duration of the exercises, and the low number of vehicles and/or personnel involved in the exercises. There would be no change in populations of animals because of vehicle use, presence of personnel, or use of ordnance and pyrotechnics associated with these training activities.

Impacts of NSW training at Indian Island on wildlife and wildlife habitat under Alternative 2 would be the same as the No Action Alternative as training activities would be occurring at the same level. Because the covert nature of these Special Forces which have a light footprint, cause little disruption because of noise, and the small number of personnel involved, the effects of this training would result in temporary displacement of individuals and would disrupt for very brief periods foraging and/or resting behaviors. As these activities are short-term and infrequent, there would not be any population level effects.

Insertion/extraction activities occur on land at OLF Coupeville and Seaplane Base and SAR activities at Seaplane Base Survival Area would increase slightly under Alternative 2, as described in Chapter 2. Personnel movements for insertion/extraction activities and SAR activities would not prohibit the use of habitats by wildlife once the disturbance ceased. As with NSW training events, wildlife behaviors would be disturbed temporarily, but would be expected to return to normal once the disruption from personnel movements had passed or shortly there after. There would be no significant impact to wildlife or wildlife habitat as a result of personnel on the ground movements associated with insertion/extraction training activities.

Land Demolition

Under Alternative 2 there would be additional training activities conducted each year involving land demolitions, as described in Chapter 2. The type of ordnance used would not change from the No Action Alternative. Because of the long-term and repeated disturbances in the DTR Seaplane Base and DTR Bangor, these areas are considered to be of poor quality as wildlife habitat and there would be little effect to wildlife within the DTR themselves. The effects of detonations on habitats and wildlife use in areas adjacent to the DTRs would be the same as under the No Action Alternative. The effects on wildlife from detonations at the DTRs would be temporary displacement and increased stress. Animal behaviors and use of habitat would return to baseline or normal conditions shortly after the training had ceased. No significant adverse impacts to wildlife are anticipated.

Aircraft Overflights

There would be a minimal increase in insertion/extraction training and SAR activities at Seaplane Base where helicopters would be used for land based training. The number of inland ACM at Okanogan and Roosevelt MOAs would increase under Alternative 2, as described in Chapter 2. The impacts of aircraft disturbance would be the same as the No Action Alternative. Wildlife exposed to low-altitude aircraft overflights under Alternative 2 could exhibit short-term behavioral and/or physiological responses, but not to the extent where the general health of individuals or populations would be compromised. Aircraft overflights are not expected to result in chronic stress based on the short duration and relative infrequency of exposure.

3.11.3 Mitigation Measures

As summarized in Section 3.11.2, the actions proposed in this EIS/OEIS could affect some terrestrial resources within the study area, but community or population level effects would not be expected under any of the alternatives. Current protective measures would continue to be implemented by the Navy, and no additional mitigation measures would be needed to protect terrestrial vegetation, wetlands, or wildlife.

3.11.4 Summary of Effects by Alternative

As summarized in Table 3.11-1, the No Action Alternative, Alternative 1, and Alternative 2 would have negligible to minor short-term impacts on terrestrial vegetation, wetlands, and wildlife. In addition, there are no federally-listed terrestrial wildlife species that would be affected by land-based NWTRC activities at Seaplane Base, Indian Island, NBK-Bangor, OLF Coupeville, Okanogan MOA, and Roosevelt MOA.

Table 3.11-1: Summary of Environmental Effects – Terrestrial Biological Resources

Alternative and Stressor	Summary of Effects and Impact Conclusion
No Action	
Land Based Training	Minor, short-term, and localized disturbance to terrestrial vegetation and wildlife from foot traffic, light vehicular use, and ordnance and pyrotechnics. No long-term population-level effects. Wetlands would not be affected.
Land Demolitions	Temporary displacement and minor disturbance of terrestrial wildlife in the areas adjacent to DTRs. Wildlife would exhibit short-term physiological response but would return to normal behaviors shortly after disturbance. No long-term population level effects. Vegetation and wetlands would not be affected by EOD actions in established DTRs.
Aircraft Overflights	Short-term behavioral responses of wildlife particularly from helicopters. Due to the infrequent occurrence and short-duration of activities, there would be no long-term population-level effects.
Alternative 1	
Land Based Training	Minor, short-term, and localized disturbance to terrestrial vegetation and wildlife from foot traffic, light vehicular use, and ordnance and pyrotechnics. No long-term population-level effects. Wetlands would not be affected.
Land Detonations	Temporary displacement and minor disturbance of terrestrial wildlife in the areas adjacent to DTRs. Wildlife would exhibit short-term physiological response but would return to normal behaviors shortly after disturbance. No long-term population level effects. Vegetation and wetlands would not be affected by EOD actions in established DTRs.
Aircraft Overflights	Short-term behavioral responses of wildlife particularly from helicopters. Although activities would increase over the No Action Alternative, they would occur relatively infrequently and for short-durations which would not result in long-term population-level effects.
Alternative 2 (Preferred Alternative)	
Land Based Training	Minor, short-term, and localized disturbance to terrestrial vegetation and wildlife from foot traffic, light vehicular use, and ordnance and pyrotechnics. No long-term population-level effects. Wetlands would not be affected.
Land Detonations	Temporary displacement and minor disturbance of terrestrial wildlife in the areas adjacent to DTRs. Wildlife would exhibit short-term physiological response but would return to normal behaviors shortly after disturbance. No long-term population level effects. Vegetation and wetlands would not be affected by EOD actions in established DTRs.
Aircraft Overflights	Short-term behavioral responses of wildlife particularly from helicopters. Although activities would increase over the No Action Alternative, they would occur relatively infrequently and for short-durations which would not result in long-term population-level effects.

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3.12 Cultural Resources

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3.12 CULTURAL RESOURCES

Typically, the term "cultural resources" includes prehistoric and historic sites, structures, objects, landscapes, ethnographic resources, and other physical evidence of human activity considered important to a culture, subculture, or community for scientific, traditional, religious, or other reasons. In this document, cultural resources are divided into three groups: archaeological resources (both historic and prehistoric), architectural resources, and traditional cultural resources. The use of these terms in relation to the cultural resources of the Northwest Training Range Complex (NWTRC) is defined below.

Archaeological Resources. Prehistoric and historic archaeological resources are locations (sites) where human activity measurably altered the earth or left deposits of physical remains. Prehistoric sites in the NWTRC consist of evidence of human activities that spanned the time from perhaps 8,000 years ago until the time of the first European contact in the late 18th century. Most frequently, such sites contain both surface and subsurface elements. Historic archaeological resources are those resources from after European contact. They may include subsurface features such as wells, cisterns, or privies or artifact concentrations and building remnants, such as foundations. Underwater archaeological resources are submerged sites that have some cultural affiliation. These may be prehistoric sites or isolated prehistoric artifacts, or they can consist of submerged historic shipwrecks, airplanes, or pieces of ship components, such as cannons or guns.

Architectural Resources. Architectural resources are elements of the built environment, such as existing buildings, dams, bridges, and other structures of historic, engineering, or artistic significance. Factors in determining a resource's significance are its age, integrity, design, and association with important events or persons. To receive protection under Federal cultural resources laws, architectural resources generally must be at least 50 years old or be of exceptional importance. Cold War-era military facilities may meet the exception criteria.

Traditional Cultural Resources. Traditional cultural resources are resources associated with cultural practices and beliefs of a living community that are rooted in its history and are important in maintaining the continuing cultural identity of the community. Traditional cultural resources may include archaeological sites, locations of historic events, sacred areas, sources of raw materials used to produce tools and sacred objects, traditional hunting or gathering areas, and usual and accustomed tribal fishing grounds. The traditional community may consider these resources essential for the persistence of their culture. Those traditional resources that are listed in or eligible for listing in the National Register of Historic Places (NRHP) are known as "traditional cultural properties."

Cultural Resource Issues. Prehistoric and historic archaeological resources, structures, and historic districts, and traditional cultural resources may be vulnerable to a variety of training activities ("stressors"). For example:

- Traditional tribal fishing and gathering practices, sites, and resources could be disturbed by training activities, or access to such resources could be limited during naval training activities. Tribes have expressed concerns over contamination of habitat and bioaccumulation of harmful substances in marine life, disruptions to ceremonial harvesting, and access to traditionally used areas.
- Archaeological resources (at sea and near shore) could be affected directly by weapons firing, bombing, missiles, vessel movement, EOD activities, anchoring, troop movement, or amphibious vessel movement.
- On land, archaeological resources could be damaged by mine warfare, troop movement, insertion activities, and other training activities.
- Historic structures on land could be affected by inappropriate adjacent uses and by blast percussion and vibrations created by high-explosive ordnance.

- Traditional cultural resources could be affected directly and indirectly by visual and noise intrusions of overflights; vessel or troop movements; weapons firing, bombing, missiles, and mine warfare; and lack of access to traditional areas.
- Noise (including sonar), weapons firing, bombing, chaff, and mine detonations could affect fish, shellfish, or other traditionally procured items either directly or indirectly.

Previous research indicates that aircraft noise vibration would have little potential for structural damage to historic structures (FAA 1985). An evaluation of the peak sound pressures impinging on structures at Naval Station Whidbey Island found that there was little probability of structural damage of noise from low-altitude, high-speed aircraft (DoN 2005b, Sutherland 1990). Therefore, the topic of noise vibration from flights over architectural sites is not evaluated in Section 3.12.2, Environmental Consequences.

3.12.1 Affected Environment

3.12.1.1 Cultural Resources in the Northwest Coastal Region

The coastal region of the northwestern United States was largely shaped by a series of glacial events and associated isostatic (that is, stable) conditions or eustatic fluctuations (that is, relating to a global change in sea level), with subsequent emergence of land masses and deposition of glacial till and outwash. Before and during the glacial period, active volcanoes contributed to formation of some of the existing landforms (Blukis Onat 1994). Present-day shorelines and islands resulted from both erosion and aggradation (building of the land surface through natural deposition of material).

3.12.1.1.1 Prehistoric Archaeological Resources

Archaeological materials in the Study Area may have been affected by these past geological processes. Specifically:

- Late prehistoric coastal sites might be located above modern shorelines because of sea level changes and uplift of coastal areas.
- Early prehistoric cultural deposits may have been buried beneath glacial till or are presently underwater or in tidal zones.
- Wave action and tides might erode deposits situated near modern high tide levels.

Most prehistoric resources in the sea ranges of the NWTRC would be expected along shallow coastal waters and along adjacent shorelines inundated by rising sea levels over the past 12,000 years (DoN 1997). Occasionally, isolated artifacts from Native American activities in or on the water may be located along coasts and island shorelines. It appears that "given the generally low-lying relief of Whidbey and Camano Islands, it is probable that only very limited portions of Island County were available for terrestrial occupation at that time" (Wessen 1988). Thus, continuing human occupation and use of the northern Puget Sound region dates to perhaps 8,000 years ago.

Prehistoric northwest coast peoples lived in an area with a relatively mild climate, temperate rain forest, and rich marine life. Cultural adaptations to this environment varied somewhat among tribes, but generally these groups were non-horticultural peoples whose basic food sources included salmon, shellfish, land mammals, berries, freshwater fish, and wild plants. Vegetable foods included camas roots and lily bulbs supplemented by berries and nuts. Net traps or spears were used to capture waterfowl, and bows and arrows were used for game.

Among the northwest tribes, fishing, especially the taking of salmon and steelhead, was universally important as an element of diet and, in cultural traditions, in religious practices, and trade. The northwest Indians developed a wide variety of fishing methods such as nets, traps, weirs, spears, and hook and line, which they used to catch fish at numerous locations throughout the areas they lived and traveled. They fished year-round in Crescent Harbor and trolled off the western shore of Whidbey Island. Species taken included coho, Chinook, pink, sockeye, and chum salmon; rockfish; perch; ling cod; halibut; herring; smelt; and trout. They gathered numerous shellfish species, including cockles, clams, saltwater snails, oysters, barnacles, crab, chitons, and mussels (DoN 1997).

With a few exceptions, northwest coast peoples occupied permanent villages in winter, and many had permanent structures for other seasons (Suttles 1990). Their cedar-plank dwellings typically housed several related families. They often settled along the estuaries of small rivers and along the open coastline where intertidal, estuarine, and marine resources were available for subsistence uses.

Northwest coast material culture is distinctive for its highly developed woodworking technology that produced plank houses, dugout canoes, and beautifully crafted utensils. Renowned art work included carving, painting, and textiles.

Spanish, English, and Russian explorers and fur traders visited the area that would become the northwest coast of the United States during the late 1700s. In 1792, Captain George Vancouver set out to map and explore coastal areas in what is now northern Washington. In May 1792, Joseph Whidbey, accompanied by Peter Puget, mapped and explored areas of Puget Sound. America’s formal incursion into this area was marked by the entry of the United States Exploring Expedition commanded by Lieutenant Charles Wilkes into Puget Sound in 1841.

These explorers encountered or were told of the numerous tribes who occupied or used the Puget Sound area during the early historic period. History records that northern Whidbey Island was once inhabited by three Coast Salish speaking groups, the Samish, Swinomish, and Lower Skagit, while the northern portions of the Kitsap Peninsula were within the traditional territories of the Suquamish Tribe. The Suquamish are members of the contemporary Suquamish Tribe (DoN 2002). Wilkes named the Toandos Peninsula after a local Native American group then occupying the Dabob Bay area.

During the 1800s, the Northwest Coast S’Klallam expanded their territory to the area of the Hood Canal, and, by 1844, the Native American population along the Hood Canal totaled around 500 people (Tiller 2005). Descendants of the Klallam are currently, (in alphabetical order), members of the Jamestown S’Klallam Tribe, Lower Elwha Klallam Tribe, and Port Gamble S’Klallam Tribe.

The Puget Sound area was part of the Oregon Country, which became United States territory when the 1846 Oregon Treaty was signed. In 1850, Colonel Isaac Ebey claimed a square mile of prairie on Admiralty Inlet to become the first permanent settler on Whidbey Island. During the late 1850s and early 1860s, traders, travelers, missionaries, and settlers entered the area and began to move into land cleared by logging operations. These newcomers interacted with local tribes in numerous ways, including bringing in new diseases and alcohol. Tribes were dislocated from their traditional territories and practices.

3.12.1.1.2 Tribal Fishing Rights

Between 1854 and 1856 the United States negotiated five treaties, consisting of the treaties of Medicine Creek, Quinault, Neah Bay, Point Elliot, and Point-No-Point, with the unlettered northwest tribes to acquire great expanses of land (U.S. District Court 1974). These treaties guaranteed tribes fishing rights in common with citizens of the territory. As a result, reservations were established, including the Sauk-Suiattle, Swinomish, and Jamestown S’Klallam at Port Gamble. In 1855, the Suquamish and several other tribes negotiated a treaty that created reservations, including the Port Madison Indian Reservation across Liberty Bay from NUWC Keyport. The treaties collectively are called the Stevens-Palmer Treaties, after Isaac I. Stevens, the governor of the Washington Territory, and Joel Palmer, the superintendent of Indian affairs for the Oregon Territory, who negotiated the treaties on behalf of the United States (Woods 2005).

These Federal treaties assured tribes living in western Washington the right to fish at “usual and accustomed grounds and stations.” Fish and other marine resources had long been a vital part of northwest coast tribes’ subsistence and traditional practices. Reluctant to be confined to small reservation bases, the Indian negotiators insisted that their people continue to fish as they had beyond the reservation boundaries. There is no indication that the Indians intended or understood the language "in common with all citizens of the Territory" to limit their right to fish in any way.

For many years following the treaties, the Indians continued to fish in their customary manner and places. Although non-Indians also fished, there initially was no need for any restrictions on fishing. However, over the next century, Euro-American immigrants occupied traditionally used land areas and increasingly harvested the area's abundant maritime resources. By using larger boats, more modern technology, and regulatory authority, the newcomers gradually displaced tribes from traditional fishing areas.

To reassert Native American fishing rights, "fish-ins" were initiated on the Puyallup River in 1964 in defiance of Washington State attempts to regulate tribal fishing. Local tribes sued to block State regulation, but an ambiguous 1968 Supreme Court decision left the issue unresolved (HistoryLink 2008).

Sixty Native Americans and their supporters were arrested in Tacoma in 1970 for failing to disperse during a fish-in on the Puyallup River. In response, the U.S. attorney for western Washington filed a complaint (*U.S. v. Washington*) against the State of Washington for failing to recognize tribal fishing rights. Commercial and sport fishing groups responded by submitting friend-of-the-court briefs opposing treaty fishing rights. The matter went to trial in the U.S. District Court for the Western District of Washington, Tacoma Division, in August, 1973.

On February 12, 1974, Judge George H. Boldt issued a landmark Federal court decision, now known as the Boldt Decision. It granted 14 western Washington Native American Tribes and Nations access to "usual and accustomed fishing grounds and stations." The case area was "that portion of the State of Washington west of the Cascade Mountains and north of the Columbia River drainage area, and included the American portion of the Puget Sound watershed, the watersheds of the Olympic Peninsula north of the Grays Harbor watershed, and the offshore waters adjacent to those areas" (Boldt 1974).

The Boldt Decision found that the "government's promise to secure the fisheries for the tribes was central to the treaty-making process and that the tribes had an original right to the fish … [and] it was not up to the State to tell the tribes how to manage something that had always belonged to them" (HistoryLink 2008). The ruling held that the treaties reserved to Indian tribes fishing rights that are distinct from those of other citizens and extended off-reservation fishing rights. The State was ordered to "take action to limit fishing by non-Indians" (HistoryLink 2008). The court decisions defined the usual and accustomed fishing grounds of the various tribes and affirmed the right of access to these fishing grounds. The legal mandates also changed the State fisheries industry and resulted in clashes among regulators and tribal and non-tribal fishermen.

The Ninth Circuit Court of Appeals upheld the Boldt ruling in 1979, and the issue of what fishing rights Indians had been given under the Stevens-Palmer Treaties reached the U.S. Supreme Court later that year. The Supreme Court modified the lower court ruling to include in the 50 percent allocation all fish caught by treaty Indians both on- and off-reservation, for any purpose (Marino 1990). Since that time, other lawsuits have been brought before the court, but the basic tenets of the Boldt decision have been upheld. Some of the principles established by the court decisions have been applied to other resources, including shellfish.

Established treaties recognize the profound relationships between American Indians and maritime resources, and traditional tribal fishing and resource procurement continues to be a vital part of tribes' traditional practices. Presently, the tribes partner with personnel from the Washington Department of Fish and Wildlife to manage fishery resources and to protect and enhance the salmon, shellfish, and hunting resources of the State. Salmon are a primary resource for the treaty tribes; salmon are "treated ceremoniously by providing a core symbol of tribal identity, individual identity, and the ability of the Indian culture to endure as well as being of nutritional and economic importance" (NMFS-NWR 2004 cited in DoN 2006).

Figure 3.12-1 shows the usual and accustomed tribal fishery grounds in the OPAREA, Puget Sound Study Area, and vicinity, and includes the Olympic Coast National Marine Sanctuary area.

Native Americans use these areas for both commercial and subsistence fishing, as follows.

- Willapa Bay is a usual and accustomed fishing area for the treaty tribes (NOAA 1993). Chinook, coho, and pink salmon are the primary species taken and, along with steelhead trout, are harvested either by gillnets or troll gear.
- Tribal activity is often centered on Grays Harbor, Quillayute, and Cape Flattery where the Makah Tribe conducts a marine gillnet fishery.
- Tribes fish in the Strait of Juan de Fuca for Chinook and sockeye salmon.
- Treaty gillnet fisheries harvest steelhead trout in all the major rivers of the Olympic Peninsula as well as coho and Chinook salmon in the Queets, Hoh, and Quillayute Rivers, and chum, coho, sockeye, and Chinook salmon in the Quinault and Ozette Rivers.
- Coastal tribes such as the Makah, Quileute, Hoh, and Quinault participate in a variety of groundfish fisheries where sablefish and Pacific halibut are taken by longline and handline gear off the north coast of the Olympic Peninsula.
- The coastal tribes conduct a variety of fisheries in the near-shore area, and take sea urchin, mussels, ocean clams, gooseneck barnacles, Dungeness crab, salmon, steelhead, rockfishes, cod, and smelt for subsistence and ceremonial purposes.
- A number of Native American tribes and nations have usual and accustomed fishing rights year-round to oysters, mussels, and intertidal clams in the Hood Canal.

The *Marine Resources Assessment for the Pacific Northwest Operating Area, Final Report* (DoN 2006:4-119 to 4-125) contains a detailed written description of the usual and accustomed fishing grounds for the treaty tribes. This information is incorporated here by reference. As shown in Figures 2-2 and 3.12-1, there is an overlap between tribal usual and accustomed areas and the locations of Navy training.

3.12.1.1.3 Culturally Significant Areas

Culturally significant areas are located on the reservations and in surrounding areas. Such sites may be historically important to a tribe’s beliefs, customs, and practices, and may play a vital role in the current community’s religious celebrations. These sites include named places, ancient villages such as Ozette, burial grounds, lookouts, and ceremonial places used for prayer, preparation, and training. For example:

- First Beach and James Island are valued by the Quileute Tribe as an ancient burial ground and a place of spiritual significance.
- Shorelines along the Hoh Reservation also are burial areas.
- Destruction Island is considered spiritually significant.

At present, no traditional cultural properties have been identified on Navy property. For additional information on resources historically used by tribes in the Study Area, see *The Marine Resources Assessment Pacific Northwest Operating Area* (DoN 2006).

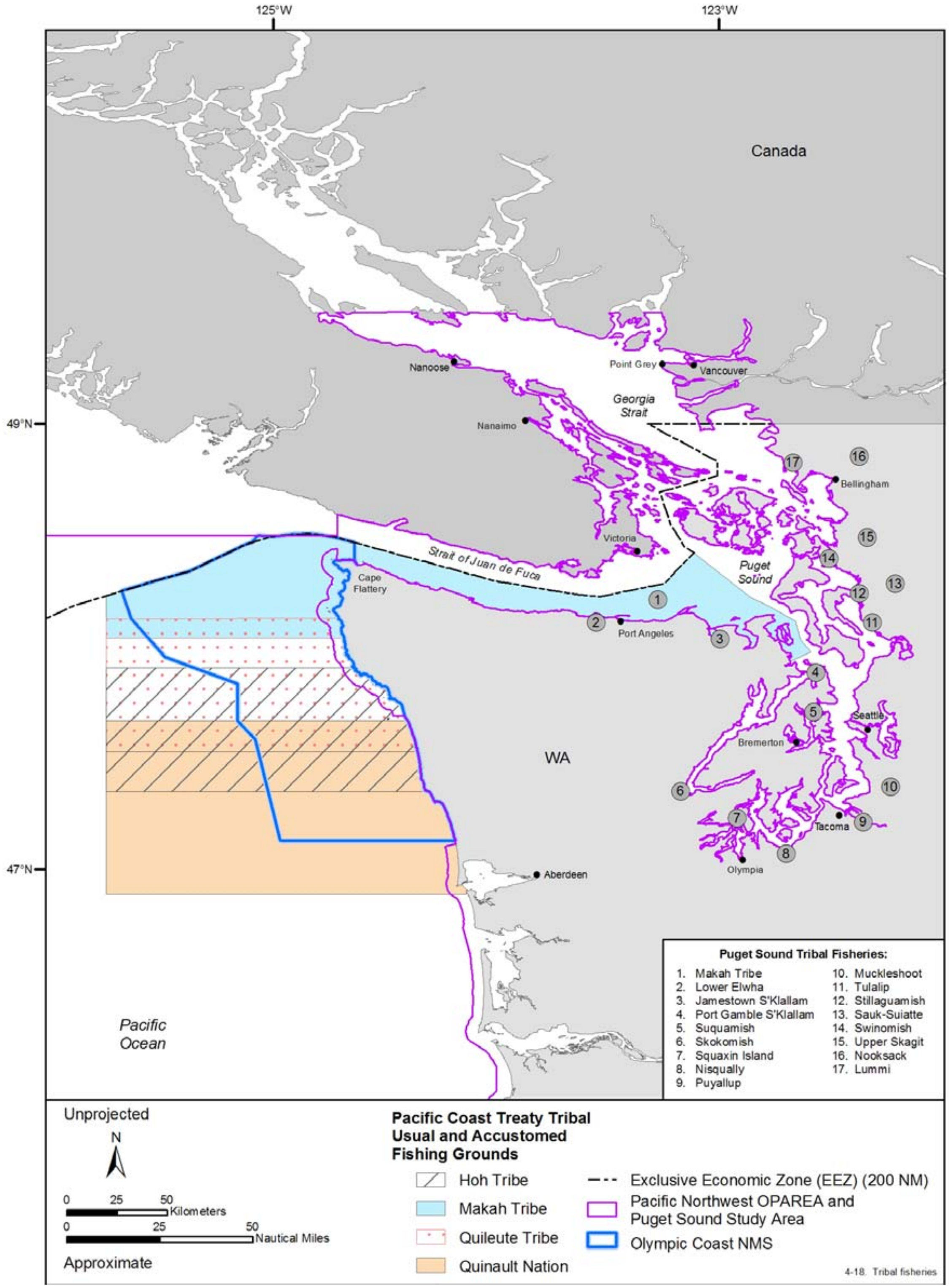

Figure 3.12-1: Tribal Fishery Grounds in the Pacific Northwest OPAREA and Vicinity

3.12.1.1.4 Pacific Coast Tribes and Tribes with Treaty Fishing Rights

There are four Federally recognized Washington coast Indian tribes and 19 Federally recognized Puget Sound Indian tribes within the Study Area. Of the following tribes, only the Samish and Snoqualmie tribes do not have Federally recognized treaty fishing rights (NMFS-NWR 2004 cited in DoN 2006). The Pacific Coast tribes include the following:

> **Hoh peoples** are a band of the Quileute Tribe, although they are recognized as a separate tribal entity. Their reservation is located on the Olympic Peninsula of northern Washington. The tribe retains many of their traditional customs, including celebrating seal hunts and practicing the canoe culture. They dip net for smelt and harvest perch, crab, and razor and butter clams from tidelands, and operate a fish hatchery program (Tiller 2005).
>
> The **Makah Reservation** on the northwestern tip of the Olympic Peninsula was established by the Treaty of Neah Bay in 1855 (Tiller 2005). The Makah, of Nooktan origin, practiced a subsistence lifestyle centered on fishing for sea otters, whale, seal, and smaller species, including shellfish, and trading these products with other tribes (Tiller 2005). Currently, although tribal income is broadly based on agriculture, livestock, forestry, gaming, construction, mining, services and retail, transportation, and tourism and recreation, the "fishing industry represents the most important aspect of the Makah's economy" (Tiller 2005). In 1998, approximately 70 percent of the tribal population was engaged in employment in fishing for salmon, groundfish, and sea urchins, while others were employed in a fish-buying and processing plant. The Makah Nation Fish Hatchery is designed for public viewing of migrating salmon.
>
> **Quileute** culture is centered on the ocean, river, and forest, and the Quileute are linguistically related to the Hoh. The Quileute Reservation is located on 700 acres along Pacific Ocean beaches at the mouth of the Quileute River. They historically practiced a hunting, fishing, and gathering subsistence lifestyle, dominated by the use of seal and/or whale oil, which also was used as a valuable trading commodity (Tiller 2005). Many present-day Quileute derive their livelihood from logging and fishing.
>
> **Quinault** peoples ("canoe people" or "people of the cedar tree") originally practiced a subsistence lifestyle centered on fishing, hunting, and gathering. Their reservation is in the southwestern corner of the Olympic Peninsula (Tiller 2005). The Quinault economy is based on off-reservation employment, gaming, resorts, logging, and fishing.

The above four Washington Coastal Tribes helped support designation and ongoing operation of the Olympic Coast National Marine Sanctuary, are members of the Sanctuary Advisory Council, and help to shape policy, education, and research (NOAA 2008b).

The following tribes have treaty fishing rights in the Puget Sound:

> **Klallam** tribal groups include the **Jamestown S'Klallam Tribe**, **Lower Elwha Klallam Tribe**, **Point No Point Treaty Nation**, and **Port Gamble S'Kallam Tribe**. Tribal reservations are located on the northern Olympic Peninsula. Historically, Klallam peoples used the Hood Canal for summer fishing and gathering, especially for shellfish, herring, and salmon. Under the Boldt Decision, the S'Klallams regained the fishing rights they had been granted in the Point-No-Point treaty (Tiller 2005). The Point-No-Point Treaty Council is a natural resource management organization established in 1974 to fulfill requirements of the Boldt Decision (http://www.pnptc.org/). Retail and fishing industries contribute to tribal economies.
>
> The **Lummi** Reservation is in northwest Washington. Prior to the Treaty of Point Elliot and reservation establishment, the Lummis occupied the northern San Juan Islands and the adjacent mainland where they traveled to traditional reef-net locations. Salmon was their primary food

source and many ceremonies, beliefs, and community activities were centered on salmon (Tiller 2005). Presently, the economy is based primarily on marine harvesting and gaming.

The **Makah** and their reservation were described previously.

The **Muckleshoot** Reservation is east of the Seattle-Tacoma metropolitan area, but tribal ancestral homelands include areas along the eastern and southern reaches of the Puget Sound. Historically, they depended on the abundance of natural resources, especially salmon and red cedar (Tiller 2005). The foundation of today's tribal economy is based on gaming, fishing, and retail.

Nisqually peoples resided in the woodlands and prairies of the Nisqually River basin. Today, their reservation is located in western Washington, east of Olympia. They operate two major fish hatcheries on the Nisqually River and derive other income from gaming enterprises (Tiller 2005).

The **Nooksack** Reservation is in the upper Nooksack River valley, in northeastern Washington. They are a Coast Salish nation whose traditional means of subsistence included fishing, hunting, clam digging, root gathering, and trading (Tiller 2005). The present-day tribal economy is supported by a number of enterprises such as service, retail, gaming, and fisheries, including operation of a fisheries laboratory and salmon-rearing pond.

Puyallup peoples reside on the Puyallup Reservation, south of Seattle, at the southern end of Puget Sound. Like many other Puget Sound groups, the Puyallup gathered salmon, shellfish, wild game, roots, and berries (Tiller 2005). Presently, they are a major employer in King County, with a wide variety of enterprises that include gaming, marina, and seafood.

The **Sauk-Suiattle** Reservation is in the Sauk Prairie area east of the Puget Sound. Historically, they fished area rivers for salmon, often traveling down to the Puget Sound to harvest fish and shellfish (Tiller 2005). Fishing continues to be a vital occupation for the tribe, and as part of the Skagit System Cooperative, the tribe helps to manage the State's salmon and steelhead resources.

The **Skokomish** Reservation, located on the delta of the Skokomish River where it empties into the Hood Canal, was created by the Point-No-Point Treaty (Tiller 2005). The territory of the Twana or Skokomish people (whose descendents now comprise the Skokomish Tribe) lies along both sides of the Hood Canal, where these people had winter villages, including the Quilcene and Dabob grounds near the Dabob Bay. They frequented Dabob Bay and surrounding beaches for seasonal salmon fishing and clam digging. The Twana assigned place names to four shoreline areas in the Dabob Bay area: Whitney Point was a summer campsite; "Pulali," as in Pulali Point, was probably derived from the native name of a wild cherry, *Pulela*; Zelatched Point was a summer campsite; and Sylopash Point was likely named for a probable mythological site. The tribe operates several businesses, including a fish hatchery, fish-processing plant, gas station, convenience store, and casino.

Squaxin Island (people of the water) include descendents of the original maritime inhabitants of the seven inlets of south Puget Sound, and Squaxin Island Reservation is in the Puget Sound. They are closely related to the Nisqually Tribe. They gathered oysters, clams, smelt, and herring for smoking and year-round consumption (Tiller 2005). The tribe is still involved with fishing as a source of tribal and individual revenue, and has "developed enterprises that move aquiculture projects onto the national and international markets" (Tiller 2005).

The **Stillaguamish** are descendants of the Stoluckwamish River Tribe, but are referred to as Stillaguamish because of their traditional location along the Stillaguamish River. Their reservation is between the Cascade Mountains and the Puget Sound. Historically, harvesting salmon, hunting goats, and gathering vegetative foods provided their subsistence base (Tiller 2005). Besides service and retail outlets, the Stillaguamish economy is now based on gaming and fisheries, including a fish hatchery.

The **Suquamish** peoples occupy the Port Madison Reservation, which lies on the Kitsap Peninsula and was set aside as part of the Point Elliot Treaty of 1855. Historically, the Suquamish Tribe used the Hood Canal for summer fishing and gathering. The tribe has usual and accustomed fishing rights near Keyport Range Site as part of their "usual and accustomed fishing places" treaty rights. Commercial fishing and shellfish harvest reflect the tribe's main nongovernmental source of income (Tiller 2005).

The **Swinomish** Reservation is located on Fidalgo Island in Washington, and is occupied by descendents of aboriginal Swinomish, Kikiallus, Lower Skagit, and Samish tribal members (Tiller 2005). Historically, their subsistence lifestyle was based on salmon and other fish, supplemented with game, berries, nuts, and roots. Current income sources include businesses, government, agriculture, forestry, gaming, manufacturing, services, tourism, and fisheries.

Tulalip peoples occupy their reservation west of the city of Marysville, on the Puget Sound. The term "Tulalip Tribes" refers to several allied tribes who traditionally made the area their homeland. Salmon harvest is an important part of the historic and contemporary economy (Tiller 2005). The Tulalip Reservation is "home to a diverse, bustling, economy with retail centers" and a fish hatchery that "produces more than nine million salmon fingerlings annually" (Tiller 2005).

The **Upper Skagit** Reservation is just northeast of the Puget Sound, in the Cascades foothills. The Upper Skagit are descendants of 11 tribal bands and groups that occupied the Samish Bay and other river drainages in Washington. The tribe owns a fish hatchery at Helmick, and their major sources of tribal revenues are tourism, gaming, Federal grants, and retail businesses (Tiller 2005).

3.12.1.2 Cultural Resources at Specific Study Area Sites

3.12.1.2.1 Pacific Northwest OPAREA

The OPAREA includes submerged prehistoric resources along the coast and island shorelines. There likely were human settlements along the submerged continental shelf dating to the time of the last glaciation (NOAA 1993). Most coastal prehistoric sites are associated with the procurement and processing of shellfish.

Submerged historic resources are primarily associated with maritime trade, transport, and military activities, and include a large number of shipwrecks. In particular, the Olympic coast of Washington is a ship graveyard as a result of the isolated, rocky shores, heavy ship traffic, and ferocious weather and wave action. These conditions have resulted in numerous founderings, collisions, and groundings. Some ships simply disappeared, with a last known location recorded by a lighthouse tender.

Approximately 1,300 shipwrecks have occurred along the Washington coast and in the Puget Sound, and the Strait of Juan de Fuca and Puget Sound are among the areas with extensive wrecks (Northern Maritime Research 2007). Six known shipwrecks are in waters adjacent to NBK-Bangor, 105 are in the Crescent Harbor area, and 141 are adjacent to Indian Island. More that 150 wrecks have been documented in the vicinity of the Olympic Coast National Marine Sanctuary (NOAA 2008b). Figures 3.12-2 and 3.12-3 show shipwrecks in the OPAREA, Puget Sound, and vicinity. Those in shallower waters could be affected by some training activities.

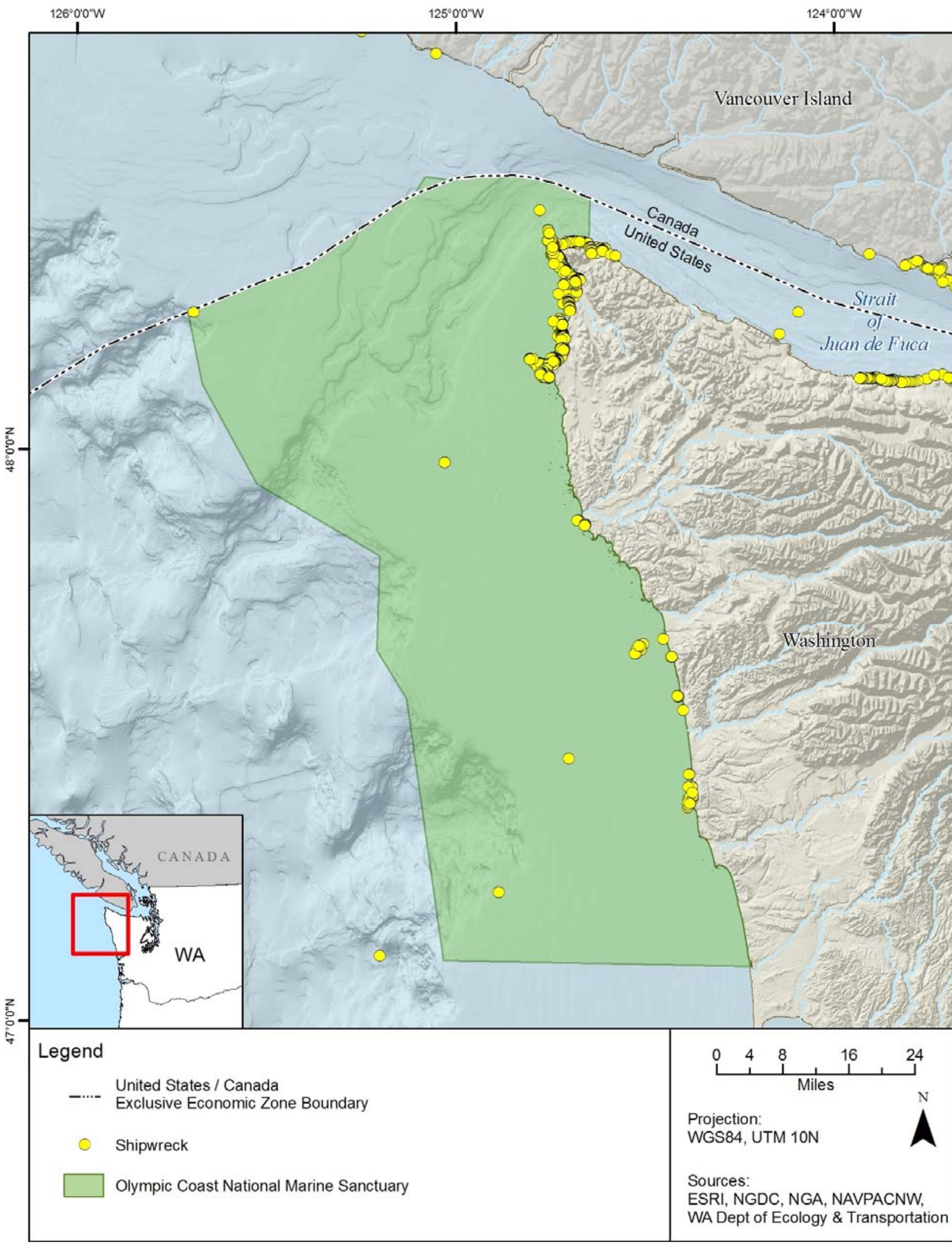

Figure 3.12-2: Shipwrecks in the OPAREA

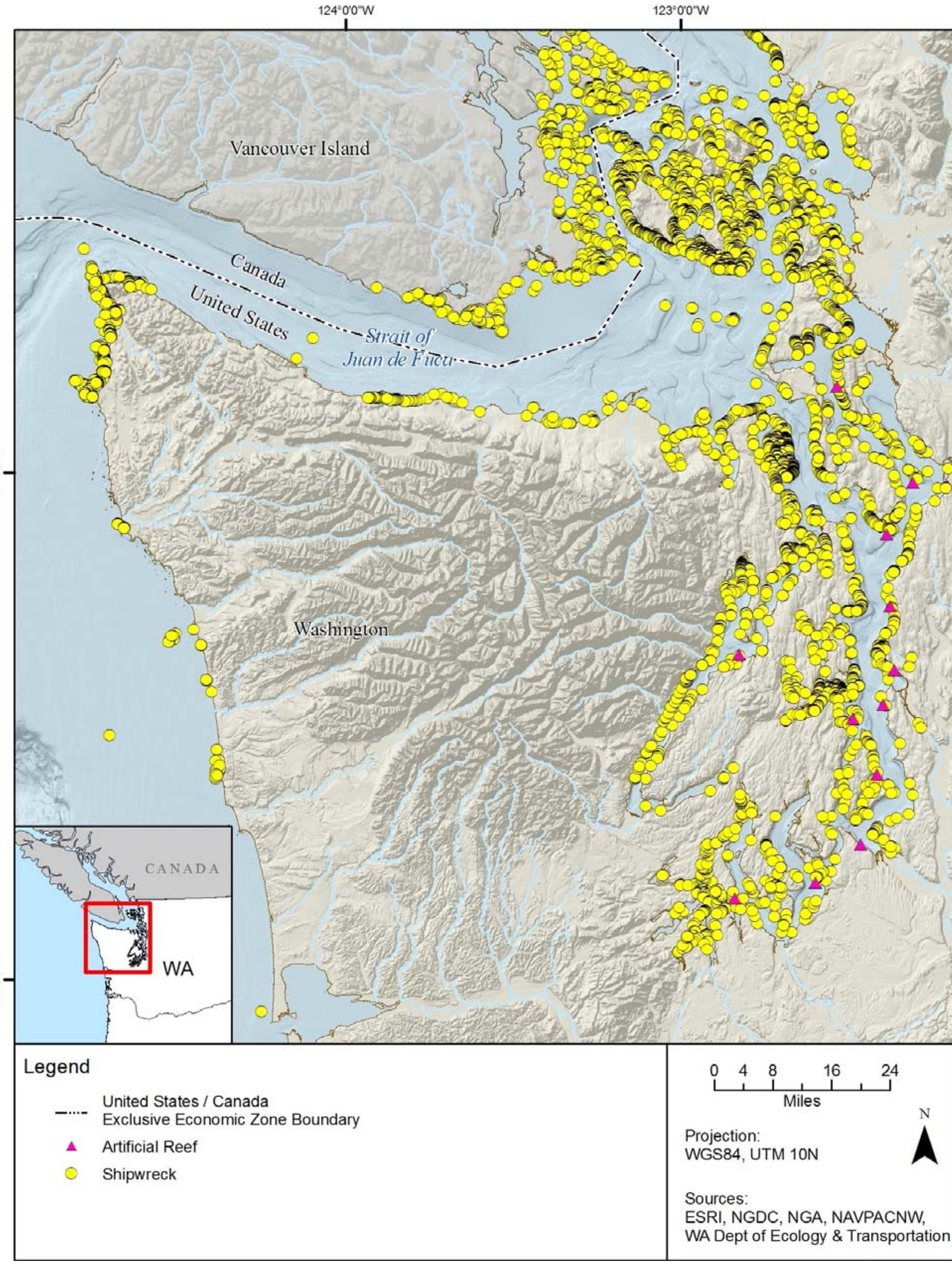

Figure 3.12-3: Shipwrecks in the Puget Sound Study Area and Vicinity

Obstructions and wrecks are listed in the National Oceanic and Atmospheric Administration (NOAA) Automated Wreck and Obstruction Information System (AWOIS) database. In this area, most shipwrecks are of unknown origin, date of sinking, or type (NOAA 2008a). Those that have been identified date from the early 1800s (including the Hudson Bay supply ship *Isabella*, which sank around 1830) to modern fishing boats, barges, cabin cruisers, and tugs. Some of the vessels were damaged during World War II and include cargo ships and freighters. A mine sweeper, the *USS Crow*, was sunk by an erratic-running aircraft torpedo in the Puget Sound in 1943 (Naval Historical Center 2008). Some ships were deliberately sunk to create artificial habitats or reefs. Most shipwrecks within the APE are in relatively shallow coastal waters and would be outside the OPAREAS, such as W-570, W-93A, and W-93B.

The numerous shipwrecks reflect a wide variety of ship types and countries of origin. Some of these include:

- A 3-masted square-rigger, later re-rigged as a bark to make her more suitable for trade among Pacific coast ports;
- An iron barkentine-rigged steam sloop;
- An iron, 3-masted bark;
- A clipper ship used in the guano trade;
- A merchant marine ship;
- A wooden sailing vessel;
- A side-wheeler;
- A steam schooner;
- A passenger steamer;
- An 1808 Russian sailing brig (for the fur trade);
- A British freighter; and
- An iron-hulled, four-masted bark refitted as a schooner-barge.

One of the better-known wrecks is the *Austria*, a “downeaster” built in Maine and converted from a full rigged ship to a bark. This conversion enabled her to ply the west coast trade. Fragments of the ship can still be seen at Cape Alava during extremely low tides (Olympic Coast National Marine Sanctuary 2008).

Along the shorelines of the Olympic Coast National Marine Sanctuary are memorials to crews and passengers who died in shipwrecks in this vicinity. Specifically, these include the wreck of the *Prince Arthur* in 1903, the *P.J. Pirrie* in 1920, and nine ships wrecked between Quillayute Rocks and Cape Alava, five at Destruction Island, and four in the vicinity of Hoh Head (NOAA 1993).

In the Study Area, including Whidbey Island, prehistoric resources include shell middens, lithic sites, earthworks, rock cairns, and burial grounds. Shell midden sites account for about 80 percent of all recorded sites (Wessen 1988). Numerous shipwrecks, submerged ruins, pilings, piers, and structural remains within the Puget Sound and Hood Canal are located close to Navy activities (Figure 3.7-3.)

3.12.1.2.2 Crescent Harbor/Seaplane Base

The Navy has inventoried currently known cultural resources at NASWI. These inventories include sites at Seaplane Base that are listed or potentially eligible (*i.e.*, cultural resources that have not been formally evaluated) for listing in the NRHP (Dames & Moore 1994 cited in DoN 1997).

- Prehistoric archaeological sites in the vicinity of Crescent Harbor include six NRHP-eligible shell midden deposits designated as Sites 451S82, 451S79, 451S80, 451S81, 451S42 and 451S201 (DoN 2007 and Wessen 1988:63).
- Human remains have been exposed by natural erosion in the general project vicinity. The remains will be returned to the affiliated tribe.
- Five terrestrial archaeologically sensitive areas (that is, areas that have moderate to high probability of containing prehistoric cultural deposits) are in the Crescent Harbor vicinity (DoN 1997).
- There are ethnographically named places within the Seaplane Base boundaries.

The Seaplane Base Historic District is the only World War II seaplane base that has not been extensively altered since the war. The entire base appears much as it did in the mid-1940s and has been determined eligible for the NRHP (DoN 2007).

Four structures at Ault Field have been determined to be NRHP eligible. These include Building 112 (Hangar 1), Building 118 (Skywarrior Theater), and Buildings 180 and 220 (Former Celestial Navigation Training). These structures are located at NASWI, several miles from the training areas.

As of 1991, no cultural resources had been identified on the EOD training range. The Washington Office of Archaeology and Historic Preservation indicated (by letter dated July 29, 1991) that it concurred that no archaeological resources were located at sites that subsequently have been identified as supporting training activities under the NWTRC alternatives (DoN 1993).

One of the “obstructions” listed in the AWOIS database for the Crescent Harbor/Seaplane Base vicinity is the locale where three unexploded, 750-pound bombs were dropped. Also in the vicinity of Seaplane NASWI is the wreckage of the Bunker Hill, a tanker that exploded and burned after hitting what was thought to be an old, submerged Navy bomb.

A draft memorandum of agreement is underway between NASWI and the Upper Skagit and Swinomish tribes for shellfish harvesting on the installation beach areas.

Tribes with interests in Island County include the Swinomish (Swinomish Reservation) and the Tulalip Tribes of the Tulalip Reservation (NPS 2008b). The Upper Skagit Tribe has requested access to the shellfish beds on the Seaplane Base, but these are not on or near the range itself.

3.12.1.2.3 Outlying Landing Field Coupeville

No prehistoric or historic archaeological sites have been identified within OLF Coupeville (DoN 2005b). However, the northern portion of OLF Coupeville is surrounded by the Central Whidbey Historic Preservation District, which also is known as Ebey’s Landing National Historic Reserve. This district is a unit of the National Park Service (NPS) and is listed on the NRHP. This rural historic district covers approximately 25 square miles and is a cultural landscape that preserves and illustrates an unbroken historical record of exploration in the Puget Sound region and area settlement from the 19th century to the present.

The Victorian seaport community of Coupeville is within the Central Whidbey Historic Preservation District. It is one of the oldest towns in Washington; settlement began when the land was claimed in 1852 by Captain Thomas Coupe. The district contains 103 buildings, 286 structures, and one object that are on the NRHP. None of the buildings or structures that are part of this district are located within OLF Coupeville (Dames & Moore 1994, cited in DoN 1997).

The military importance of this area for more than a century is reflected by resources within the Central Whidbey Historic Preservation District. During the late 1890s, Fort Casey was built on the bluff above Admiralty Head as part of a three-fort defense system designed to protect the entrance to the Puget Sound.

Nearby Fort Ebey is a remnant of the defensive buildup during World War II, and the 1943 OLF Coupeville is still used today, providing aircraft carrier landing practice for Navy pilots (NPS 2008a).

Tribes associated with Island County include the Swinomish Indians of the Swinomish Reservation, Tulalip Tribes of the Tulalip Reservation, the Kikiallus Tribe, the Skagit Tribe, and the Snohomish Tribe.

3.12.1.2.4 Indian Island

Indian Island is a small, unincorporated community that is the location of the Indian Island Naval Reserve. The Navy has had a presence there since 1939. The Reserve covers the entire island, and no civilian residences are allowed on the island.

Naval Magazine Indian Island is a major U.S. Navy ordnance handling facility that receives and discharges ordnance in support of U.S. military operations worldwide. From the World War II period to 1970, the Navy used the island for production of underwater mines, storage of antisubmarine nets, as a minor ammunition depot, and as a seaplane station (DoN 2005a).

A number of historical structures lie in the waters of Port Townsend and the general vicinity of Indian Island Underwater EOD Range (NOAA 2008a). These include “obstructions” (mostly abandoned pilings); fixed structures in the water such as piers and dolphins; log booms; structural ruins, including four walls of a concrete building; breakwaters; railroad cars that were lost from a barge; artificial reefs built of small barges and other vessels, rock, concrete, bridge rubble, and other materials. and shipwrecks. Shipwrecks include remains of a 20-foot-long sailing vessel, metal wreckage of unknown derivation, two unidentified hulk outlines from sunken vessels, and the remains of the ship *Governor* and the boat *Comet*, which sank from old age (NOAA AWOIS 2008a).

Federally recognized tribes with an interest in Jefferson County sites include the:

- Confederated Tribes of the Warm Springs Reservation of Oregon;
- Hoh Indian Tribe (Hoh Indian Reservation);
- Jamestown S’Klallam Tribe;
- Lower Elwha Tribal Community (Lower Elwha Reservation);
- Quileute Tribe (Quileute Reservation);
- Quinault Tribe (Quinault Reservation); and
- Skokomish Indian Tribe (Skokomish Reservation) (NPS 2008b).

The Navy has completed a memorandum of agreement (MOA) with the Jamestown S’Klallam and Port Gamble S’Klallam regarding the Native American reburial site at Indian Island.

Beaches at Indian Island were closed to shellfish gathering for a time, based on concerns about possible contamination from the Naval Ordnance Depot that occupied part of the island during the 1970s. The Navy conducted remedial actions, and monitoring data indicate that requirements of the record of decision for the facility have been met. A beach-specific clam harvest plan for NAVMAG beaches on Indian Island was developed for 2007-2008. The plan presented the harvestable quantities and harvest allowances for tribal and non-tribal harvest of native littleneck and Manila clams (DoN 2007). Parties to the plan include the U.S. Navy, Lower Elwha Klallam Tribe, Jamestown S’Klallam Tribe, Port Gamble S’Klallam Tribe, and Suquamish Tribe.

3.12.1.2.5 Bangor and Floral Point

Shell midden sites and historic deposits reflect the several types of archaeological materials that occur on the shoreline access areas of Dabob Bay, including the shores of SUBASE Bangor. Shell middens tend to be associated with sandspits or are located near streams adjacent to these areas, which means that shoreline areas designated for project activity and access have a moderate probability for hunter-fisher-gatherer sites.

The Floral Point Shell Midden, the Carlson Spit Shell Midden and the Amberjack Road Shell Midden (age and extent unknown) are situated along the Hood Canal shoreline. All three of these middens are potentially eligible for the NRHP.

Around 1853, the Puget Mill Company established a sawmill at Port Gamble. Other mills soon followed, and the mills helped supply lumber to the gold rush building boom in California.

The Bangor town site was laid out in 1890, and was named for the founder's home town in Maine. Logging and fishing continued over the next century.

During World War II, Bangor became a site for shipping ammunition to the Pacific theater. After the war, the Navy purchased land near the town of Bangor and established the U.S. Naval Magazine. Bangor continued to operate as an ammunition depot until 1973, when it became the homeport for the first squadron of TRIDENT submarines. In June 2004, SUBASE Bangor merged with Naval Station Bremerton (Naval Base Kitsap).

There are two NRHP-listed historic sites in the vicinity of Dabob Bay: the Quilcene-Quinault Battleground site (1825 to 1849) and Seal Rock Shell Mounds (45JE15). Nine other historic sites on SUBBASE Bangor are not eligible for the NRHP, but would be maintained by the Navy. These are itemized in the historic and archaeological resources protection (HARP) plan for the base. Underwater resources include the presence of several mooring dolphins (NOAA 2008a).

Federally recognized tribes with an interest in Jefferson County sites include the:

- Confederated Tribes of the Warm Springs Reservation of Oregon;
- Hoh Indian Tribe (Hoh Indian Reservation);
- Jamestown S'Klallam Tribe;
- Lower Elwha Tribal Community (Lower Elwha Reservation);
- Quileute Tribe (Quileute Reservation);
- Quinault Tribe (Quinault Reservation); and
- Skokomish Indian Tribe (Skokomish Reservation) (NPS 2008b).

Federally recognized tribes associated with sites in Kitsap County include the:

- Port Gamble Indian Community (Port Gamble Reservation);
- Skokomish Indian Tribe/Skokomish Reservation; and
- Suquamish Indian Tribe (Port Madison Reservation) (NPS 2008b).

Based on rights of the tribes under the Treaty of Point-No-Point (1855), and in recognition of its mission and responsibilities, the Navy has developed a cooperative shellfish harvest agreement for SUBASE Bangor with the Skokomish, Port Gamble S'Klallam, Lower Elwha S'Klallam, and Jamestown S'Klallam Tribes.

3.12.1.3 Government-to-Government Consultations

This draft EIS has considered tribes' comments resulting from government-to-government consultation. The following Washington tribes, listed in alphabetical order, have been invited to participate in government-to-government consultation:

- Hoh Indian Nation;
- Jamestown S'Klallam Tribe;
- Lower Elwha Klallam Tribe;
- Lummi Tribe, Makah Tribe;
- Nisqually;
- Nooksack;
- Northwestern Indian Fisheries Commission;
- Point No Point Treaty Nation;
- Port Gamble S'Kallam Tribe;
- Puyallup, Quileute Tribe;
- Quinault Nation;
- Sauk-Suiattle;
- Skokomish Tribe;
- Squaxin Island;
- Stillaguamish;
- Swinomish Tribe; and
- Tulalip Tribe.

Consultation has begun with the following Washington tribes, listed alphabetically:

- Suquamish Tribe; and
- Upper Skagit Tribe.

Consultation also has begun with the following Oregon and California tribes, listed alphabetically:

- Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians;
- Confederated Tribes of Grande Ronde;
- Confederated Tribes of Siletz;
- Confederated Tribes of the Umatilla Indian Reservation;
- Confederated Tribes of the Warm Springs Reservation;
- Coquille Tribe;
- Cow Creek Band of Umpqua Tribe;
- Klamath Tribes (Klamath, Modoc, Yahooskin);
- Upper Shoal Water Tribe;
- Tolowa Nation/Trinidad Rancheria; and
- Yurok Indian Reservation.

3.12.1.4 Current Requirements and Practices

The Navy has established protective measures to reduce potential effects on cultural and natural resources from training exercises. Some are generally applicable, while others apply to particular geographic areas during specific times of year for certain types of Navy training activities. These measures are based on environmental analyses conducted by the Navy for coastal waters and for land and sea ranges. While most of these protective measures focus on protection of the natural environment, they also benefit culturally valued natural resources, such as salmon and shellfish. Some of the protective measures include use of inert ordnance and passive tracking and acoustical tools, avoidance of sensitive habitats, and visually monitoring areas to ensure significant concentrations of sea life are not present.

Areas along the northwest Washington coastline were designated in 2002 as an area to be avoided (ATBA) by ships and barges carrying oil or hazardous materials and by all ships 1,600 gross tons and above that are solely in transit. The ATBA has helped reduce near-shore vessel traffic and traffic within the tribal treaty fishing grounds, and is helping to protect the Olympic Coast National Marine Sanctuary and its resources valued by tribes. This voluntary measure places no new requirements on Navy ships. In the open ocean, most of the Pacific Coast Treaty Tribal Fishing Grounds lie within the Olympic Coast National Marine Sanctuary, which is within W-237A and W-237B. Navy activities within the Olympic Coast National Marine Sanctuary and military activity exemptions for current activities are established in 15 CFR 922.152, Chapter IX, Subpart O, Olympic Coast National Marine Sanctuary.

Base cultural resources programs would strive to preserve and protect their cultural resource sites, including efforts to retain the integrity of cultural sites that, over time, could deteriorate, erode, or be damaged by human actions. Protective measures would include keeping current and future human activities off known sites, or when this is not possible, minimizing impacts on those sites. Projects would consider the probability for occurrence of hunter-gatherer (prehistoric) resources in areas along the salt-water beaches, shell middens, or eroding shorelines.

Locations and extent of NRHP-eligible and -listed archaeological resources would not be made public or provided to Navy personnel on other than a need-to-know basis until such time as they may be displayed and interpreted in a manner that provides protection from vandalism. Protective measures would be described in the HARP plan for the individual base, and would be compatible with HARP goals.

NRHP resources would be managed in a manner that is compatible with the military mission of the individual base and its tenant commands. Navy actions would be planned to avoid potential NRHP resources, including shipwrecks. Natural resources projects that involve ground-disturbing activities would be processed through the HARP program manager to avoid damage to historic properties. Resource treatment would be cognizant of the base integrated cultural resources management plan (ICRMP).

Discovery of archaeological evidence of previous human occupation would cause work to stop on any base undertaking. The discovery would be protected from damage, and Federal, State, and tribal authorities would be notified, as appropriate. The resource would be evaluated for NRHP significance in accordance with 36 CFR 800, and mitigation measures would be developed in consultation with the SHPO and, as appropriate, the tribal historic preservation officer (THPO).

For management purposes, sites deemed eligible for the NRHP would be treated in the same manner as sites that are actually listed in the NRHP. Archaeological sites, historic structures, and historic sites that have not been evaluated for NRHP significance would be considered eligible until evaluation is completed. Projects in areas where eligibility for the NRHP has not been determined would require coordination and consultation in accordance with Section 106 of the NHPA.

Appropriate tribal representatives would be contacted prior to Navy undertakings in undeveloped areas. Consultation and coordination would aid in reducing potential impacts of intrusions on traditional practices. Traditional cultural properties would be protected through the Section 106 consultation process.

3.12.2 Environmental Consequences

3.12.2.1 Approach to Analysis

3.12.2.1.1 Regulatory Framework

Numerous laws and regulations mandate that possible effects on important cultural resources be considered during the planning and execution of Federal undertakings. These laws define the compliance process and Federal agency responsibilities, and prescribe the relationship among other involved agencies such as the Advisory Council on Historic Preservation (ACHP) and state historic preservation officer (SHPO).

Federal mandates include provisions of the National Environmental Policy Act (NEPA) and Sections 106 and 110 of the National Historic Preservation Act (NHPA) and their implementing regulations at 40 Code of Federal Regulations (CFR) 1500 and 36 CFR 800, respectively.

- Under the NEPA, for all Federal actions that could significantly affect the quality of the human environment, agencies must consider the effect an action would have on historic properties, including prehistoric and historic resources, and traditional cultural properties that are eligible for listing in the NRHP.
- Section 106 includes the mandate to assess the significance and integrity of those cultural resources to determine eligibility for listing in the NRHP. The NRHP eligibility criteria are defined by the Secretary of the Interior's Standards for Evaluation in 36 CFR 60. Regulations at 36 CFR 800.8 provide for coordination of public participation, consultation, and evaluation to meet the purpose and requirements of both the NEPA and NHPA in a timely and efficient manner.
- Section 110 of the NHPA requires inventory of cultural resources present in the area of potential effects (APE).

As provided in these regulations, the Navy has complied with the requirements for using the NEPA process to achieve Section 106 compliance. Groups that have been formally notified about the project include American Indian tribes; the Washington, California, and Oregon SHPOs; and the ACHP. The Navy also has taken public involvement activities throughout development of this EIS/OEIS. This draft EIS will be forwarded to these groups for their review and comment.

Other relevant laws include the:

- 1906 Antiquities Act (16 United States Code (U.S.C.) 431);
- Historic Sites Act of 1935;
- Submerged Lands Act of 1953; and
- Archaeological Resource Protection Act of 1979 (16 U.S.C. 470aa-470mm), which prohibits the removal of items of archaeological interest from Federal lands without a permit.

The Abandoned Shipwreck Act of 1987 extends the jurisdiction of abandoned shipwrecks in U.S. waters, considering them U.S. property, and then transfers management authority to the states. The NPS' Abandoned Shipwreck Act Guidelines are published in 55 Federal Register (FR) 50116, 55 FR 51528, and 56 FR 7875. Lost U.S. Navy vessels and downed aircraft remain the property of the U.S. regardless of where they were lost or the passage of time. These properties are administered by the U.S. Naval Historical Center, a facility that has begun an underwater archaeological program to inventory shipwrecks under Navy jurisdiction, including those owned or managed by the U.S. Navy.

In 2004, the Sunken Military Craft Act (passed as Title XIV of the fiscal year 2005 National Defense Authorization Act) preserved the "sovereign status of sunken U.S. military vessels and aircraft by codifying both their protected sovereign status and permanent U.S. ownership regardless of the passage of time." This act recognizes the probable historic status of the craft and the fact that these craft often contain the remains of U.S. military personnel. The Sunken Military Craft Act explicitly states that the protection of the law "shall not be extinguished by the passage of time, regardless of when the sunken military craft sank regardless of age."

The Native American Graves Protection and Repatriation Act (NAGPRA) (25 U.S.C. § 3001 *et seq.*) requires Federal agencies to return Native American cultural items to the native groups with which they are associated, and specifies procedures to be followed if such items are discovered on Federal land.

Government-to-government consultation with Federally recognized Native American tribes and nations was outlined in an April 29, 1994 presidential memorandum "Government-to-Government Relations with Native American Tribal Governments." Native American sacred sites were included in Executive Order 13007, May 24, 1996. EO 13175, "Consultation and Coordination with Tribal Governments," was issued in 2000 to establish collaboration with American Indian tribal governments.

Military regulatory that mandate protection of cultural resources as part of the Navy's mission include:

- DoD Directive 47 10.I;
- Chief of Naval Operations Instruction 5090.IA;
- NAVINSTR 11010.14A;
- Department of the Navy Policy for Consultation with Federally Recognized Indian Tribes SECNAVINST 11010.14A 11 October 2005;
- OPNAVINST 5090.1B (1994);
- DoDD 3200.15 10 January 2003; and
- DoDINST 4715.3.

Under the NHPA, the APE includes areas within which land-based or near-shore activities could potentially affect NRHP-listed or -eligible historic properties, including archaeological and traditional cultural resources. Also included in the APE are any at-sea locales where bombing, mine warfare, underwater trenching, demolition, placement of systems, infrastructure, operations, or equipment might affect submerged ruins, sites, features, or shipwrecks. Depending on location, vessel affiliation, and whether the wreck meets the criteria of abandonment, shipwrecks in coastal waters may fall under the jurisdiction of the individual State, or one or more Federal agencies, or may belong to other nations.

The APE also includes land, near-shore, and at-sea areas where proposed Navy training activities could potentially affect ethnographic resources, traditional cultural properties, or traditional uses such as the tribal fishery grounds within the Puget Sound and off the coast of Washington.

3.12.2.1.2 Study Area

The Study Area includes the PACNW OPAREA, W-237 Warning Areas, Washington coastal areas within the tribal treaty areas, underwater and shoreline areas of the Puget Sound adjacent to Indian Island, Whidbey Island (Crescent Harbor, Seaplane Base, and OLF Coupeville), Bangor, and Dabob Bay (Bangor and Floral Point). Although the Study Area includes training activities off the coasts of Oregon and California (W-570, W-93A, and W-93B), the type and locations of these activities make it unlikely that cultural resources would be affected. Therefore, the environmental analysis focuses on Washington.

3.12.2.1.3 Data Sources

Information on the locations of resources, the probability of affecting currently unknown resources, general prehistory and history of the area, and ethnographic concerns was obtained from:

- *Archaeological Resources Assessment and Protection Plan for the Naval Air Station Whidbey Island (*DoN 1997);
- *Handbook of North American Indians* (Suttles 1990);
- *Tiller's Guide to Indian Country* (Tiller 2005);
- NOAA's Automated Wreck and Obstruction Information System; and
- Other environmental and reference documents from the area, as cited.

3.12.2.1.4 Methods

This draft EIS/OES evaluates project effects on historic properties listed in or eligible for inclusion in the NRHP. Historic properties must meet one or more of the NRHP criteria defined at 36 CFR 60.4, and are evaluated in consultation with the SHPO. Cultural resources that have not been formally evaluated may also be considered potentially eligible, and as such are afforded the same regulatory consideration as listed properties. According to these criteria, "significance" is present in districts, sites, buildings, structures, and objects that:

- Are associated with events that have made a significant contribution to the broad patterns of American history;
- Are associated with the lives of persons significant in our past;
- Embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
- Have yielded, or may be likely to yield, information important in prehistory or history.

Integrity of location, design, setting, materials, workmanship, feeling, and association are also used to qualify a historic property for the NRHP. In some cases, cultural resources that not eligible for the NRHP may still require some level of management and protection.

Section 106 criteria of adverse effect were applied to resources that could be affected by the project, and ways were considered to avoid, minimize, or mitigate adverse effects as described in the following sections of this document. As part of the NEPA process, consultation required by Section 106 of the NHPA, and the government-to-government consultation required by the presidential memorandum of April 29, 1994 and by NAVINSTR 11010.14A will be accomplished with the SHPOs of Washington, Oregon, and California; Native American tribes and nations; and other public agencies.

ACHP guidelines and 36 CFR 60.4 provide information on assessing the importance of a traditional cultural resource, but significance is established primarily through consultation with Native American tribes and nations. When applicable, consultation with other affected groups provides the means to establish the importance of their traditional resources.

Adverse effects under the NHPA include reasonably foreseeable effects caused by the alternatives that would occur later in time, be farther removed in distance, or be cumulative (36 CFR 800.5[a][1]). Because cultural resources are nonrenewable, all adverse effects on NRHP-listed or -eligible archaeological and structural resources would be long-term. Effects on traditional cultural properties would also be long-term, but some short-term effects could occur to tribal religious activities.

3.12.2.1.4.1 Resources that would not be Affected by Any of the Alternatives

None of the proposed actions under any alternative would have more than a negligible effect on historic structures, archaeological sites and shipwrecks, or traditional cultural practices and properties along the California and Oregon coasts. Therefore, cultural resources in these areas will not be discussed in this document.

3.12.2.1.4.2 Warfare Areas and Associated Environmental Stressors

Aspects of the proposed actions with the potential to act as stressors to cultural resources were identified by conducting an analysis of the warfare areas and specific activities included in the alternatives. A listing of potential stressors is presented in Table 3.12-1.

3.12.2.1.5 Impact Thresholds

Archaeological and Architectural Resources.

- A negligible effect of an action would not alter any of the characteristics that qualify a resource for eligibility in the NRHP (an NHPA finding of *no historic properties affected).*
- A minor adverse effect would be observable, but would not alter characteristics qualifying a resource for eligibility (*no adverse effect).*
- Moderate adverse effects would diminish the characteristics of a resource that qualify it for the NRHP (an *adverse effect).*
- A major adverse effect would result in loss of NRHP eligibility (also an NRHP *adverse effect).*

Traditional Cultural Resources.

- A negligible effect would not alter resource conditions, access, or site preservation, or the relationship between the resource and the affiliated group's body of beliefs and practices (an NHPA finding of no historic properties affected).
    - A minor adverse effect would have a slight but noticeable effect but would not appreciably alter resource conditions (*no adverse effect).*
    - Even though the tribe's beliefs and practices would survive, a moderate adverse effect on traditional cultural resources would be apparent, and would alter resource conditions (such as traditional access or site preservation, or the relationship between the resource and the affiliated group's body of beliefs and practices), resulting in an *adverse effect* under the NHPA.
    - A major adverse effect would result from actions that greatly affected resources and practices to the extent that survival of a group's beliefs and/or practices would be jeopardized (*adverse effect* under the NHPA).

3.12.2.2 No Action Alternative

3.12.2.2.1 Archaeological Resources

3.12.2.2.1.1 Small Boat Activities

Occasional, minor, adverse effects on coastal or shoreline archaeological resources could occur in selected areas of Indian Island, Seaplane Base, or Crescent Harbor whenever amphibious craft were used or beach landings occurred in the vicinity of sites during Naval Special Warfare exercises. Research indicates that "hydrodynamic forces affect the spatial distribution of exposed artifacts and therefore disturb horizontal stratigraphy and artifacts" (Stojanowski 2002). Water and debris churned up by boat propellers or troop movements could contribute to such adverse effects.

Table 3.12-1: Warfare Areas, Stressors, and Potential Effects on Cultural Resources

Activity and Training Area	Environmental Stressors	Cultural Resources Affected
Air combat maneuver (ACM): Okanoogan, Olympic, and Roosevelt MOAs	Noise and visual intrusions, aircraft overflights	Traditional cultural practices
A-A MISSILEX at sea with simulated target: W-237 beyond 12 nm	Noise, visual intrusions, and vessel movement	Traditional cultural practices
S-A GUNEX: W-237 beyond 12 nm, PACNW OPAREA	Same as above	Same as above
S-A MISSILEX: W-237 and PACNW OPAREA	Same as above	Same as above
S-S GUNEX (boat and ship): W-237 PACNW OPAREA	Same as above	Same as above
A-S BOMBEX (at sea): W-237, PACNW OPAREA	Same as above	Same as above
SINKEX: W-237, PACNW OPAREA beyond 12 nm	Noise and visual intrusions, vessel movement	Limited potential for cultural resources effects
Anti-submarine warfare TRACKEX-MPA: W-237, PACNW OPAREA	Noise, visual intrusions, and vessel movement	Traditional cultural practices
Extended echo ranging ASW activities: W-237, PACNW OPAREA	Visual intrusions, vessel movement	Same as above
Surface ship ASW TRACKEX: PACNW OPAREA	Same as above	Same as above
TRACKEX (submarine ASW): PACNW OPAREA	Noise and visual intrusions, vessel movement	Same as above
Electronic combat exercises: Darrington Area, W-237	Noise (aircraft)	Same as above
EOD (mine countermeasures; underwater mine neutralization activities): Crescent Harbor, Indian Island, and Floral Point	Explosions (direct impact), explosions (concussion), troop movement, expended materials, and noise	Archaeology and traditional cultural resources and practices
MIW (land demolitions): DTR Seaplane Base and DTR Bangor	Explosions (direct impact), explosions (concussion), troop movement, and noise	Same as above
Insertion/extraction: OLF Coupeville, Seaplane Base, and Crescent Harbor	Troop movement and aircraft noise	Traditional cultural practices and archaeological resources
NSW (SEALs land-based training): Indian Island	Troop movement	Archaeology and traditional cultural practices
HARM non-firing exercise: Okanogan, Olympic, and Roosevelt MOA	Noise (aircraft), visual intrusion	Traditional cultural practices
Intelligence, surveillance, and reconnaissance: PACNW OPAREA	Noise (aircraft)	Limited potential for cultural resources effects
Unmanned aerial systems ops: NWTRC OPAREA	Noise, visual intrusion	Same as above

The Navy's guidance for personnel insertions indicates these are usually done at high tide, and in some areas, no anchor drops would be allowed close to the shoreline as a protective measure for eel grass.

These provisions also would help protect near-shore or beach archaeological resources. The potential for resource damage also would be reduced by identification and avoidance of known sites prior to training exercises, and by coordination of training activities with the base ICRMP and HARP guidance.

3.12.2.2.1.2 Land-based Training

Heliocopter training activities at OLF Coupeville and the Seaplane Base Survival Area that involve landing helicopters and crewmembers would have potential to disturb and/or compact soils in the vicinity of archaeological resources, or to contribute to erosion of sites on slopes. Foot traffic associated with the insertion activities also could contribute to soil disturbance, compaction, or erosion. Any adverse effects would be minor.

3.12.2.2.1.3 Land and Underwater Demolition

Under the No Action Alternative, the current level of 60 mine countermeasure and 102 land demolition events per year would continue. At the present level of EOD training, which typically involves 2.5-lb. NEW detonations on land at DTR Seaplane Base and DTR Bangor, there would be a negligible effect from concussion on archaeological resources at either site. The land areas set aside for detonations at these two bases have been used for many years, and charges are set in a sand base, so the ground in these areas is already heavily disturbed. The likelihood of direct impacts to significant archaeological sites within detonation areas would be negligible. Some potential for damage to underwater or littoral archaeological resources could occur in the Puget Sound, especially in the vicinity of Crescent Harbor, Bangor, and Indian Island where underwater cultural resources have been identified.

EOD units use underwater explosive charges (typically 2.5-lb. NEW or less) to destroy or neutralize simulated mines. Because water rapidly transmits shock waves, such charges could damage nearby cultural sites, depending on factors such as the distance from the detonation and area topography. Underwater detonations also produce blast holes that could affect submerged resources.

3.12.2.2.1.4 Weapons Firing at Sea

Explosions at sea from bombing, missile, and gunnery exercises have the potential to directly impact shipwrecks or other archaeological resources. For example, if pilots are unaware of the locations of shipwrecks in the OPAREA, or wrecks have not been identified, stray bombs or surface-to-surface gunnery exercises could damage shipwrecks. However, if bomb fragments or expended armament sank to the ocean bottom, it is unlikely that they would come into contact with a wreck. If they sank in the vicinity of a wreck, the small quantities of expended materials would not affect the historic properties of the shipwreck, and eventually all expended material would be covered by sediments.

3.12.2.2.2 Historic Structures

3.12.2.2.2.1 Land and Underwater Demolition

There are historic structures in the vicinity of Seaplane Base/Crescent Harbor, Bangor, and Indian Island. Effects of explosives detonations on historic structures could result from the blast (through the air) or from vibrations transmitted through the ground, depending on factors such as the size of the blast, geomorphology, and distance to the structure. However, the areas used for both underwater and land detonations are approximately five miles from the historic structures, and these training sites have been in operation for several decades without appreciable or observable damage to historic structures. In addition, because of noise concerns, the amount of explosives used in underwater and land detonations has been limited. Thus, there would be no new impacts on historic structures under a continuation of existing conditions. Under the No Action Alternative, effects on historic structures would be negligible (*no historic properties affected*).

3.12.2.2.3 Traditional Cultural Resources

Traditional places and activities potentially affected by the No Action Alternative may include religious or sacred sites (sometimes with an archaeological component), named and remembered ancestral places that are revered in tribal oral traditions, ceremonial gathering activities, husbandry of subsistence items (especially maritime resources) and fishing grounds, including areas where shellfish and other resources are gathered.

With traditional cultural resources, it is difficult to separate physical resources from religious activities because, to most tribes, the physical and spiritual worlds are tightly interrelated and cannot be separated. Religious activities are often associated with a specific place and/or resource, and procurement of the resource may require prayers or ceremonies. For tribal religious practices to be successful, the site, habitat, or particular resource and its context often must remain undisturbed.

During special religious or other traditional celebrations, tribes have the expectation of quiet and privacy. Mine detonation, overflights, vessel and troop movements, firing of weapons, bombing, and missiles could intrude on the solemnity and privacy of the occasion.

Under the No Action Alternative, helicopter training at Seaplane Base Survival Area and OLF Coupeville, aircraft combat maneuvers, and gunnery exercises would continue at the same level. Most of these activities would continue to take place over military bases, over sparsely populated areas such as the MOAs and Darrington Area,, in areas such as the Seaplane Base Survival Area (where helicopter noise is common), or over open water (W-237 and NWTRC OPAREA). As a result, there would be a negligible change in the level of intrusion. However, if the timing and location of insertion/extraction exercises, combat maneuvers, gunnery exercises, or mine warfare coincided with traditional fishing or gathering activities in a given locale, prayers and ceremonies could be interrupted by intrusive noise and visual elements. The noise would be limited in both space (the potential area disturbed) and in time (relatively short-term).

3.12.2.2.3.1 Land and Underwater Demolition

When detonations occur, some of the energy is lost to the atmosphere as a noise and/or concussion. Sound energy spreads as it radiates from its source, decreasing the loudness at a rate of 6 dBA per doubling of the distance. The atmosphere absorbs some of the sound energy, with the amount of absorption depending on the sound frequency and on the temperature and relative humidity of the atmosphere. Landforms, and to a modest extent, vegetation also can reduce sound. To avoid potential damage to cultural resources and to avoid noise disturbance of adjacent communities or traditional activities, mine detonation training would not be conducted unless atmospheric conditions are optimal. NEW would be limited to 2.5 pounds, so there would not be any increase in noise levels above existing conditions.

With regard to noise from detonations, the Navy agreed in 1993 to limit detonations to daytime working hours and to favorable weather conditions (DoN 1993). Because these limitations would continue, changes to the sound environment under the No Action Alternative would be negligible.

Tribes have expressed concerns that training activities could have adverse effects on fish and other maritime resources. For example, fish could be affected by vessel movement, aircraft overflights, or underwater explosions, weapons firing, and large objects hitting the water. Fish habitat could be modified or damaged. Tribal comments also suggest there could be direct effects on fish populations and other marine resources from Navy training activities using sonar. However, analysis suggests that Navy training activities would not result in significant impacts on resources valued by tribes. For an evaluation of the effects of Navy training activities see Section 3.7 (Fish), Section 3.8 (Sea Turtles), Section 3.9 (Marine Mammals), and 3.10 (Birds).

Tribes also have expressed concerns that fish, shellfish, and other marine species could be affected by contaminants from expended materials. For a discussion of the potential effects on fish, shellfish, and other traditionally valued species, see Section 3.3 (Hazardous Materials and Wastes). Expended materials can build up in sediments, but these generally are transported by tidal and wave action. Eventually, potentially hazardous constituents are dispersed and diluted to a level that would be below a level of water quality that would affect living organisms (see Section 3.4 Water Resources).

Some protective measures already put in place by the Navy for endangered and threatened species would help protect species valued by tribes (see Sections 3.7 Fish, 3.8 Sea Turtles, 3.9 Marine Mammals, and 3.10 Birds for further information). The Navy provides the U.S. Coast Guard with information on the location and area of potentially hazardous training activities at sea so the Coast Guard can issue notices to mariners (NOTMAR). Tribes can use the information in a NOTMAR to ensure their activities remain clear of any potentially hazardous training events at sea.

Some ethnographic concerns center on limits on access for fishing and gathering, including restricted access to traditionally used beach areas and to tribal usual and accustomed fishing grounds or shellfish procurement areas. Because the Study Area overlaps the tribal usual and accustomed use areas, Navy training activities may be underway at a time when tribes would like to access a particular use area. Some traditionally used areas may be inaccessible because of safety concerns relating to, for example, ordnance storage or testing. Thus, there is potential for tension in timing and access between Navy training activities and desired traditional uses. The Navy would strive to accommodate, to the extent possible, access to tribes' usual and accustomed areas.

Under the No Action Alternative, traditional uses such as shellfish harvest by the Point-No-Point Treaty Council, and cedar bark harvest by the Suquamish Tribe would continue. The Upper Skagit Tribe has requested access to the shellfish beds on the Seaplane Base, but these are not on the range itself. At Indian Island, beaches have been restricted for safety purposes (nearby ordnance). It is Navy policy to accommodate tribal requests for access to Navy-owned tidelands to the extent possible within mission requirements. Consultation and coordination with tribes would help alleviate many tribal concerns such as expectations of privacy for traditional ceremonies.

Potentially adverse effects on traditional activities would be moderated by collaboration and consultation between the Navy and concerned tribes. Such consultation would help ensure appropriate coordination of timing and location of tribal religious and traditional activities with naval activities.

3.12.2.3 Alternative 1

Along with continuation of existing activities and weapons, implementation of Alternative 1 would include increases and changes in the Navy's force structure to include new weapon systems, vessels, and aircraft in the fleet. Alternative 1 would also increase the number of most training activities. However, the effects of these new systems on cultural resources would be quite similar to those of existing activities. For example, new aircraft and armament would still cause noise and possible visual intrusion into traditional cultural activities, while bombing and missile exercises could still affect traditionally harvested resources, shipwrecks, or other submerged resources. Many of the new weapons systems, such as improved sonobuoys or tracking systems, would have little, if any, impact on cultural sites and traditional practices. Alternative 1 would also result in a decrease in the number of underwater detonations that take place within the NWTRC as part of mine countermeasure training activities.

3.12.2.3.1 Archaeological Resources

Under Alternative 1, most training activities would increase only a modest amount, and many of these would have little, if any, potential for effect on archaeological resources. Air-to-surface bombing exercises would increase from 24 to 30 times per year, and annual SINKEX activities would increase from one live torpedo to two. These increases would have only a very small potential for increased damage to cultural resources at sea. The same is true for gunnery exercises, which would increase from 90 to 100 per year.

Mine countermeasures would decrease from 60 to 4, and land demolitions would increase from 102 to 110. The same general training areas would be used for land-based mine countermeasure activities. The detonations would continue to be set off in a sand-filled area that is lined with impermeable material, and residual materials would be removed periodically.

NSW training on Indian Island would remain constant at 35 activities a year. As discussed under the No Action Alternative, shoreline archaeological resources at Indian Island, Seaplane Base, and Crescent Harbor could be affected by beach landings occurring in the vicinity of sites during NSW exercises, or inland resources could be affected by helicopter training at OLF Coupeville and Survival Area. Although occurrences would be limited, there would be potential for minor adverse effects on the integrity of area archaeological resources.

Other activities would increase slightly (for example, insertion/extraction training activities would increase from 108 per year to 120 per year). These increases would slightly increase the potential for negligible to minor adverse effects on archaeological resources. These impacts would result from disturbance of soils or shell middens on beaches by vehicle, vessel, and/or troop movement, as described under the No Action Alternative. Such military training is a historical part of the Central Whidbey Historic Preservation District and continues to be a function in and adjacent to the historic district. Thus such activities would not contribute to adverse effects on the historic character of the historic district.

3.12.2.3.2 Historic Structures

Effects of land demolitions on historic structures at DTR Seaplane Base and DTR Bangor were discussed under the No Action Alternative. Because training activities would continue to be located at least five miles from detonation training sites, and because the amount of explosives would be limited due to noise concerns, increases in the number of land based training activities would not significantly increase the potential for damage to structures. Under Alternative 1, the number of underwater detonations and the net explosive weight of underwater demolitions would decrease. The resulting effects on historic structures would be negligible.

3.12.2.3.3 Traditional Cultural Resources

Percent increases in mine warfare, anti-surface warfare, and other training programs over the No Action Alternative levels would be relatively small, although aircraft combat maneuvers would increase from 1,353 to 2,000 per year. Increased noise and visual intrusions from planes, troop movement, anti-air and surface activities, and mine warfare could adversely affect tribal religious ceremonies or activities. Increases in training activities may increase the potential for occasional noise and visual intrusions on traditional practices. However there would be a reduction in underwater detonations occurring under Alternative 1 that would have the potential for reducing fish kills and potential damage to shellfish and other resources traditionally used by tribes.

Consultation between the Navy and tribes would help reduce potential effects of most of the increased training programs such as troop movement, insertion activities, planes, anti-air and surface warfare, and mine warfare on traditional cultural properties, including culturally valued archaeological sites and traditional areas. To counter any increased effects of noise and other visual and physical intrusions on traditional activities, the Navy would work closely with tribal leaders to find mutually acceptable solutions to tribal concerns while fulfilling Navy training requirements. Such consultation would help ensure appropriate coordination so that significant tribal religious activities could be conducted undisturbed. Consultation also would continue regarding use of traditionally used beaches and other cultural areas important to tribes.

Protective measures already put in place by the Navy for endangered and threatened species would continue to help protect species valued by tribes (see Sections 3.7 Fish, 3.8 Sea Turtles, 3.9 Marine Mammals, and 3.10 Birds for further information). The Navy would also continue to provide the U.S. Coast Guard with information on the location and area of potentially hazardous training activities at sea so the Coast Guard can issue notices to mariners (NOTMAR). Tribes would be able to continue to use the information in a NOTMAR to ensure their activities remain clear of any potentially hazardous training events at sea.

Increases in residual expended materials from warfare activities under Alternative 1 would be minimal, as would the use of sonar. As described for the No Action Alternative, the indirect effects from Navy training activities would have a negligible to minor effect on ethnographic resources.

3.12.2.4 Alternative 2

Under Alternative 2, there would be an increase in the number of most training activities, and range enhancements would include new electronic combat threat simulators and development of air and surface target services.

3.12.2.4.1 Archaeological Resources

Development of a small-scale underwater minefield would be preceded by identification of any cultural resources (for example, shipwrecks and prehistoric remains) in the proposed Study Area. Sites considered eligible for the NRHP would be avoided during development of the minefield. As a result, there would be negligible effects on cultural sites during training activities.

Decreased underwater detonation activities and increased numbers of activities at existing EOD land ranges, including DTR Seaplane Base, would not substantially increase the potential for direct effects on archaeological resources. Existing EOD ranges have been in use for years, so the potential for damaging new and unknown archaeological resources is low. If the EOD range is relocated, the Navy site plan and review process would ensure any relocation would not have a significant (adverse) impact on cultural resources.

Prehistoric sites have been documented along the shores of Crescent Harbor and Indian Island, and shipwrecks and other historic resources lie beneath the waters of the sound. Reductions in underwater detonation activities would reduce the potential for both direct and indirect, minor, adverse effects on adjacent resources in selected areas.

The number of surface-to-air and surface-to-surface gunnery exercises would more than double under Alternative 2. Air-to-surface bombing exercises also would increase. These exercises would have a very limited potential to damage underwater sites or shipwrecks at sea, should unknown resources lie within the APE. Such occurrences would be limited in time and space, resulting in the potential for occasional, minor, long-term, adverse effects in selected areas.

Some insertion/extraction exercises and other special warfare activities could contribute to shoreline erosion or disturbance of soils and shell middens on beaches or inland. Such actions can uncover and disturb archaeological resources and indirectly cause adverse effect.

3.12.2.4.2 Historic Structures

Under Alternative 2, increased activities at existing EOD land ranges would only slightly increase the potential for gradual damage to historic structures from repeated vibrations or concussions from EOD training activities at Bangor and Seaplane Base EOD ranges. Reduction in underwater detonations would reduce the potential to effect historic structures. While the amount of damage would depend on factors such as the location of the structure relative to the blast, land topography, and age and condition of the structure, incremental damage would be minimal because NRHP-eligible structures at these ranges are at least five miles from the blast area and because noise concerns would continue to limit the amount of explosive used.

3.12.2.4.3 Traditional Cultural Resources

Percent increases in mine warfare, anti-surface warfare, and other training programs over the No Action Alternative levels would be relatively small, although aircraft combat maneuvers would increase from 1,353 to 2,000 per year. The effects of anti-air and anti-surface warfare, (combat maneuvers, gunnery, missiles, and bombing) would be of the same type as described under the No Action Alternative, but the intensity would be greater because of increases in numbers of most activities. Lower frequency of underwater detonation training would have the potential for reducing fish kills and potential damage to shellfish and other resources traditionally used by tribes. Increases in residual expended materials from warfare activities under Alternative 2 would be minimal, as would the use of sonar.

Navy activities, such as anti-air warfare and anti-surface warfare over land and water in the Puget Sound and Strait of Juan de Fuca, and over tribal fishery grounds along the northwest coast of Washington, could directly and indirectly affect traditional fishing and gathering activities. Tribal treaty fishing areas extend into the ocean approximately 100 miles (into W-237A and W-237B). Effects would occur if more frequent noise from more training exercises detracted from traditional religious and procurement activities. Also, traditional activities could be affected if Native Americans wanted to use a particular area for subsistence or religious uses at the same time Navy activities were occurring at that location, or if traditionally used places were unavailable to tribes because they were placed off-limits for activities or security reasons. Some archaeological sites potentially threatened by activities may also be ethnographic sites of concern to tribes. Any potential impacts would generally be limited in time and space, and would occur occasionally, not routinely. Thus, potential adverse impacts of implementing Alternative 2 could be long-term, both direct and indirect, and negligible to minor.

Protective measures already put in place by the Navy for endangered and threatened species would continue to help protect species valued by tribes (see Sections 3.7 Fish, 3.8 Sea Turtles, 3.9 Marine Mammals, and 3.10 Birds for further information). The Navy would also continue to provide the U.S. Coast Guard with information on the location and area of potentially hazardous training activities at sea so the Coast Guard can issue notices to mariners (NOTMAR). Tribes would be able to continue to use the information in a NOTMAR to ensure their activities remain clear of any potentially hazardous training events at sea.

3.12.3 Mitigation Measures

As summarized in Section 3.12.2, the actions proposed in this EIS/OEIS would have minor to no adverse effects on cultural resources. Current protective measures would continue to be implemented by the Navy, and no additional mitigation measures would be needed to protect archaeological, historic, or traditional cultural resources.

3.12.4 Summary of Effects

3.12.4.1 No Action Alternative

With identification of cultural sites, shipwrecks, and submerged resource locations prior to exercises, and avoidance of known cultural sites, there would be few if any direct, adverse effects from personnel insertions, helicopter training, EOD training, or explosions from bombing, missiles, and gunnery exercises on shipwrecks or other archaeological resources. Land-based training and nearshore activities could disturb archaeological resources, but effects would be minor due to the small number of activities and/or covert nature of the activities that limit the amount of disturbance. EOD training would have minimal impact on historic sites or archaeological resources due to the confined nature of the detonations and the distance of activities from historic sites. There would be few if any effects to shipwrecks or other archaeological resources from explosions at sea from bombing, missile, and gunnery exercises with continued implementation of protective measures. Small quantities of expended materials that sink to the ocean bottom would not affect the historic properties of the shipwreck, and eventually all expended material would be covered by sediments. The No Action Alternative would have a negligible to minor adverse effect ("*no adverse effect*" under Section 106). Under the No Action Alternative, effects on historic structures would be negligible (*no historic properties affected*).

Under the No Action Alternative, there would be no new training locations for mine warfare on land, and no additional training venues. The Navy would continue to provide the Coast Guard with pertinent NOTMAR information about upcoming training events in a particular area so that noise and visual intrusions from these activities could be avoided by tribes. Consultation and coordination would continue.

Under the No Action alternative, no new impacts to tribal cultural traditions or resources would be expected (“*no adverse effect”* under the NHPA*).*

3.12.4.2 Alternative 1

Because of the continued use of protective measures, such as identification of cultural sites, shipwrecks, and submerged resource locations prior to exercises, and avoidance of known cultural sites, EOD training and explosions from bombing, missiles, and gunnery exercises would have few if any direct adverse effects on shipwrecks or other archaeological resources. Land-based training and nearshore activities would increase and could disturb archaeological resources, but effects would be minor due to the small number of activities and/or covert nature of the activities that limit the amount of disturbance. Slight increase in land-based EOD training would have minimal impact on historic sites or archaeological resources due to the confined nature of the detonations and the distance of activities from historic sites. There would be a substantial decrease in underwater EOD activities that would reduce the potential for impacts to archaeological resources and historic sites. There would be few, if any, effects to shipwrecks or other archaeological resources from a slight increase in explosions at sea from bombing, missile, and gunnery exercises with continued implementation of protective measures. Small quantities of expended materials that sink to the ocean bottom would not affect the historic properties of the shipwreck, and eventually all would be covered by sediments. Alternative 1 would have a negligible to minor adverse effect (*“no adverse effect”* under Section 106), and negligible effects to historic structures.

With consultation and coordination, effects on traditional cultural practices and archaeological and ethnographic sites and resources valued by tribes would change very little from those described for the No Action Alternative (negligible to minor; *“no adverse effect*” under the NHPA).

3.12.4.3 Alternative 2

Because of the continued use of protective measures, such as identification of cultural sites, shipwrecks, and submerged resource locations prior to exercises, and avoidance of known cultural sites, EOD training and explosions from bombing, missiles, and gunnery exercises would have few if any direct adverse effects on shipwrecks or other archaeological resources. Land-based training and nearshore activities would increase and could disturb archaeological resources, but effects would be minor due to the small number of activities and/or covert nature of the activities that limit the amount of disturbance. Slight increase in land-based EOD training would have minimal impact on historic sites or archaeological resources due to the confined nature of the detonations and the distance of activities from historic sites. There would be a substantial decrease in underwater EOD activities that would reduce the potential for impacts to archaeological resources and historic sites. There would be few, if any, effects to shipwrecks or other archaeological resources from a slight increase in explosions at sea from bombing, missile, and gunnery exercises with continued implementation of protective measures. Small quantities of expended materials that sink to the ocean bottom would not affect the historic properties of the shipwreck, and eventually all would be covered by sediments. Alternative 2 would have a negligible to minor adverse effect (*“no adverse effect”* under Section 106), and negligible effects to historic structures.

With consultation and coordination, effects on traditional cultural practices and archaeological and ethnographic sites and resources valued by tribes would change very little from those described for the No Action Alternative (negligible to minor; *“no adverse effect*” under the NHPA).

Table 3.12-2 summarizes the potential impacts to cultural resources.

Table 3.12-2: Summary of Effects – Cultural Resources

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative		
Small Boat Activities	Minor, short-term, and localized disturbance to archaeological resources are possible, but unlikely due to low number and covert nature of small boat activities.	Small boat activities would have no effect on cultural resources beyond 12 nm.
Land-based Training	Helicopter landings at OLF Coupeville and the Seaplane Base Survival Area could potentially disturb soils in the vicinity of archaeological resources, but any effects would be minor.	Land-based activities would have no effect on cultural resources beyond 12 nm.
Land and Underwater Demolition	Confined explosives would have limited concussive or noise impacts to archaeological sites. Nearest historic sites are distant from detonations and are unlikely to suffer effects. Noise effects on traditional cultural resources are possible, but not likely due to current protective measures in place during all detonations.	These land-based and inshore activities would have no effect on cultural resources beyond 12 nm.
Weapons Firing At Sea	Weapons fired at sea have the potential to cause fragments to settle on shipwrecks. However, the small quantities of expended material would not affect the historic properties of any shipwrecks.	Potential impacts would be minor due to the low density of munitions and shipwrecks beyond 12 nm.
Alternative 1		
Small Boat Activities	Alternative 1 small boat activities that could impact cultural resources are the same as the No Action Alternative, with no increase in number of activities. Therefore, potential for impact would be the same.	Impacts generally the same as for the No Action Alternative.
Land-based Training	Helicopter landings at OLF Coupeville and the Seaplane Base Survival Area would increase only slightly over No Action levels. No additional impacts are expected.	
Land and Underwater Demolition	Alternative 1 land demolition training will increase, and underwater demolition training will decrease significantly, from 54 annual detonations, to 4. These changes in the level of training activity are expected to have no net effect on impacts to cultural resources.	
Weapons Firing At Sea	Weapons firings will increase under Alternative 1. However, more than half of all rounds that enter the ocean are small caliber. Many of the rest are fragments of their original shells. The resulting increase in small objects entering the water is not likely to affect the historic properties of any shipwrecks.	

Table 3.12-2: Summary of Effects – Cultural Resources (continued)

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
Alternative 2 (Preferred Alternative)		
Small Boat Activities	Alternative 2 small boat activities that could impact cultural resources are the same as the No Action Alternative, with no increase in number of activities. Therefore, potential for impact would be the same.	Impacts generally the same as for the No Action Alternative.
Land-based Training	Helicopter landings at OLF Coupeville and the Seaplane Base Survival Area would increase only slightly over No Action levels. No additional impacts are expected.	
Land and Underwater Demolition	Alternative 2 land and underwater demolition training is the same as Alternative 1, therefore, the potential for impacts will be the same.	
Weapons Firing At Sea	Weapons firings will increase from the No Action Alternative under Alternative 2. However, more than half of all rounds that enter the ocean are small caliber. Many of the rest are fragments of their original shells. The resulting increase in small objects entering the water is not likely to affect the historic properties of any shipwrecks.	

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3.13 Traffic

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3.13 TRAFFIC

Traffic issues relate to the movement and circulation of vehicles, vessels, and/or aircraft within an organized framework. This section addresses air and marine traffic in the vicinity of the Northwest Training Range Complex (NWTRC). The impacts that Navy ranges and activities have on local traffic and circulation will be evaluated in a regional context as it relates to the Offshore Area and the Inshore Area of the NWTRC.

3.13.1 Definition of Resource

3.13.1.1 Air Traffic

Air traffic refers to movements of aircraft through airspace (Figure 3.13-1). Safety and security factors dictate that use of airspace and control of air traffic be closely regulated. Accordingly, regulations applicable to all aircraft are promulgated by the Federal Aviation Administration (FAA) to define permissible uses of designated airspace, and to control that use. These regulations are intended to accommodate the various categories of aviation, whether military, commercial, or general aviation. The regulatory scheme for airspace and air traffic control varies from highly controlled to uncontrolled. Less controlled situations include flight under Visual Flight Rules (VFR) or flight outside of U.S. controlled airspace, such as flight over international waters off the coasts of Washington, Oregon, and California. Examples of highly controlled air traffic situations are flights in the vicinity of airports, where aircraft are in a critical phase of flight, either take-off or landing, and flight under Instrument Flight Rules (IFR), particularly flight on high or low altitude airways. “Controlled airspace” is a generic term that covers different classes of airspace, to include:

- Class A airspace extends from 18,000 feet (ft) Mean Sea Level (MSL) up to but not including 60,000 ft MSL and includes designated airways for commercial aviation operations at those altitudes.
- Class B airspace extends from the ground to 10,000 ft MSL surrounding the nation’s busiest airports.
- Class C and D airspace are defined areas around certain airports, tailored to the specific airport.
- Class E airspace is controlled airspace not included in Class A, B, C, or D.
- Jet Routes are the network of airways serving commercial aviation operations from flight level (FL) 180 up to but not including FL 450.
- “Victor Routes” are the network of airways serving commercial aviation operations up to but not including 18,000 ft MSL.
- Class G is uncontrolled airspace (i.e., all airspace not designated as Class A-E).

Special use airspace (SUA) refers to areas with defined dimensions where flight and other activities are confined due to their nature and the need to restrict or limit nonparticipating aircraft. SUA is established under procedures outlined in 14 (C.F.R), Part 73. The majority of SUA is established for military flight activities and may be used for commercial or general aviation when not reserved for military activities. There are multiple types of SUA. One type of SUA, of particular relevance to the NWTRC, is a Warning Area, which is defined in 14 C.F.R. Part 1 as follows:

> “A warning area is airspace of defined dimensions, extending from 3 nautical miles outward from the coast of the United States that contains activity that may be hazardous to nonparticipating aircraft. The purpose of such warning areas is to warn nonparticipating pilots of the potential danger. A warning area may be located over domestic or international waters or both.”

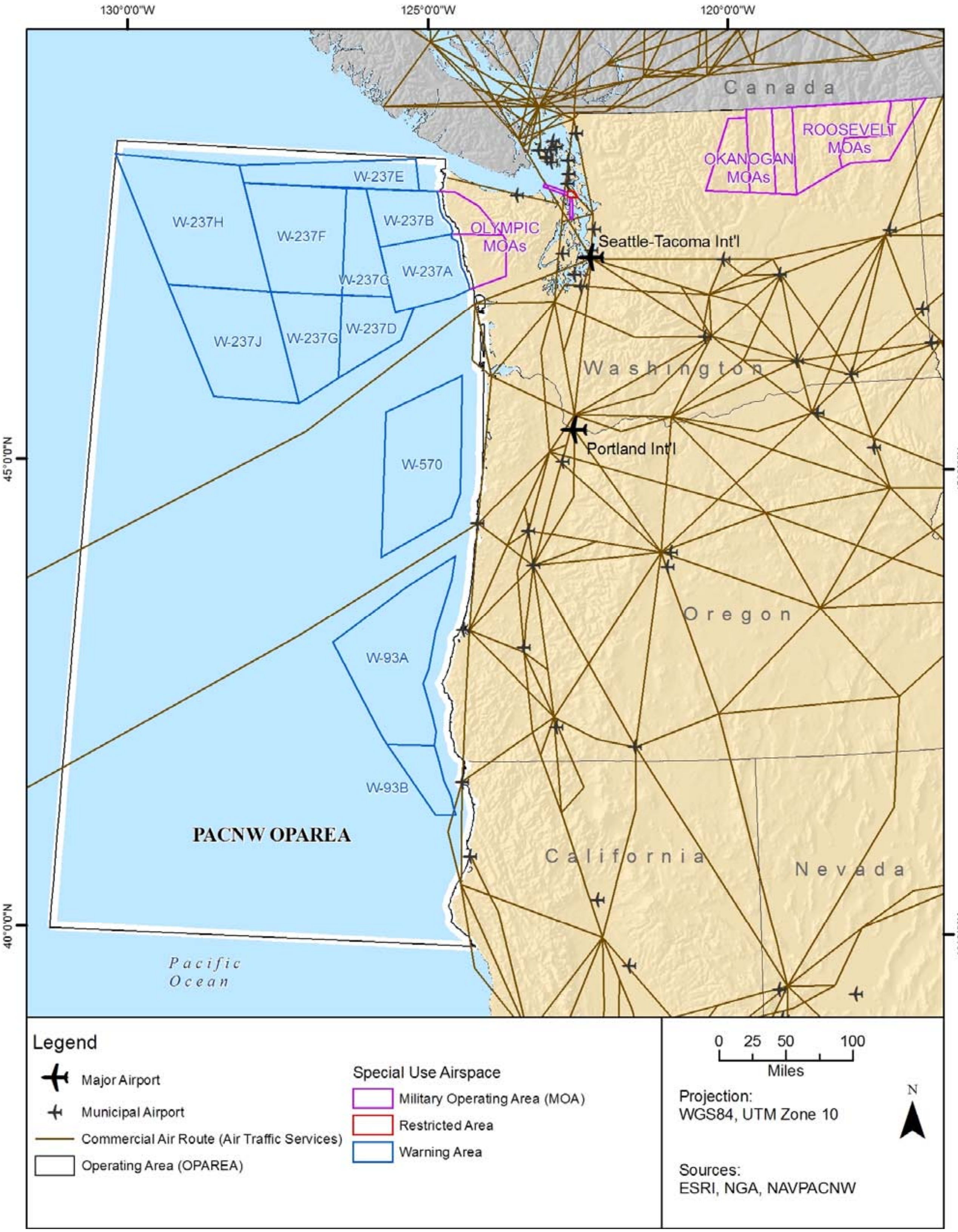

Figure 3.13-1: Air Routes in Vicinity of NWTRC

Warning areas are established to contain a variety of hazardous aircraft and non-aircraft activities, such as aerial gunnery, air and surface missile firings, bombing, aircraft carrier operations, surface and subsurface activities, and naval gunfire. When these activities are conducted in international airspace, the FAA regulations may warn against, but do not have the authority to prohibit, flight by non-participating aircraft.

A Restricted Area is a type of SUA within which non-military flight activities are closely restricted. The NWTRC contains one restricted area R-6701, which is a 22 square nautical miles (nm^2) (75 square kilometers [km^2]) area that extends from the surface to 5,000 ft MSL (1,524 meters [m]). Navy 7 OPAREA is the surface and subsurface restricted area that underlies R-6701.

Another type of SUA found within the NWTRC is the Military Operations Area (MOA). A MOA is "airspace established outside Class A airspace to separate or segregate certain nonhazardous military activities from IFR Traffic and to identify for VFR traffic where these activities are conducted." (14 C.F.R. §1.1, U.S.A.) Similar structures exist under international flight standards. These are designed for routine training or testing maneuvers. Areas near actual combat or other military emergencies are generally designated as restricted airspace.

An MOA is a type of SUA, other than restricted airspace or prohibited airspace, where military activities are of a nature that justifies limitations on aircraft not participating in those activities. MOAs are often positioned over isolated, rural areas to limit the amount of noise nuisance and accident potential. Roosevelt and Okanogan MOAs are located in northeastern Washington and a small portion of Idaho. Each designated MOA appears on the relevant sectional charts, along with its normal hours of operation, lower and upper altitudes of operation, controlling authority contact, and using agency.

Whenever an MOA is active, nonparticipating IFR traffic may be cleared through the area provided air traffic control (ATC) can ensure IFR separation; otherwise, ATC will reroute or restrict nonparticipating IFR traffic. Although MOA's do not restrict VFR operations, pilots operating under VFR should exercise extreme caution while flying within, near, or below an active MOA. Additionally, prior to entering an active MOA, pilots are encouraged to contact the controlling agency for traffic advisories due to the frequently changing status of these areas.

The final type of SUA that occurs in the NWTRC is the Alert Area. Alert Area 680 (A-680) surrounds Naval Outlying Landing Field (OLF) Coupeville on Whidbey Island. An Alert Area is established to inform pilots of a specific area wherein a high volume of pilot training or an unusual type of aeronautical activity is conducted.

3.13.1.2 Marine Traffic

Ocean traffic is the transit of commercial, private, or military vessels at sea, including submarines. The ocean traffic flow in congested waters, especially near coastlines, is controlled by the use of directional shipping lanes for large vessels, including cargo, container ships, and tankers. Traffic flow controls are also implemented to ensure that harbors and ports-of-entry remain as uncongested as possible. There is less control on open-ocean traffic involving recreational boating, sport fishing, commercial fishing, and activity by naval vessels. In most cases, the factors that govern shipping or boating traffic include the following: adequate depth of water, weather conditions (primarily affecting recreational vessels), availability of fish of recreational or commercial value, and water temperature. Higher water temperatures will increase recreational boat traffic, jet skis, and diving activities.

3.13.2 Affected Environment

3.13.2.1 Existing Conditions – Offshore Area

Air Traffic

The Offshore Area includes three warning areas (W): W-237, W-570, and W-93A/B. (See Figure 3.13-1). W-237 comprises 33,997 nm^2 (116,606 km^2) of airspace that generally overlays the Pacific Northwest Ocean Surface/Subsurface Operating Area (PACNW OPAREA) off the coast of Washington, Oregon, and California. W-237 begins 3 nm (5.5 km) off the coast and extends westward into international airspace for a distance of approximately 250 nm (463 km). Vertically, W-237 extends from the ocean surface up to several specified altitudes depending upon which sub-area is used. The warning area can be activated by the FAA at the Navy's request when activities that would pose a hazard to non-participating aircraft are being conducted. Military pilots travel under IFR flight plans from local air bases until they reach W-237 and proceed under VFR to their scheduled or instructed subcomponent operating area. W-570 is a smaller warning area off the central coast of Oregon primarily used by the United States Air Force (USAF) Western Air Defense Sector aircraft. P-3 aircraft from Commander, Patrol and Reconnaissance Wing TEN (CPRW-10) at Naval Air Station Whidbey Island (NASWI) occasionally use W-570 for reconnaissance training. W-93 is located south of W-570, off the coast of Oregon and Northern California. Similar in size to W-570, it is used primarily by Oregon Air National Guard aircraft; however, CPRW-10 P-3 aircraft occasionally use W-93 for reconnaissance training.

Warning Areas are activated either by Notice to Airmen (NOTAM) or as annotated on aviation charts by time of day. This provides real time notices and deconfliction to pilots to alter their courses to avoid military activities.

Military Aviation

Military aircraft routinely operate in international airspace in W-237, W-570, and W-93. These aircraft take off from military airfields in Washington, Oregon and California, or from aircraft carriers operating offshore. Military aircraft take off from mainland airfields normally with an IFR clearance from FAA Air Traffic Control Center. After entering a Warning Area, flights proceed via VFR, using a "see-and-avoid" rule to remain clear of other air traffic. According to NAWSI, W-237 was utilized by Navy aircraft approximately 4,000 hours for Fiscal Year (FY) 2007. Subsequently, W-237 was returned to the controlling agency, Seattle Air Route Traffic Control Center (ARTCC), for approximately 4,760 hours of public use (Wicker 2008).

Commercial and General Aviation

Aircraft operating under VFR can fly along the coast in the Northwest U.S. largely unconstrained, except by safety requirements and mandated traffic flow requirements. Aircraft operating under IFR clearances, authorized by the FAA, normally fly on the airway route structures (See Figure 3.13-1). In the Northwest, these routes include both high and low altitude routes. When W-237, W-570, and W-93 are active, aircraft on IFR clearances are precluded from entering the warning areas by the FAA. However, since W-237, W-570, and W-93 are located entirely over international waters, non-participating aircraft operating under VFR are not prohibited from entering the area. Examples of aircraft flights of this nature include light aircraft, such as those used in fish spotting and whale watching, which can occur under VFR throughout W-237 on a variable basis.

Marine Traffic

A significant amount of ocean traffic, consisting of both military, Coast Guard, commercial, and recreational vessels transit through the Offshore Area. For commercial vessels, the major trans-oceanic routes transit due west from the Puget Sound area, bypassing W-237 or entering the area briefly to the north. Ships also travel southwest to Hawaii entering the NWTRC Offshore OPAREAs briefly to transit

(Figure 3.13-2). The approach and departure routes into the Puget Sound (Figure 3.13-3) can be adjusted depending on Navy activities notification through Notice to Mariners (NOTMARs) found at http://www.navcen.uscg.gov/lnm/d13/.

Due to deep water dangers and suitability of small craft in the open ocean, only a very small volume of small craft traffic, primarily recreational, occurs throughout the Offshore Area. The majority of all small craft traffic occurs within 3 nm of shore or within the bays and harbors of the Puget Sound.

Military

The types of Navy vessels that operate in the Offshore Area range from small work boats to major Navy combatants such as aircraft carriers, cruisers, and submarines. The activity level of ships and boats is characterized as a ship or boat training event. According to Commander, Navy Surface Forces Pacific (CNSP) data in FY07, Naval vessels accumulated 528 annual days at sea in the NWTRC for all ship classes. Based on these days at sea, vessels accumulated a total of 12,672 annual hours at sea either in the Offshore or Inshore Area. Some of these events may occur simultaneously, as the vessels operate together or separately in one of the many training areas available.

Civilian

Commercial

The vessel traffic approaching ports is managed by the Vessel Traffic Service (VTS), which is operated jointly by the United States Coast Guard (USCG) and the Marine Exchange. The VTS is located at Pier 36 in Seattle and monitors the Strait of Juan de Fuca, Rosario Strait, Admiralty Inlet, and Puget Sound south as far as Olympia. Since 1979, the USCG has worked cooperatively with the Canadian Coast Guard in managing vessel traffic in adjacent waters. Through the Cooperative Vessel Traffic Service (CVTS), two Canadian Vessel Traffic Centers work hand in hand with Puget Sound VTS. Tofino VTS manages the area west of the Strait of Juan de Fuca. North of the Strait of Juan de Fuca, through Haro Strait, to Vancouver, B.C. is managed by Vancouver VTS. The three Vessel Traffic Centers communicate via a computer link and dedicated telephone lines to advise each other of vessels passing between their respective zones (http://www.navcen.uscg.gov/).

Portland, Oregon is also a major port in the Pacific Northwest. Portland's economy relies heavily on the Columbia and Willamette rivers and their access to the Pacific Ocean. For a long time, the deep, fresh-water port has helped the city grow into an important part of the growing lumber industry, and a number of manufacturing concerns settled there because of the ease of transportation.

Today, Portland is the third largest export tonnage port on the West Coast, with import and export shipments of $11.8 billion in 2003 (City Data 2008). Easy access to the north/south and east/west interstate freeway system, international air service, and both west coast intercontinental railroads make Portland an important distribution center.

Portland enjoys a long history of association with high-technology industries, beginning with Tektronix in 1946. There are now more than 1,200 technology companies currently operating in Portland. In 2004, Portland's largest employer was microcomputer components manufacturer Intel Corporation. Well-established support industries and farsighted commercial planning continue to draw electronics, computer, and other high-technology companies to the area (City Data 2008).

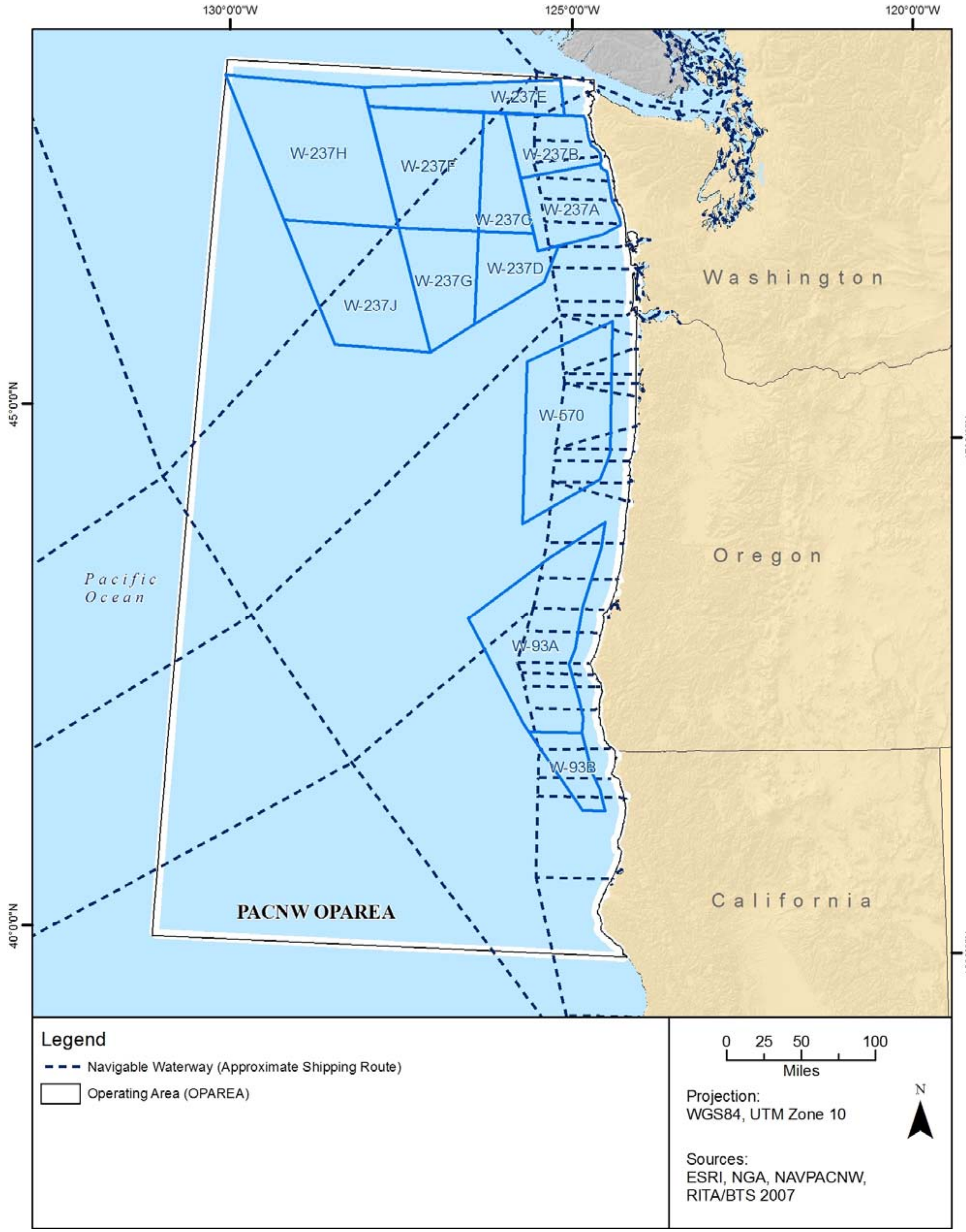

Figure 3.13-2: Marine Traffic in Vicinity of NWTRC

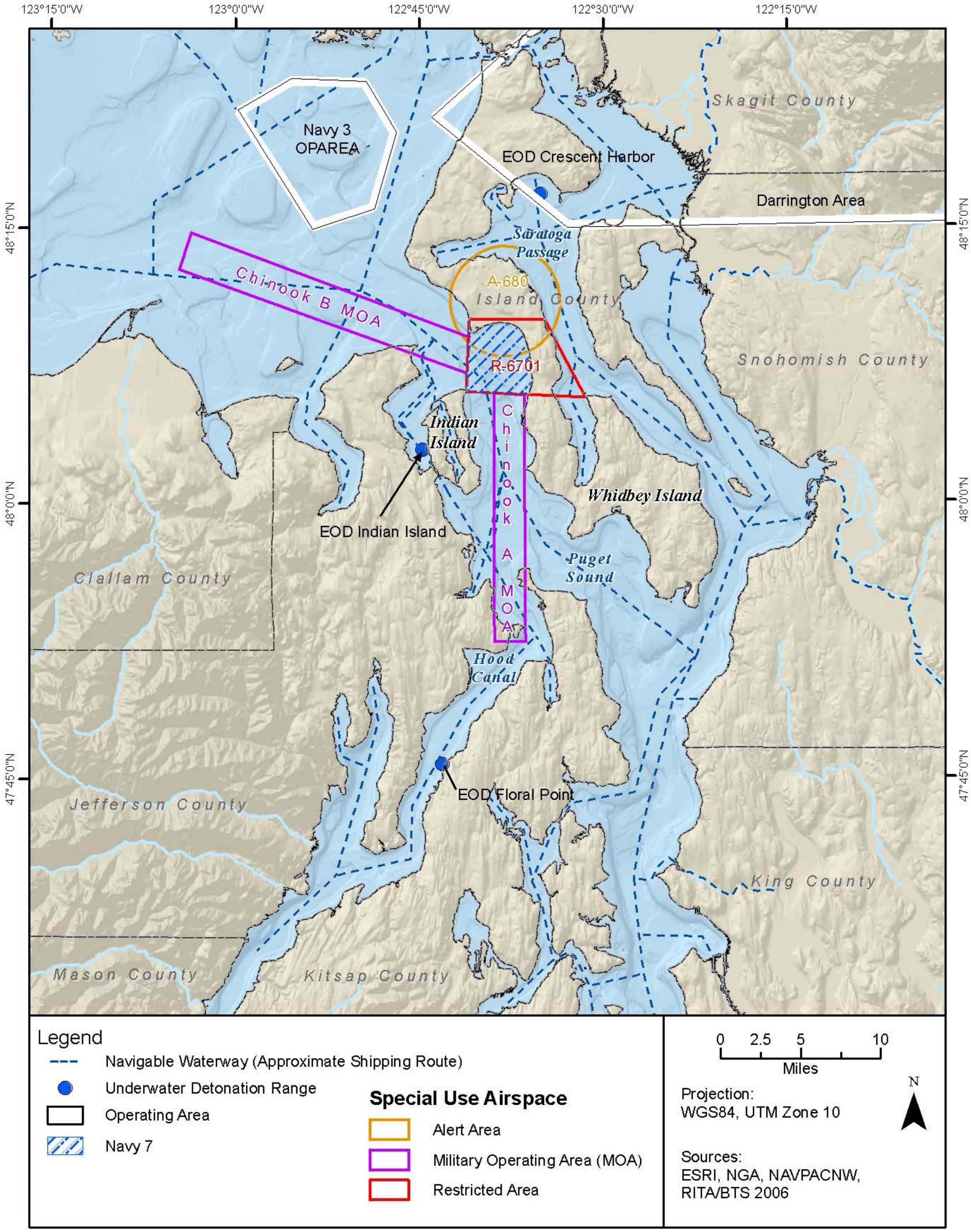

Figure 3.13-3: Marine Traffic in Vicinity of the Puget Sound

Several ports in northern California, to include San Francisco, Oakland, Stockton, Sacramento, and Redwood City, all contribute greatly to the economy within the region and require access to the Pacific Ocean to reach trade routes. However, with the exception of those vessels that head north to Portland, Seattle, and destinations throughout Alaska and Canada, the majority of vessel traffic from these California ports bypass the NWTRC.

Recreational and Fishing

Recreational craft operate from ports within the Puget Sound, the San Juan Islands, and from other locations all along the coasts of Washington, Oregon, and northern California. The Coast Guard has indicated that there are no precise estimates for recreational or commercial fishing or boating activity in the NWTRC. Recreational activities in the NWTRC include fishing, diving, sailing, yachting, kayaking, canoeing, surfing, biking, hiking, whale watching and various other activities (Figure 3.13-4). Water based activities occur mainly within the protected harbors and straits and must operate under the USCG PART 162—INLAND WATERWAYS NAVIGATION REGULATIONS (33 C.F.R. § 162.225, 162.230, and 162.235) and general maritime rules and regulations. Other recreational activities can be found sporadically throughout the Offshore Area but are centered on the Inshore Area inner waters for safety.

3.13.2.2 Existing Conditions – Inshore Area

Air Traffic

Military Aviation

By definition, the Inshore Area includes no warning area airspace. As depicted in Figure 3.13-1, several MOAs exist over land in the NWTRC. In addition, a small amount of restricted airspace, designated R-6701, is located at the intersection of the Chinook MOA A and Chinook MOA B and has a lower limit of 300 ft MSL and an upper limit of 5,000 ft MSL for a total of 56 nm^2 (192 km^2).

OLF Coupeville is located within A-680 airspace. In addition, Class D airspace has been established to support the safe and efficient air traffic movement to and from OLF Coupeville. The Class D airspace consists of a 5 nm (9 km) radius circle centered on the airfield and includes the airspace from the surface to 2,700ft MSL. All aircraft entering this airspace, or operating within it, must maintain radio contact with the OLF Coupeville control tower.

Commercial and General Aviation

Aircraft operating under VFR can fly throughout the Northwest U.S. largely unconstrained, except by safety requirements and mandated traffic flow requirements. Aircraft operating under IFR clearances, authorized by the FAA, normally fly on the airway route structures (See Figure 3.13-1). In the Northwest, these routes include both high and low altitude routes. Commercial and general aviation aircraft are restricted from entering restricted airspace, such as R-6701, but can operate in MOAs unless the FAA releases the MOA to military use.

Marine Traffic

A significant amount of ocean traffic, consisting of both military, Coast Guard, commercial, and recreational vessels transit through the Inshore Area. The majority of all small craft traffic occurs within 3 nm of shore or within the bays and harbors of Puget Sound.

Military

The types of Navy vessels that operate in the Offshore Area range from small work boats to major Navy combatants such as aircraft carriers, cruisers, and submarines. The activity level of ships and boats is characterized as a ship or boat training event. According to CNSP data in FY07, Naval vessels accumulated 528 annual days at sea in the NWTRC for all ship classes. Based on these days at sea, vessels accumulated a total of 12,672 annual hours at sea either in the Offshore or Inshore Area. Some of these events may occur simultaneously, as the vessels operate together or separately in one of the many training areas available.

Civilian

Commercial

The vessel traffic approaching ports is managed by the Vessel Traffic Service (VTS), which is operated jointly by the United States Coast Guard (USCG) and the Marine Exchange. The VTS is located at Pier 36 in Seattle and monitors the Strait of Juan de Fuca, Rosario Strait, Admiralty Inlet, and Puget Sound south as far as Olympia. Since 1979, the USCG has worked cooperatively with the Canadian Coast Guard in managing vessel traffic in adjacent waters. Through the Cooperative Vessel Traffic Service (CVTS), two Canadian Vessel Traffic Centers work hand in hand with Puget Sound VTS. Tofino VTS manages the area west of the Strait of Juan de Fuca. North of the Strait of Juan de Fuca, through Haro Strait, to Vancouver, B.C. is managed by Vancouver VTS. The three Vessel Traffic Centers communicate via a computer link and dedicated telephone lines to advise each other of vessels passing between their respective zones (http://www.navcen.uscg.gov/).

VTS Puget Sound monitors approximately 250,000 vessel movements a year, comprised of tankers, cargo ships, ferries, and tug boats with tows. The purpose of VTS Puget Sound is to function as an integral part of the Thirteenth Coast Guard District's waterways management efforts by facilitating the safe and efficient transit of vessel traffic to assist in the prevention of collisions, groundings, maritime casualties and ensuing environmental damage. Twenty-four hours a day, seven days a week, carefully trained military and civilian watch standers monitor and communicate with vessels in the Strait of Juan de Fuca.

Recreational and Fishing

Recreational craft operate from ports within the Puget Sound, the San Juan Islands, and from other locations all along the coasts of Washington, Oregon, and northern California. The Coast Guard has indicated that there are no precise estimates for recreational or commercial fishing or boating activity in the NWTRC. Recreational activities in the NWTRC include fishing, diving, sailing, yachting, kayaking, canoeing, surfing, biking, hiking, whale watching and various other activities (Figure 3.13-4). Water based activities occur mainly within the protected harbors and straits and must operate under the USCG PART 162—INLAND WATERWAYS NAVIGATION REGULATIONS (33 C.F.R. § 162.225, 162.230, and 162.235) and general maritime rules and regulations. Other recreational activities can be found sporadically throughout the Offshore Area but are centered on the Inshore Area inner waters for safety.

3.13.2.3 Current Requirements and Practices

The Navy strives to ensure that it retains access to ocean training areas and SUA as necessary to accomplish its mission, while facilitating joint military-civilian use of such areas to the extent practicable and consistent with safety. These goals of military access, joint use, and safety are promoted through various coordination and outreach measures, including:

- NOTAMs advising of the status of activities being conducted in W-237, W-570, and W-93, and other components of SUA in the NWTRC. NOTAMs are available via the internet at https://www.notams.jcs.mil.
- Return of SUA to civilian FAA control when not in use for military activities. According to FAA and Department of Defense (DoD) policy, SUA, including Warning Areas, should be made available for use by nonparticipating aircraft when all or part of the airspace is not needed by the using agency. To accommodate the joint use of SUA, a letter of agreement or a letter of procedure is drafted between the controlling agency and the using agency. In the case of W-237H and W-237J, a letter of agreement is in place between Seattle ARTCC and Naval

Air Station Whidbey Island (NASWI). The agreement establishes the activation/deactivation procedures for the SUA and may outline periods when the FAA, with the Navy's concurrence, may route IFR traffic through the active SUA. The letter of agreement also defines the conditions and procedures to ensure safe and efficient joint use of warning areas. The FAA does not prohibit aircraft operating under VFR from entering warning areas that overlie international waters.

- Publication of NOTMARs. The Navy provides information about potentially hazardous activities planned for the NWTRC OPAREA, for publication by the USCG in NOTMARs. To ensure the broadest dissemination of information about hazards to commercial and recreational vessels, the Navy provides schedule conflicts along with other Coast Guard concerns at: http://www.navcen.uscg.gov/lnm/d13/.

3.13.3 Environmental Consequences

3.13.3.1 Approach to Analysis

The traffic analysis addresses air and ocean traffic in the NWTRC. The principal issue is the potential for existing or proposed military air or vessel traffic to affect existing transportation and circulation conditions. Impacts on traffic were assessed with respect to the potential for disruption of transportation pattern and systems, and changes in existing levels of transportation safety.

Factors used to assess the significance of impacts on air traffic include consideration of an alternative's potential to result in an increase in the number of flights such that they could not be accommodated within established operational procedures and flight patterns; a requirement for an airspace modification; or an increase in air traffic that might increase collision potential between military and non-participating civilian operations. The Proposed Action and Alternatives do not include proposed airspace modifications and would not change the existing relationship of the Navy's SUA with federal airways, uncharted visual flight routes, and airport-related air traffic operations.

Factors used to assess the significance of impacts on ocean vessel traffic include the extent or degree to which an alternative would seriously disrupt the flow of commercial surface shipping or recreational fishing or boating. A serious disruption occurs when a vessel is unable to proceed to its intended destination due to exclusion from areas in the NWTRC. However, the need to use alternative routes during the time of exclusion does not constitute a serious disruption.

3.13.3.2 No Action Alternative

Both military and non-military entities have been sharing the use of the airspace and ocean surface comprising the NWTRC for more than 50 years. Military, commercial, and general aviation activities have established an operational coexistence consistent with federal, state, and local plans and policies and compatible with each interest's varying objectives. Activities under the No Action Alternative include activities that are and have been routinely conducted in the area for decades.

<u>Offshore Area</u>

<u>Air Traffic</u>

The FAA has established Warning Areas for military activities that take place offshore. Warning areas such as; W-237, W-570, and W-93 have been established to coordinate civilian and military uses. When military aircraft are conducting activities that are not compatible with civilian activity, the military aircraft are confined to the designated warning area, which is specifically designed for this purpose. Limitations are communicated to commercial airlines and general aviation by NOTAMs, published by the FAA. Under the No Action Alternative, there are no additional impacts on the FAA's capabilities, no expected decrease in aviation safety, and no adverse effects on commercial or general aviation activities.

Marine Traffic

Military use of the Offshore Area is also compatible with civilian use. Where naval vessels are conducting activities that are not compatible with other uses, they operate away from shipping lanes to reduce interruptions to their training activities and to allow traffic to flow freely. When activities must occur within shipping or high traffic areas, these operation areas are communicated to all vessels and operators by NOTMARs, published by the Coast Guard.

Inshore Area

Air Traffic

The FAA has established SUA for Inshore Area military activities. SUA such as the Roosevelt and Okanogan MOAs in northeast Washington as well as military restricted areas and alert areas around Whidbey Island have been established to allow all air traffic to work in concurrence with each other. When military aircraft are conducting activities that are not compatible with civilian activity, the military aircraft are confined to the designated MOA or restricted area, which is specifically designed for this purpose. Limitations are communicated to commercial airlines and general aviation through the use of NOTAMs and aviation charts, published by the FAA. Under the No Action Alternative, there are no additional impacts on the FAA's capabilities, no expected decrease in aviation safety, and no adverse effects on commercial or general aviation activities.

Marine Traffic

Military use of the Inshore Area is also compatible with civilian use. Where naval vessels are conducting activities that are not compatible with other uses, such as restricted maneuvering, they operate away from shipping lanes or in designated areas, such as Navy 3 or Navy 7, to allow traffic to flow freely. When activities must occur within shipping or high traffic areas, these operation areas are communicated to all vessels and operators by NOTMARs, published by the Coast Guard. Explosive ordnance disposal (EOD) locations are limited to three locations within the Puget Sound inner waters. All EOD activities are patrolled by safety vessels during activities to prevent civilian traffic from coming in conflict with Navy activities. Any scatter of civilian vessels is on a temporary basis and does not increase traffic concerns in the areas.

3.13.3.3 Alternative 1

Offshore Area

Air Traffic

The FAA has established Warning Areas for military activities; in this case, W-237, W-570, and W-93. Offshore activities proposed under Alternative 1 would have all the components of the No Action Alternative, but the training tempo would increase by about 17 percent resulting in more air traffic. It is possible that the training tempo increase could result in the warning area airspace being retained by the Navy more than under the No Action Alternative. The traffic control procedures implemented under this alternative would be the same as those described above under the No Action Alternative. No additional impacts on the FAA's capabilities would be created. The remoteness of the offshore use areas, the use of LOAs to better orchestrate traffic, and public notification procedures would substantially reduce possible congestion during these activities.

Marine Traffic

Military use of the offshore ocean is also compatible with civilian use. Where naval vessels are conducting activities that are not compatible with other uses, they are confined to operating areas away from shipping lanes and recreational use areas. These hazardous activities are communicated to all vessels and operators by NOTMARs, published by the Coast Guard. Of the total increases in activities in Alternative 1 over the No Action Alternative (1,215 activities), naval vessels would be involved in 23 of these activities, which represents a 1.9 percent increase over baseline activities. However, these increases in training activities would not necessarily increase naval vessel traffic, as the majority of them would be conducted concurrently with existing training activities. Subsequently, despite a modest increase in training tempo for most activities, commercial and recreational interests would not be affected by operational increases.

Inshore Area

Air Traffic

The FAA has established SUA for Inshore military activities; in this case, restricted areas, MOAs, and alert areas. Inshore activities proposed under Alternative 1 would have all the components of the No Action Alternative, but the training tempo would increase by about 17 percent resulting in more air traffic. It is possible that the training tempo increase could result in the MOAs being retained by the Navy more than under the No Action Alternative. The traffic control procedures implemented under this alternative would be the same as those described above under the No Action Alternative. No additional impacts on the FAA's capabilities would be created. The remoteness of the inshore use areas, the use of LOAs to better orchestrate traffic, and public notification procedures would substantially reduce possible congestion during these activities.

Marine Traffic

Military use of the Inshore Area is also compatible with civilian use. Where naval vessels are conducting activities that are not compatible with other uses, they are confined to operating areas away from shipping lanes and recreational use areas. These hazardous activities are communicated to all vessels and operators by NOTMARs, published by the Coast Guard. Of the total increases in activities in Alternative 1 over the No Action Alternative (1,215 activities), naval vessels would be involved in 23 of these activities, which represents a 1.9 percent increase over baseline activities. However, these increases in training activities would not necessarily increase naval vessel traffic, as the majority of them would be conducted concurrently with existing training activities. Subsequently, despite a modest increase in training tempo for most activities, commercial and recreational interests would not be affected by operational increases. EOD activities will decrease from 60 annual events in the No Action Alternative to 4 in Alternative 1.

3.13.3.4 Alternative 2

Offshore Area

Air Traffic

The FAA has established Warning Areas for military activities; in this case, W-237, W-570, and W-93. Offshore events proposed under Alternative 2 would have all the components of the No Action Alternative, but the number of annual events would increase by about 54 percent. It is possible that the training tempo increase could result in the warning area airspace being retained by the Navy more than under the No Action Alternative. Although proposed increases in activities and range enhancements to the NWTRC would occur, they would not affect the current routing and flow of air traffic. The traffic control procedures implemented under this alternative would be the same as those described above under the No Action Alternative. No additional impacts on the FAA's capabilities would be created. The remoteness of the offshore use areas, the use of LOAs to better orchestrate traffic, and public notification procedures would substantially reduce possible congestion during these activities.

Marine Traffic

Military use of the offshore ocean is also compatible with civilian use. Where naval vessels are conducting activities that are not compatible with other uses, they are confined to operating areas away from shipping lanes and other recreational use areas. These hazardous activities are communicated to all vessels and operators by NOTMARs, published by the Coast Guard. Of the total increases in activities in Alternative 2 over the No Action Alternative (3,879 activities), naval vessels could be involved in 262 of these activities, which represents a 6.7 percent increase over baseline activities. However, these increases in training activities would not necessarily increase naval vessel traffic, as the majority of them would be conducted concurrently with existing training activities. Subsequently, despite a modest increase in training tempo for most activities, commercial and recreational interests would not be affected by operational increases.

Alternative 2 includes two range enhancements with the potential to impact marine traffic in the Offshore Area; a Portable Undersea Tracking Range (PUTR) and an underwater training minefield.

- Portable Undersea Tracking Range. The PUTR involves the temporary placement of seven electronics packages on the seafloor, each approximately 3 ft long by 2 ft in diameter. Although no candidate locations have yet been identified, the electronic packages would be placed in water depths greater than 600 ft, at least 3 nm from land. Because this is a temporary installation—to be recovered once training is complete—no formal restricted areas would be designated and no limitations would be placed on commercial or civilian use, thus limiting impacts to marine traffic.
- Underwater training minefield. An underwater minefield would be permanently installed on the seafloor in a location not yet determined. The minefield would be used by submarines for mine location and avoidance training. Requirements for the minefield training dictate that the mine shapes would be tethered to the ocean floor in water depth of 500 to 600 ft (150 to 185 m) and rising to within 400 to 500 ft (120 to 150 m) of the ocean surface. Because the mine shapes are well below the ocean surface, and the training would be conducted by submerged submarines, there are no expected impacts to marine traffic.

Inshore Area

Air Traffic

The FAA has established SUA for Inshore military activities; in this case, restricted areas, MOAs, and alert areas. Inshore activities proposed under Alternative 2 would have all the components of the No Action Alternative, but the training tempo would increase by about 54 percent resulting in more air traffic. It is possible that the training tempo increase could result in the MOAs being retained by the Navy more than under the No Action Alternative. The traffic control procedures implemented under this alternative would be the same as those described above under the No Action Alternative. No additional impacts on the FAA's capabilities would be created. The remoteness of the inshore use areas, the use of LOAs to better orchestrate traffic, and public notification procedures would substantially reduce possible congestion during these activities.

Marine Traffic

Military use of the Inshore Area is also compatible with civilian use. Where naval vessels are conducting activities that are not compatible with other uses, they are confined to operating areas away from shipping lanes and other recreational use areas. These hazardous activities are communicated to all vessels and operators by NOTMARs, published by the Coast Guard. Of the total increases in activities in Alternative 2 over the No Action Alternative (3,879 activities), naval vessels could be involved in 262 of these activities, which represents a 6.7 percent increase over baseline activities. However, these increases in training activities would not necessarily increase naval vessel traffic, as the majority of them would be conducted concurrently with existing training activities. Subsequently, despite a modest increase in training tempo for most activities, commercial and recreational interests would not be affected by operational increases. EOD activities will decrease from 60 annual events in the No Action Alternative to 4 in Alternative 2.

3.13.4 Mitigation Measures

No adverse effects on air or marine traffic were identified. Therefore, no additional mitigation measures are necessary.

3.13.5 Unavoidable Environmental Effects

No unavoidable consequences to air or marine traffic were identified.

3.13.6 Summary of Effect by Alternative

As outlined in Table 3.13-1, the majority of these training and test activities are located within the charted, designated military operations boundaries; hence, there would be minimal potential for conflict with non-military shipping or flight plans. Air and shipping traffic within the offshore areas is sparse enough that Navy ships and aircraft can conduct their activities far from non-participants if required. Therefore, no adverse effects would occur as a result of implementation of the No Action Alternative, Alternative 1, or Alternative 2.

Table 3.13-1: Summary of Effects – Traffic

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Hazardous air operation effects are minimal and any possible effects are limited by confining military aircraft to the warning areas to prevent accidental contact. • Activities at Explosive Ordnance Disposal (EOD) locations do not have an appreciable effect on traffic concerns due to the temporary dispersal of traffic and current requirements and practices of safety vessels. • Military use of the offshore ocean does not create a considerable risk to impact traffic because Navy aircraft and vessels are confined to operating areas (OPAREAs) away from shipping lanes and other recreational use areas.	• Impacts would be similar to those described for the No Action Alternative for territorial waters.
Alternative 1	• Hazardous air operation effects would be minimal and any possible effects are limited by confining military aircraft to the warning areas to prevent accidental contact. • Activities at EOD locations do not have an appreciable effect on traffic concerns due to the temporary dispersal of traffic and current requirements and practices of safety vessels. (Significant reduction in EOD underwater detonation activities from No Action Alternative.) • Military use of the offshore ocean would not create a considerable risk to impact traffic because Navy aircraft and vessels are confined to OPAREAs away from shipping lanes and other recreational use areas.	• Impacts would be similar to those described for the No Action Alternative for territorial waters.
Alternative 2 (Preferred Alternative)	• Hazardous air operation effects would be minimal and any possible effects are limited by confining military aircraft to the warning areas to prevent accidental contact. • Activities at EOD locations do not have an appreciable effect on traffic concerns due to the temporary dispersal of traffic and current requirements and practices of safety vessels. (Significant reduction in EOD underwater detonation activities from No Action Alternative.) • Military use of the offshore ocean would not create a considerable risk to impact traffic because Navy aircraft and vessels are confined to OPAREAs away from shipping lanes and other recreational use areas.	• Impacts would be similar to those described for the No Action Alternative for territorial waters.

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3.14 Socioeconomics

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3.14 SOCIOECONOMICS

Socioeconomics comprise the basic attributes and resources associated with the human environment, particularly population and economic activity. This section addresses the socioeconomic effects on commercial and recreational fishing, commercial shipping, tourism, housing and the economy, as well as diving, boating and other recreational activities.

The Northwest Training Range Complex (NWTRC) Study Area includes the Offshore Area and the Inshore Area. The Offshore Area includes the warning areas (W-) that have been established off of the coasts of Washington, Oregon, and California (W-237 A-D, F-H, and J; W-570; W-93 A and B). Military flights to these areas are controlled through agreement with the Federal Aviation Administration (FAA) and local scheduling authority. The Inshore Area includes three Explosive Ordnance Disposal (EOD) areas, Naval Air Station Whidbey Island (NASWI), and the Navy 3 range located over water in the middle of the Strait of Juan de Fuca. EOD Crescent Harbor is found on the east side of Whidbey Island, EOD Indian Island is found in the waters between Port Hadlock and the U.S. Naval Reservation at Naval Magazine Indian Island, and EOD Bangor is found at NBK-Bangor. Airspace in the Inshore Area includes the Darrington Area which extends inland from Whidbey Island, the Okanogan Military Operation Area (MOA), the Olympic MOA, Chinook MOA, and the Roosevelt MOA.

3.14.1 Affected Environment

3.14.1.1 Offshore Area

Military Activity

Navy activities in the Pacific Northwest United States (U.S.) make a substantial contribution to the social and economic well-being of the area. The Department of the Navy supports a large concentration of naval forces in the region. The majority of the ships, aircraft, submarines, and other units that train in the NWTRC are home-ported at Naval Air Station (NAS) Whidbey Island, Naval Station (NS) Everett, Naval Base Kitsap (NBK)-Bremerton, NBK-Bangor, and Puget Sound Shipyard. Their social and positive economic impact is felt in the cities, towns, and countryside of the region. According to the 2004 Washington State Office of Financial Management (OFM) report on the *Economic Impacts of the Military Bases in Washington*:

> In Island County, 88 percent (Net Direct Impact of $494.5 million) of the economic activity comes from military bases. Other counties with large percentages of economic activity from bases include Kitsap (54 percent – Net Direct Impact of $1.335 billion), Pierce (30 percent – Net Direct Impact of $2.2312 billon), Spokane (9 percent – Net Direct Impact of $462.3 million), and Snohomish (5 percent – Net Direct Impact of $296.2 million). Other findings in the report include data that sales by Washington companies to local bases total $528 million per year. In King County alone, businesses sold $174 million to bases statewide. Forty-four companies in the State derive 100 percent of their business from military bases, and 30 others generate more than half of their business from the bases. While much of the health care is provided to service personnel and their families on base, $116 million is paid out per year to private health care providers in Washington State. Schools also receive Federal assistance for educating military dependents. Local districts receive $31.7 million in school impact aid from the Federal government (OFM 2004).

However, the Proposed Action does not include an increase in personnel stationed in the region.

Civilian Activity

Commercial Shipping

Ocean shipping is a significant component in the regional economy. The State's population is relatively small in comparison to the State's port activity which constitutes the world's largest locally controlled port system. Washington State handles seven percent of the country's exports and six percent of its imports. Seattle and Tacoma were ranked seventh and tenth, respectively, among U.S. ports with respect to total cargo imported and exported in 2005 (http://www.bts.gov). Taken together, these two ports comprise the nation's third largest "container load center" in the U.S., second only to Los Angeles/Long Beach and New York/New Jersey (www.washingtonports.org). Other key ports in the region include:

- Bellingham (Whatcom County)
- Orcas, Friday Harbor, and Lopez (San Juan County)
- Anacortes and Skagit County (Skagit County)
- Coupeville and South Whidbey Island (Island County)
- Port Angeles (Clallam County)
- Port Townsend (Jefferson County)
- Everett and Edmonds (Snohomish County)
- Olympia (Thurston County)
- Shelton, Allyn, Grapeview, Dewatto, and Hoodsport (Mason County)
- Kingston, Indianola, Keyport, Poulsbo, Brownsville, Tracyton, Waterman, Bremerton, Silverdale, and Manchester (Kitsap County)
- Grays Harbor (Grays Harbor County)

Most vessels entering or leaving the Washington Ports travel northwest, southwest, or south through the NWTRC without incident or delay. Shipping to and from the south typically follows the coastline of Washington, Oregon and California. Ships traveling between Washington Ports, Hawaii, and the Far East travel via the most direct route or great circle route.

Commercial Fishing

Commercial fishing takes place throughout the Offshore Area from near shore waters adjacent to the mainland to the offshore fishing grounds. The Pacific Fishery Management Council, which is one of eight regional fishery management councils established by the Magnuson Fishery Conservation and Management Act of 1976 for the purpose of managing fisheries 3-200 miles offshore of the United States of America coastline (to include the coasts of California, Oregon, and Washington), has defined four main fisheries: groundfish; highly migratory species (tuna); coastal pelagic species (anchovy, mackerel, herring, sardines); and salmon. Pacific Fisheries Information Network (PacFIN) maintains commercial catch block data for ocean areas off the coasts of Washington, Oregon, California, Alaska, and British Columbia (see Table 3.14-1), and all statements referring to catch are for that part of the Study Area for which data are available. For 2007, the most commonly harvested commercial species in the NWTRC were groundfish, Dungeness crab, tuna (albacore), chum salmon, and Pacific sardine (see Table 3.14-1).

Water depths in the Offshore Area reach a maximum depth of about 2.8 miles (mi) (4.5 kilometers (km) below sea level around the Pacific/Juan de Fuca tectonic plates. Within the Offshore Area, groundfish species encompass the majority of the commercial catch. Specifically, of the 2007 annual catch, groundfish accounted for approximately 66 percent, pelagic species accounted for approximately 19 percent, and salmon accounted for 15 percent (Table 3.14-1). The 2007 annual catch of groundfish, highly migratory species, coastal pelagic species, salmon, and all other fish amounts to approximately 59,689 metric tons, and $56,661,497 (in dollar value).

Of the 2007 catch of crustaceans, over 83 percent was attributable to the Dungeness crab (approximately 10,084 metric tons). The remaining percent being allocated among crustaceans (shrimp) (2,036 metric tons). The catch of crustaceans was worth approximately $67,409,474 in 2007. In comparison, the annual catch of geoduck was worth $21,001,493, and squid was worth $16,975. Urchins were worth $350,249, whereas other invertebrates (e.g., snails, sea cucumbers) were worth approximately $39,131,123 (Table 3.14-1).

Recreation and Tourism

Whale watching is most popular April through September and usually focuses on the area around the San Juan Islands, although it also occurs along the coasts of Washington, Oregon, and California. A number of charter boat companies run whale watching cruises. Such charters operate out of Seattle and from various other ports around Puget Sound. Though tourist day trips typically remain within the Bay for safety, these activities can occur throughout the NWTRC.

Fishing destinations are generally more fluid, in response to changing fishing conditions, but a number of charter boats fish NWTRC waters off the coasts of Washington, Oregon, and California on a routine basis. Charter and privately operated boats embark from the Puget Sound for salt-water sport fishing interests. Fishing within the offshore OPAREAs is inherently more hazardous due to its open-ocean conditions. Therefore, salt-water sport fishing is centered primarily on Puget Sound's inner waters. Sport fishermen pursue various fish species with hook and line, traps, and seining. Some divers also spearfish or take invertebrates by hand within the NWTRC.

Population and Housing

The Offshore Area consists of open ocean with no permanent population centers or housing. All activities occur offshore from the coasts of the United States and Canada.

3.14.1.2 Inshore Area

Military Activity

Inland MOAs located in northeast Washington and a small portion of northwestern Idaho consists of airspace training areas and no landing areas. Okanogan and Roosevelt MOAs cover a large area of northeastern Washington covering the counties of Okanogan, Ferry, Stevens, and Pend Orielle. A small area of Chelan County and portions of Boundary and Bonner counties in Idaho are also part of the area covered by the OPAREAs. Darrington Area is located over Skagit and Whatcom counties and consists of no landing areas; it is accessed from nearby NASWI.

Whidbey Island can be considered to have two different economic regions: the northern end of the island (encompassing Oak Harbor and NASWI), and the remainder of the island (encompassing Coupeville, Langley, Freeland, Greenbank, Clinton and the smaller communities in-between). Military support facilities on Whidbey Island are staffed by government contractors or Navy civilian or military personnel.

Civilian Activity

Recreation and Tourism

The inland areas of Washington contain many outdoor activities including backpacking, bird watching, boating, canoeing, fishing, golf, camping, hunting, kayaking, off-roading, mountain biking, hiking &

nature walks, swimming, tubing, and wildlife viewing & photography. National Parks in inland areas include Colville National Forest and Okanogan National Forest.

Table 3.14-1: Annual Commercial Landing of Fish and Invertebrates and Value within Washington Waters (2007)

Type		Annual Catch (Metric Tons)	Value (Dollars)
Fish	Northern anchovy	153.0	$35,883
	Pacific herring	382.0	$350,042
	Pacific sardine	4,664.9	$489,635
	Chinook salmon	1,377.3	$6,895,704
	Chum salmon	5,351.9	$8,997,670
	Coho salmon	1,139.1	$3,862,282
	Pink salmon	886.8	$449,751
	Sockeye salmon	35.6	$87,628
	Steelhead salmon	146.8	$439,464
	Chinook salmon roe	2.7	$20,972
	Chum salmon roe	4.7	$37,616
	Coho Salmon roe	1.1	$7,383
	Steelhead salmon roe	0.1	$234
	Tuna (Albacore)	5,976.1	$10,472,463
	Pacific halibut	883.7	$9,046,020
	groundfish	38,346.3	$14,923,480
	All other fish	336.7	$545,270
Invertebrates	**Total Fish**	59,688.8	$56,661,497
	Dungeness crab	10,083.3	$63,623,216
	Other crustaceans (shrimp)	2,035.9	$3,786,258
	Geoduck	2,347.3	$21,001,493
	Sea urchins	200.4	$350,249
	Squid	77.0	$16,975
	Other invertebrates	7,314.6	$39,131,123
	Total Invertebrates	22,058.5	$127,909,314
	Totals	81,747.3	$184,570,811

Source: PacFIN Report #310, WDFW All Species Report: 2007 Commercial Landed Catch

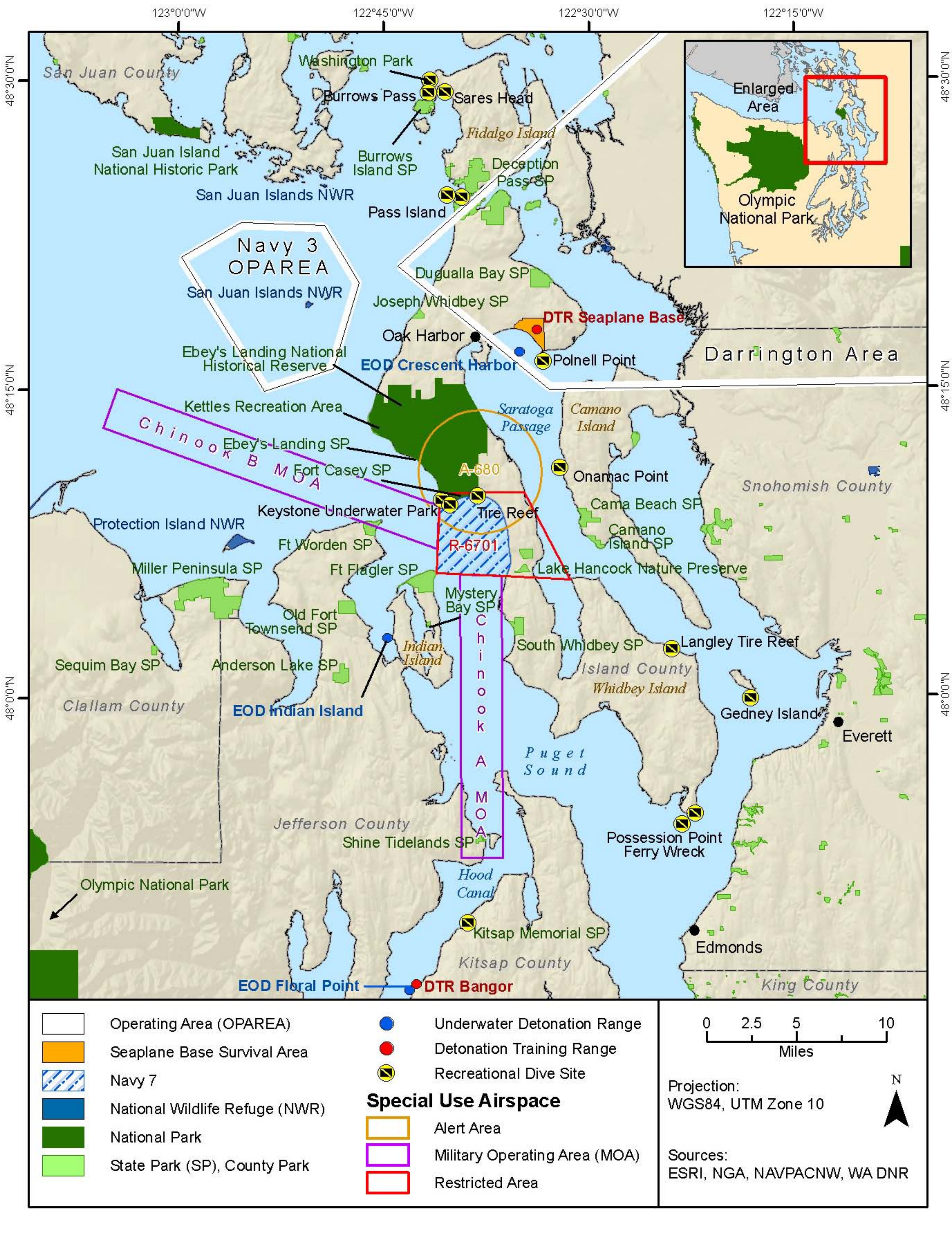

Figure 3.14-1: Dive Sites, Parks, and Recreation in the NWTRC

The economy of Whidbey Island south of Oak Harbor relies heavily on tourism related commerce and, to some degree, on small-scale agriculture. Tourism is especially important for the towns of Coupeville and Langley while Penn Cove Mussel Farm exports large quantities of its highly renowned Penn Cove Mussels. This aquaculture facility, along with a number of small farms, reflects the rural agricultural nature of most of central Whidbey Island. Other areas within the Puget Sound have recreational fishing, boating, sailing, diving, whale watching, and other tourist activities which are centered on boat basins, marinas, and the ports of the areas.

Sportfishing, sailing, power boating, kayaking, diving, whale watching, and other watersports are all activities found in the Puget Sound marine areas. Rock-climbing, camping, cross-country skiing, biking, snowshoeing, and snowmobiling are activities found in Washington’s interior and mountains.

Recreational boating and ocean-related tourism activities also contribute to the regional economy of Puget Sound. Puget Sound has 244 marinas with 39,400 moorage slips and another 331 launch sites for smaller boats (Washington Department of Ecology 2006). Statewide, approximately 180,000 boats are registered, not counting thousands more small boats and watercraft that do not require registration. An estimated $464 million in combined boat, motor, and related purchases ranks Washington tenth highest in the nation for boating related expenditures (Washington Department of Ecology 2006). An estimated 390,000 people participate in recreational activities in the waters and on the beaches of Puget Sound at least once a year (Washington Department of Ecology 2006).

The Olympic National park is located adjacent to the Puget Sound on the Olympic peninsula. State parks and recreation areas on Whidbey Island includes: Deception Pass State Park, Ala Spit (a popular birding location bordering Deception Pass), Joseph Whidbey State Park (which contains a recreational beach within the Puget Sound), South Whidbey State Park, Dugualla State Park, Oak Harbor (home of many Naval families and popular launch site for kayaking around the island), Fort Casey State Park (which contain two salt-water boat ramps), Keystone Underwater Park, Ebey's Landing National Historical Reserve, Coupeville & Rhododendron Park, Kettles Recreation Area, and Hancock Nature Reserve & Overlook (Figure 3.14-1).

Areas that contribute to recreational activity within the Sound include: Cama Beach and Camano Island State parks on Camano Island, Ft. Worden, Miller Peninsula, Anderson Lake, Shine Tidelands, and Sequim Bay State Parks on the Olympic peninsula and Mystery Bay and Ft. Flagler State Parks on Indian Island. To the south, near Dabob Bay Range Complex (DBRC), the Kitsap Memorial State Park and other regional parks on the Kitsap peninsula also allow for beach and water access.

Puget Sound’s good underwater visibility, rich sea life, and largely pristine diving conditions make it a popular destination for divers in the northwest. Charter dive trips to specific sites are often published and booked as many as 6 months in advance. Most dive charters are scheduled for weekends, though not all. Diving occurs year-round, though the number of trips to popular dive sites peak during the summer months (See Figure 3.14-1).

To facilitate many of these interests, many boat ramps have been placed in sheltered areas of the Puget Sound to allow for access from different points around the bays, straights, and canals of the NWTRC. These are maintained and controlled by the local, State, or Federal ownership of the location. Boat licenses are controlled by the State and permits for launching are controlled by the jurisdiction where the site is located as well. These launch points see an increase in activity on the weekends and also an increase during the summer months.

Population and Housing

There is no military housing beneath the Inshore Area MOAs. The many cities and towns within Okanogan, Ferry, Stevens, and Pend Orielle counties are subject to overflight noise by military aircraft during activities. Population density is centered on major cities. Inland counties have very low densities for the State. Based on U.S. Census density for the year 2000, Okanogan County has only 5-10 persons per square mile, Ferry 0-5, Stevens 10-20, and Pend Orielle 5-10 (OFM 2000).

Military housing on Whidbey Island is centered on Oak Harbor. Tourist and visitor facilities are located throughout Whidbey Island. Military support housing is staffed by Navy personnel while stationed on the island who are not recorded as residents during census counts. Whidbey Island is home to 58,211 residents (according to the 2000 census). An estimated 29,000 of Whidbey Islanders live in rural locations, many who are retired military. Other areas that are in the vicinity of NASWI and the Puget Sound EOD ranges include Camano Island across the Saratoga Passage, Port Townsend across the Admiralty Inlet, Coyle in Jefferson County, and Poulsbo and Silverdale on the Kitsap peninsula.

Current Requirements and Practices

Long-range advance notice of scheduled activities times are made available to the public and the commercial fishing community via the internet (http://www.uscg.mil/safeports/west_coast/puget_sound/). The local 13th District United States Coast Guard (USCG) NOTMARs may be found at: http://www.navcen.uscg.gov/lnm/d13/. The FAA NOTAM may be found on the FAA publication webpage: http://www.faa.gov/airports_airtraffic/air_traffic/publications/. These sites provide commercial fishermen, recreational boaters, and other area users notice that the military will be operating in a specific area and will allow them to plan their own activities accordingly. Military actions may temporarily relocate civilian and recreational activities. Schedules will be updated when changes occur with sufficient prior notice. If activities are cancelled at any time, this information is posted and the area is identified as clear for public use (U.S. Navy 2007). To minimize potential military/civilian interactions, the Navy would continue to publish scheduled potentially hazardous training activities using the NOTAM and NOTMAR systems as applicable.

3.14.2 Environmental Consequences

3.14.2.1 Approach to Analysis

This analysis investigates the potential for activities associated with the considered alternatives to noticeably affect (either adversely or beneficially) socioeconomic activity in the NWTRC. Typical socioeconomic analysis considerations include an action's impacts on employment, population, income, economic growth, and associated effects such as the need for schools, roads, or other infrastructure improvements. Such changes, if they occur, have the potential to affect the local or regional environment. Other potentially affected socioeconomic activities specific to the NWTRC and the Seattle region include commercial sea and air transport, commercial and sport fishing, recreational diving, and other ocean-based tourism.

Within the boundaries of the NWTRC, all military and civilian activities and their potential socioeconomic impacts are considered. Assessed herein are changes in activities or related expenditures for military facilities construction, equipment, or supplies within the NWTRC that are directly associated with the proposed alternatives and that would affect the socioeconomics of the NWTRC.

Implementation of any of the alternatives, including the Proposed Action, would not produce a direct increase in personnel or employment opportunities within the NWTRC. However, any indirect socioeconomic impacts attributable to proposed activities that produce substantial shifts in population or employment trends or adversely affect regional spending and earning patterns must also be considered. The magnitude of potential impacts depends in large part on the location of the Proposed Action.

Potential effects on socioeconomic activities or on population, employment, housing, and public service provision within the NWTRC area are addressed for each alternative.

3.14.2.2 No Action Alternative

Offshore Area

Civilian activities currently conducted in the NWTRC include commercial shipping, commercial fishing, sport fishing/diving, and tourist-related activities. These activities make an appreciable contribution to the overall economy of Pacific Northwest region. Temporary range clearance procedures for safety purposes do not adversely affect these economic activities because displacement is of short duration. The Navy has performed military activities within this region in the past and has not precluded fishing in the NWTRC, even during peak seasons. Similarly, recreational boating, sailing, or diving has not been precluded either. When hazardous training needs to be conducted in the Offshore Area, a NOTMAR is issued. This measure provides mariners with Navy use areas in advance, which allows non-participants to select an alternate destination without appreciable affect to their activities. To help manage competing demands and maintain public access in the NWTRC, the Navy conducts its offshore activities in a manner that minimizes restrictions to commercial fisherman (U.S. Navy 2007). Similarly, activities performed within the OPAREAs rarely affect divers due to the infrequency of diving in these areas.

For years, fisheries in various parts of the world have complained about declines in their catch after acoustic activities (including naval exercises) moved into the area, suggesting that noise is seriously altering the behavior of some commercial species. The potential of Navy activities, specifically those in the proposed action, to impact fish species is analyzed in this EIS/OEIS in Section 3.7 (Fish).

In summary, some marine fish may be able to detect mid-frequency sounds; most marine fish are hearing generalists and have their best hearing sensitivity below mid-frequency sonar. If they occur, behavioral responses would be brief, reversible, and not biologically significant. Sustained auditory damage is not expected. Sensitive life stages (juvenile fish, larvae and eggs) very close to the sonar source may experience injury or mortality, but area-wide effects would likely be minor. The use of Navy mid-frequency sonar would not compromise the productivity of fish or adversely affect their habitat.

Explosive activities conducted within the Offshore Area include Anti-Surface Warfare (ASUW) and Anti-Submarine Warfare (ASW) training; these activities are typically conducted within W-237. Only a small number of fish may be injured or killed locally by explosive ordnance use in these areas because there are no resident populations in these open water areas. Therefore, these actions are not expected to have any significant impacts to fish populations.

Many different types of commercial fishing gear are used in the NWTRC: drift gillnets, longline gear, troll gear, trawls, seining, and traps or pots occur. Trawling or trolling is used for flatfish and demersal species which account for a small percent of the fishing in the entire NWTRC. Damage to fishing gear from Navy mine and submarine warfare activities in the Offshore Area is rare. When damage does occur to commercial fishing gear due to Navy actions (i.e., net entanglement, destructions of buoys), the fishermen (or the owner of the property damaged) can file a claim with the Department of Navy under the Federal Tort Claims Act ("FTCA") under the provisions of 28 United States Code Section 2671, et seq. and request reimbursement. Forms for filing an FTCA claim can be obtained from any Naval Legal Service Office. Reimbursement requests must be made within two years of incurring damage.

Inshore Area

Navy activities in the Inshore Area entail scheduling procedures and temporary civilian inconvenience during activities. Only one specific area around Whidbey Island is deemed a Restricted Area. The MOAs entail overflight traffic which has only an aesthetic impact to the areas. The counties of Okanogan, Ferry, Stevens, and Pend Orielle do not have socioeconomic effects associated with Navy activities.

Certain areas within NWTRC involve sonar. Of the three types of sonar (high-, mid-, and low-frequency), mid- frequency and low-frequency have the greatest potential to affect humans. The Naval Sea Systems Command Instruction (NAVSEAINST) 3150.2, "Safe Diving Distances from Transmitting Sonar," is the Navy's governing document for human divers in relation to mid-frequency active (MFA) sonar systems; it provides procedures for calculating safe distances from active sonars. This is discussed in detail within Public Health and Safety (Section 3.16.2.2).

The Navy temporarily limits public access to areas where there is a risk of injury or property damage. Locations of all popular dive sites are well documented and the Navy restricts access to certain areas within the range by notifying divers of hazardous activities through the use of NOTMARs. Activities temporarily prevent civilian activities and would not have an effect on socioeconomic interests.

3.14.2.3 Alternative 1

Offshore Area

The increase in activities for the NWTRC, including the Offshore Area, amounts to a 17.3 percent increase in the training activities. The increased training tempo associated with increase in range clearance would not cause a considerable impact due to advanced public notification and primarily short-term duration of military activities.

To minimize potential military/civilian interactions with all activities, the Navy would continue to publish scheduled potentially hazardous training activities using the NOTAM and NOTMAR systems as applicable. This ensures that commercial and recreational users are aware of the Navy's plans, and allows users to plan their activities to avoid the scheduled activity (U.S. Navy 2007).

Inshore Area

Under Alternative 1, EOD activities would decrease from 60 to 4 Mine Countermeasures activities. Otherwise, activities would increase by 17.3 percent over the No Action Alternative. Activities associated with Alternative 1 would not have any new effects on socioeconomic interests; as a result, socioeconomic impacts would not occur.

3.14.2.4 Alternative 2-Preferred Alternative

Offshore Area

The increase in activities in the NWTRC amounts to approximately a 31 percent increase in all activities in the Offshore Area. The increased training tempo associated with range clearance would not cause a considerable impact due to advanced public notification and primarily short-term duration of military activities.

Alternative 2 includes two range enhancements with the potential to cause a socioeconomic impact to the Offshore Area; a Portable Undersea Tracking Range (PUTR) and an underwater training minefield.

- Portable Undersea Tracking Range. The PUTR involves the temporary placement of seven electronics packages (sensors) on the seafloor, each approximately 3 ft long by 2 ft in diameter. Although no candidate locations have yet been identified, the electronic packages would be placed in water depths greater than 600 ft, at least 3 nm from land. Because this is a temporary installation—to be recovered once training is complete—no permanent restricted areas would be designated. While use of the range by Fleet ships and aircraft would have no socioeconomic impact to the region, the gear placement on the seafloor could be incompatible with certain commercial fishing activities. The Navy would have to establish a temporary restricted area which would limit any activity that could damage or disturb the sensors. This could place an economic hardship on commercial fishing enterprises if the range is deployed in a viable fishing area.

- Underwater training minefield. An underwater minefield would be permanently installed on the seafloor in a location not yet determined. The minefield, approximately 15 mine-like shapes anchored to the seafloor in a 2-nm by 2-nm area, would be used by submarines for mine location and avoidance training. Requirements for the minefield training dictate that the mine shapes would be tethered to the ocean floor in water depth of 500 to 600 ft (150 to 185 m) and rising to within 400 to 500 ft (120 to 150 m) of the ocean surface. While use of the range by Navy submarines would have no socioeconomic impact to the region, the mine shapes' placement on the seafloor could be incompatible with commercial fishing and some research activities. The Navy would have to establish a permanent restricted area which would limit any activity that could damage or disturb the sensors. This could place an economic hardship on commercial fishing enterprises if the range is deployed in a viable fishing area.

Other proposed activities such as the Electronic Combat (EC) threat simulators/targets would be part of Alternative 2 in the offshore areas as well. This activity consists of a fixed radio transmitter on land and would not have any effect on socioeconomic interests in the OPAREAs. Additionally, the proposal for commercial air and surface target services would bring some economic benefit to businesses hired to haul target banners and barges.

To minimize potential military/civilian interactions with all activities, the Navy would continue to publish scheduled potentially hazardous training activities using the NOTAM and NOTMAR systems as applicable. This ensures that commercial and recreational users are aware of the Navy's plans, and allows users to plan their activities to avoid the scheduled activity (U.S. Navy 2007).

Inshore Area

Under Alternative 2, EOD activities would decrease from 60 to 4 Mine Countermeasures activities. Otherwise, activities would increase by approximately 31 percent over the No Action Alternative. Activities associated with Alternative 2 would not have any new effects on socioeconomic interests; as a result, socioeconomic impacts would not occur.

3.14.3 Mitigation Measures

As described in Section 3.14.2, the proposed action would result in no significant impacts. Therefore, no mitigation measures are required.

3.14.4 Summary of Effects by Alternative

Table 3.14-2: Summary of Effects – Socioeconomics

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Navy activities in the areas around Whidbey Island, the EOD ranges, nearshore OPAREAs, and inland OPAREAs entail range clearance procedures and temporary civilian inconvenience during activities. Only one specific area around Whidbey Island is deemed a Restricted Area. Training activities do not have an effect on socioeconomic interests. • Limitations on recreational use of areas on a regular basis have been chosen as the least restrictive area possible for Navy activities to be conducted. • Fish and marine wildlife populations are currently at healthy population levels; commercial and recreational fishing is not affected by current Navy action.	• Impacts would be similar to those described for the No Action Alternative for territorial waters.
Alternative 1	• Navy activities in the areas around Whidbey Island, the EOD ranges, nearshore OPAREAs, and inland OPAREAs entail range clearance procedures and temporary civilian inconvenience during activities. Only one specific area around Whidbey Island is deemed a Restricted Area. Activities do not have an effect on socioeconomic interests. • Limitations on recreational use of areas on a regular basis have been chosen as the least restrictive area possible for Navy activities to be conducted. • Fish and marine wildlife populations are currently at healthy population levels; commercial and recreational fishing would not be affected by proposed Navy action. • EOD activities involving underwater demolitions will be decreasing from 60 to 4 activities per year.	• Impacts would be similar to those described for the No Action Alternative for territorial waters.
Alternative 2 (Preferred Alternative)	• Navy activities in the areas around Whidbey Island, the EOD ranges, nearshore OPAREAs, and inland OPAREAs entail range clearance procedures and temporary civilian inconvenience during activities. Only one specific area around Whidbey Island is deemed a Restricted Area. Activities do not have an effect on socioeconomic interests. • Limitations on recreational use of areas on a regular basis have been chosen as the least restrictive area possible for Navy activities to be conducted. • Fish and marine wildlife populations are currently at healthy population levels; commercial and recreational fishing would not be affected by proposed Navy action. • EOD activities involving underwater demolitions will be decreasing from 60 to 4 activities per year. • Portable Undersea Tracking Range (temporary installation) and the permanent underwater training minefield could have negative economic impacts to commercial fishing.	• Impacts would be similar to those described for the No Action Alternative for territorial waters.

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3.15 Environmental Justice & Protection of Children

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3.15 ENVIRONMENTAL JUSTICE AND PROTECTION OF CHILDREN

3.15.1 Environmental Justice

Executive Order 12898 (EO 12898), *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, was issued on February 11, 1994. This EO requires each Federal agency to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies and activities on minority populations and low-income populations in the United States and its territories and possessions. The Environmental Protection Agency (EPA) and the Council on Environmental Quality (CEQ) have emphasized the importance of incorporating environmental justice review in the analyses conducted by Federal agencies under the National Environmental Policy Act (NEPA) and of developing protective measures that avoid disproportionate environmental effects on minority and low-income populations. Objectives of this EO as it pertains to this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) include development of Federal agency implementation strategies and identification of minority and low-income populations where proposed Federal actions have disproportionately high and adverse human health or environmental effects.

3.15.2 Protection of Children

The President issued EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, in 1997. This order requires that each Federal agency "(a) shall make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children; and (b) shall ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks."

3.15.3 Affected Environment

3.15.3.1 Offshore Area

The Northwest Training Range Complex (NWTRC) includes the Offshore Area, off the coasts of Washington, Oregon, and northern California. The Offshore Area consist of open water, where no permanent human populations exist. Further, all flight plans and vessel routes are such that they will not affect any population centers.

3.15.3.2 Inshore Area

Military support facilities within the Inshore Area that would possibly have an effect on civilian populations cover small areas within the following counties: Clallam, Island, Kitsap, Jefferson, San Juan, Snohomish, Skagit, Whatcom, Okanogan, Ferry, Stevens, and Pend Orielle.

Navy aircraft conduct training over much of the State of Washington in Military Operating Areas (MOAs). Although the airspace floor in these areas is as low as 300 ft above the ground, most of the activities are conducted at higher altitudes with no discernable impact to the public. Therefore, the counties that lie beneath these areas are not considered for analysis in this EIS/OEIS.

Minority Population Trends

Table 3.15-1 provides the ethnic composition for source receptor areas (SRAs) within the NWTRC range of influence (ROI). In comparison to the State of Washington, the counties analyzed have a lower minority population percentage than the State as a whole except for Ferry and Okanogan counties. These two counties contain more than the state average of minority populations but still contain primarily non-Hispanic white residents.

Table 3.15-1: Population and Race for the NWTRC Inshore Area

	Racial Classifications				
			Minority		
County	Total Percent	Non-Hispanic White	Non-Hispanic Other Races	Hispanic[1]	Total
Clallam	100.0	87.8	8.8	3.3	12.2
Island	100.0	85.5	10.6	4.0	14.5
Kitsap	100.0	82.7	13.1	4.1	17.3
Jefferson	100.0	91.5	6.2	2.3	8.5
San Juan	100.0	94.1	3.5	2.4	5.9
Skagit	100.0	83.5	5.3	11.2	16.5
Snohomish	100.0	83.8	11.5	4.7	16.2
Whatcom	100.0	86.6	8.1	5.2	13.4
Okanogan	100.0	72.0	13.6	14.4	28.0
Ferry	100.0	76.2	21.0	2.8	23.8
Stevens	100.0	89.6	8.6	1.8	10.4
Pend Orielle	100.0	92.7	5.3	2.1	7.3
State of Washington	**100.0**	**81.8**	**10.7**	**7.5**	**18.2**

Source: U.S. Census Bureau, Census 2000.

[1] In accordance with the Office of Management and Budget (OMB) racial classification, Hispanic is not a race category. A Hispanic person can be racially White, Black, or any other race.

Low-Income Population Trends

Table 3.15-2 depicts poverty and household income data for counties in the NWTRC ROI as compared to Washington State data.

Table 3.15-2: Families and Individuals at the Poverty Level within the Inshore Area

	Families		Individuals	
County	Below the poverty level	Percent Below the Poverty Line[1]	Below the poverty level	Percent Below the Poverty Line
Clallam	1,613	8.9	7,825	12.5
Island	1,036	5.1	4,895	7.0
Kitsap	3,866	6.3	19,601	8.8
Jefferson	548	7.2	2,899	11.3
San Juan	241	6.0	1,286	9.2
Snohomish	7,717	4.9	41,024	6.9
Skagit	2,161	7.9	11,244	11.1
Whatcom	3,231	7.8	23,003	14.2
Okanogan	1,697	16.0	8,311	21.3
Ferry	262	13.3	1,368	19.0
Stevens	1,278	11.5	6,316	15.9
Pend Orielle	445	13.6	2,095	18.1
State of Washington	**110,663**	**7.3**	**612,370**	**10.6**

Source: U.S. Census Bureau, Census 2000.

Protection of Children

Regulatory actions covered under EO 13045 include those that may be "economically significant" (under EO 12866 [*Regulatory Planning and Review*]) and "concern an environmental health risk or safety risk that an agency has reason to believe may disproportionately affect children." Furthermore, EO 13045 defines "environmental health risks and safety risks [to] mean risks to health or to safety that are attributable to products or substances that the child is likely to come in contact with or ingest (such as the air we breathe, the food we eat, the water we drink or use for recreation, the soil we live on, and the products we use or are exposed to).” To comply with the EO, this document addresses child-specific environmental health and safety risks.

Population estimates based upon the 2000 Census identify the population of children residing in the surrounding areas. The data are for Clallam, Island, Kitsap, Jefferson, San Juan, Skagit, Snohomish, Whatcom, Okanogan, Ferry, Stevens, and Pend Orielle counties. Demographic census data are broken down by age into five-year increments up through age 19 (Table 3.15-3). To correspond to this age distribution of the available data, individuals are considered in this analysis to be children from birth to 19 years of age. Table 3.15-3 also shows the distribution of children among the age groups is relatively uniform and represents a small portion of the population for each county.

Table 3.15-3: Age Distribution by Percentage for the NWTRC Puget Sound OPAREAs

County	Under 5 years	5-9 years	10-14 years	15-19 years	Total Population
Clallam	5.1	5.8	6.7	7.0	64,525
Island	6.7	7.2	7.3	6.6	71,558
Kitsap	6.7	7.5	7.8	7.4	231,969
Jefferson	4.1	5.4	6.3	5.9	25,953
San Juan	3.7	5.2	6.7	5.2	14,077
Skagit	6.5	7.3	7.7	7.7	102,979
Snohomish	7.2	7.8	7.9	7.1	606,024
Whatcom	6.1	6.8	7.0	8.4	166,814
Okanogan	6.3	7.6	8.5	7.9	39,564
Ferry	5.4	6.9	8.1	9.6	7,260
Stevens	6.1	7.8	9.0	8.4	40,066
Pend Orielle	5.4	6.9	8.7	7.5	11,732

Source: U.S. Census Bureau, Census 2000.

Children do not constitute a substantial percentage of the population for any of the counties within the ROI (less than 30%). However, children do constitute a substantial portion of the population in residential and recreational areas, and in certain institutions (e.g., schools, daycares, private schools). Transportation, residential, commercial, recreational, and open space uses are the dominant land uses in and near NWTRC areas which are not areas where children typically congregate. The NWTRC ROI encompasses approximately 50 school districts. Together these districts encompass approximately 150 elementary, middle, and high schools statewide. Parks and playgrounds are typically found in the vicinity of schools. Local parks and playgrounds typically increase the number of children in an area. The presence of daycare facilities and other private schools may also contribute to an increase in the number of children in a particular area. Within the Puget Sound, daycare facilities on Whidbey Island include approximately 28 centers within Oak Harbor, 6 around Langley, 5 within Coupeville, and a few others in major towns on the island. Daycare within other parts of the NWTRC ROI is centered upon city hubs and larger towns just as elementary, middle, and high schools to better serve the community.

3.15.4 Environmental Consequences

3.15.4.1 Approach to Analysis

Environmental factors related to Environmental Justice or Protection of Children are identified and assessed for disproportionate effects on minority populations, low-income populations, or populations of children.

3.15.4.2 No Action Alternative

Offshore Area

As noted in Section 3.15.3.1, no permanent human populations exist in the Offshore Area. No effects are possible without resident populations. Therefore, no disproportionately high and adverse human health or environmental effects on minority or low-income populations would occur with implementation of the No-Action Alternative, nor would implementation of the proposed action have the potential for causing environmental health or safety risks to children.

Inshore Area

As noted in Section 3.15.3.2, Navy activities occurring in Washington State have possible effects to individuals within a number of nearby counties but no disproportionate effects to minority/low-income populations or populations of children. In addition, no public health or safety impacts have been identified with regard to ongoing activities within the Inshore Area. Navy land activities account for a small percentage of total activities within the NWTRC. Activities within Puget Sound include Explosive Ordnance Disposal (EOD) sites at Crescent Harbor, Indian Island, and Naval Base Kitsap (NBK)-Bangor. None of these activities have impacts which disproportionately affect minority/low-income populations or populations of children. The remaining activities within the Puget Sound areas are air activities, research, development, test and evaluation (RDT&E) activities, and support operations. As stated in Section 3.15.3.3, Navy aircraft conduct training over northern counties of the State of Washington is in Military Operating Areas (MOAs). Although the airspace floor in these areas is as low as 300 ft above the ground, most of the activities are conducted at higher altitudes with no discernable impact to the public as a whole. Therefore, the counties that lie beneath these areas are not considered for analysis in possible effects to minority or low-income populations. Based on these activities, there would be no disproportionately high and adverse human health or environmental effects of the Navy's programs, policies, or activities on minority/low-income populations or populations of children.

3.15.4.3 Alternative 1

Offshore Area

As noted in Section 3.15.3.1, no permanent human populations exist in the Offshore Area. No impacts will occur through implementation of Alternative 1 and therefore, no disproportionately high and adverse human health or environmental effects on minority or low-income populations would occur with implementation of Alternative 1, nor would implementation of the proposed action have the potential for causing environmental health risks or safety risks to children because there are no populations of children present.

Inshore Area

As noted in Section 3.15.3.2, Navy activities occurring in Washington State have possible effects to individuals within a number of nearby counties. The overall increase in activities from baseline (no action) to Alternative 1 would be less than 20 percent. Navy land activities account for a small percentage of total activities within the NWTRC. Activities within Puget Sound include EOD sites at Crescent Harbor, Indian Island, and NBK-Bangor. Operational tempo from underwater EOD training would decrease significantly (from 60 to 4 annual activities) and no new activities will be added.

The remaining activities within the Puget Sound and inland areas are air activities, RDT&E, and support activities. Air activities entail takeoffs and landings at Whidbey Island and the following of designated flight plans to and from inland MOAs or offshore warning areas. However, airfield activities are not within the scope of this EIS/OEIS. RDT&E and support activities entail intelligence, surveillance, reconnaissance, and unmanned aerial vehicle training. Sound levels in the ROI will decrease as a result of replacing the EA-6B with the new EA-18G Growler. As stated in Section 3.15.3.3, Navy aircraft conduct training over northern counties of the State of Washington is in Military Operating Areas (MOAs).

Although the airspace floor in these areas is as low as 300 ft above the ground, most of the activities are conducted at higher altitudes with no discernable impact to the public as a whole. Therefore, the counties that lie beneath these areas are not considered for analysis in possible effects to minority or low-income populations. No air activities, RDT&E, or support activities would impact minorities/low-income populations or children any more than the rest of the population. Based on these activities, there would be no disproportionately high and adverse human health or environmental effects of the Navy's programs, policies, or activities on minorities/low-income populations or children.

3.15.4.4 Alternative 2 Preferred Alternative

Inshore activities proposed under Alternative 2 would have all the components of the No Action Alternative, but the training tempo would increase. However, the increases would occur in existing areas, with no disproportionate effect on any population groups or children.

In addition, Alternative 2 includes two range enhancements in the Offshore Area; a Portable Undersea Tracking Range (PUTR) and an underwater training minefield.

- Portable Undersea Tracking Range. The PUTR involves the temporary placement of seven electronics packages on the seafloor, each approximately 3 ft long by 2 ft in diameter. Although no candidate locations have yet been identified, the electronic packages would be placed in water depths greater than 600 ft, at least 3 nm from land. Because this is a temporary installation—to be recovered once training is complete—no formal restricted areas would be designated and no limitations would be placed on commercial or civilian use, thus limiting impacts.
- Underwater training minefield. An underwater minefield would be permanently installed on the seafloor in a location not yet determined. The minefield would be used by submarines for mine location and avoidance training. Requirements for the minefield training dictate that the mine shapes would be tethered to the ocean floor in water depth of 500 to 600 ft (150 to 185 m) and rising to within 400 to 500 ft (120 to 150 m) of the ocean surface. Because the mine shapes are well below the ocean surface, and the training would be conducted by submerged submarines, there are no expected impacts.

Offshore Area

As noted in Section 3.15.3.1, no permanent human populations exist in the Offshore Area. No impacts will occur through implementation of Alternative 2 and therefore, no disproportionately high and adverse human health or environmental effects on minority or low-income populations would occur with implementation of Alternative 2, nor would implementation of the proposed action have the potential for causing environmental health risks or safety risks to children because there are no populations of children present.

Inshore Area

As noted in Section 3.15.3.2, Navy activities occurring in Washington State have possible effects to individuals within a number of nearby counties. Navy land activities account for a small percentage of total activities within the NWTRC. Activities within Puget Sound include EOD sites at Crescent Harbor, Indian Island, and NBK-Bangor. Operational tempo for underwater EOD training would decrease significantly (from 60 to 4 annual activities) and no new activities will be added.

The remaining activities within the Puget Sound and inland areas are air activities, RDT&E, and support activities. Air activities entail takeoffs and landings at Whidbey Island and the following of designated flight plans to and from inland MOAs or offshore warning areas. However, airfield activities are not within the scope of this EIS/OEIS. RDT&E and support activities entail intelligence, surveillance, reconnaissance, and unmanned aerial vehicle training. Sound levels in the ROI will decrease as a result of replacing the EA-6B with the new EA-18G Growler. As stated in Section 3.15.3.3, Navy aircraft conduct training over northern counties of the State of Washington is in Military Operating Areas (MOAs). Although the airspace floor in these areas is as low as 300 ft above the ground, most of the activities are conducted at higher altitudes with no discernable impact to the public as a whole. Therefore, the counties that lie beneath these areas are not considered for analysis in possible effects to minority or low-income populations. No air activities, RDT&E, or support activities would impact minorities/low-income populations or children any more than the rest of the population. Based on these activities, there would be no disproportionately high and adverse human health or environmental effects of the Navy's programs, policies, or activities on minorities/low-income populations or children.

3.15.5 Mitigation Measures

Due to the absence of impacts related to Environmental Justice or Protection of Children, no mitigation measures are necessary.

3.15.6 Summary of Effects by Alternative

Table 3.15-4 summarizes the Environmental Justice (EO 12898) and Protection of Children (EO 13045) effects of the No Action Alternative, Alternative 1, and Alternative 2.

1 **Table 3.15-4: Summary of Effects – Environmental Justice and Protection of Children**

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO 12114 (Non-U.S. Territorial Waters)
No Action Alternative	**Environmental Justice** • No permanent human populations exist in the NWTRC Ocean OPAREAs. Therefore, no disproportionate effects on minority or low-income populations currently occur. • Navy activities occurring within Puget Sound OPAREAs have possible effects to populations within a number of nearby counties. Land activities account for a small percentage of total activities within the NWTRC. Activities conducted consist of air activities, undersea EOD activities, RDT&E, and support operations. None of these activities have a disproportionate effect on populations of minority or low-income populations. • Navy activities occurring within Inland OPAREAs have possible effects to populations within a number of nearby counties. None of the proposed activities have a disproportionate effect on populations of minority or low-income populations. **Protection of Children** • No human populations exist in the NWTRC OPAREAs. Therefore, no disproportionate risks to children currently occur. • There are no populations of children disproportionately affected by Navy activities within the Puget Sound OPAREAs. Land activities account for a small percentage of total activities within the NWTRC. Activities conducted consist of air activities, undersea EOD activities, RDT&E, and support activities. None of these locations are near populations of children that are disproportionately affected. • There are no populations of children disproportionately affected by Navy activities within the Inland OPAREAs. None of these locations are near populations of children that are disproportionately affected.	• No permanent human populations exist in the NWTRC OPAREAs outside of territorial waters. Therefore, no disproportionate effects on minority or low-income populations or health and safety risks to children would occur.
Alternative 1	• Impacts to Environmental Justice and Protection of Children would be the same as in the No Action Alternative	• Impacts to Environmental Justice and Protection of Children would be the same as in the No Action Alternative
Alternative 2 (Preferred Alternative)	• Impacts to Environmental Justice and Protection of Children would be the same as in the No Action Alternative	• Impacts to Environmental Justice and Protection of Children would be the same as in the No Action Alternative

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3.16 Public Safety

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3.16 PUBLIC SAFETY

Public safety issues include potential hazards inherent in flight activities, vessel movements, underwater detonations, offshore use of sonar, and onshore explosives training. It is Navy policy to prevent personal injury or property damage by observing every possible precaution in the planning and execution of all activities that occur onshore or offshore.

Impacts to public health and safety are assessed in terms of the potential of Navy training activities to injure or compromise civilians in any way. Impacts may arise from physical injury directly from hazardous activities or as an indirect result of hazardous materials expended from a training event. Stressors that would likely impact public health and safety include surface and subsurface ship movements, aircraft movements, use of explosives, torpedoes, missiles and various ordnance, lasers, expended materials, radio frequencies, aircraft noise, and use of offshore sonar that may affect divers. These stressors were identified by conducting a detailed analysis of the warfare areas, geographic location, and specific activities included in the alternatives.

3.16.1 Affected Environment

3.16.1.1 Offshore Area

Military, commercial, institutional, and recreational activities take place in the Northwest Training Range Complex (NWTRC). The Federal Aviation Administration (FAA) has established Warning Areas (W-) for military aircraft activities; however, most of the airspace and seaspace is available for co-use most of the time. The PACNW Ocean Surface/Subsurface OPAREA is the only range in the Northwest available for naval surface ship live firing. The OPAREA also hosts aircraft bombing exercises (not authorized in the Olympic Coast National Marine Sanctuary), several of which involve the use of laser-guided weapons. The OPAREA is used for the full range of naval ordnance. Only hazardous activities require exclusive use of an area, and these are scheduled and broadcast by the Navy through Notices to Mariners (NOTMARs) and Notices to Airmen (NOTAMs).

The public typically accesses the offshore ocean areas for recreational purposes such as sport fishing, sailing, boating, tourist-related activities (sightseeing and whale watching), diving, and swimming. Public access to offshore marine areas is a safety concern for the Navy because its activities occur primarily in international waters. Warning Areas 237, 570, and 93 (W-237, W-570, and W-93) are special use airspaces (SUAs) lying over international waters and special use surface and subsurface training ranges where the Navy conducts hazardous activities, including missile firings, naval gunfire, and air-to-surface ordnance delivery. Commercial and recreational vessels generally are allowed to operate in the operating areas (OPAREAs). During training events or exercises in these offshore areas, weapons delivery events are delayed or cancelled if range areas are not clear. Prior to issuing a "Green Range," Navy personnel must ensure that the hazard footprint of the ordnance being fired is clear of non-participating surface vessels, divers, and aircraft.

3.16.1.2 Inshore Area

The Inshore Area includes air, surface, and land ranges. Several military operating areas (MOAs), alert areas (A-), and restricted areas (R-) exist throughout the Inshore Area of the NWTRC (Figure 3.16-1, Table 3.16-1). These areas have been identified and described in 33 Code of Federal Regulation (C.F.R.) Parts 110, 165, and 334 as restricted to naval aircraft or vessels (as appropriate) only or as presenting a significant hazard to mariners or aviators.

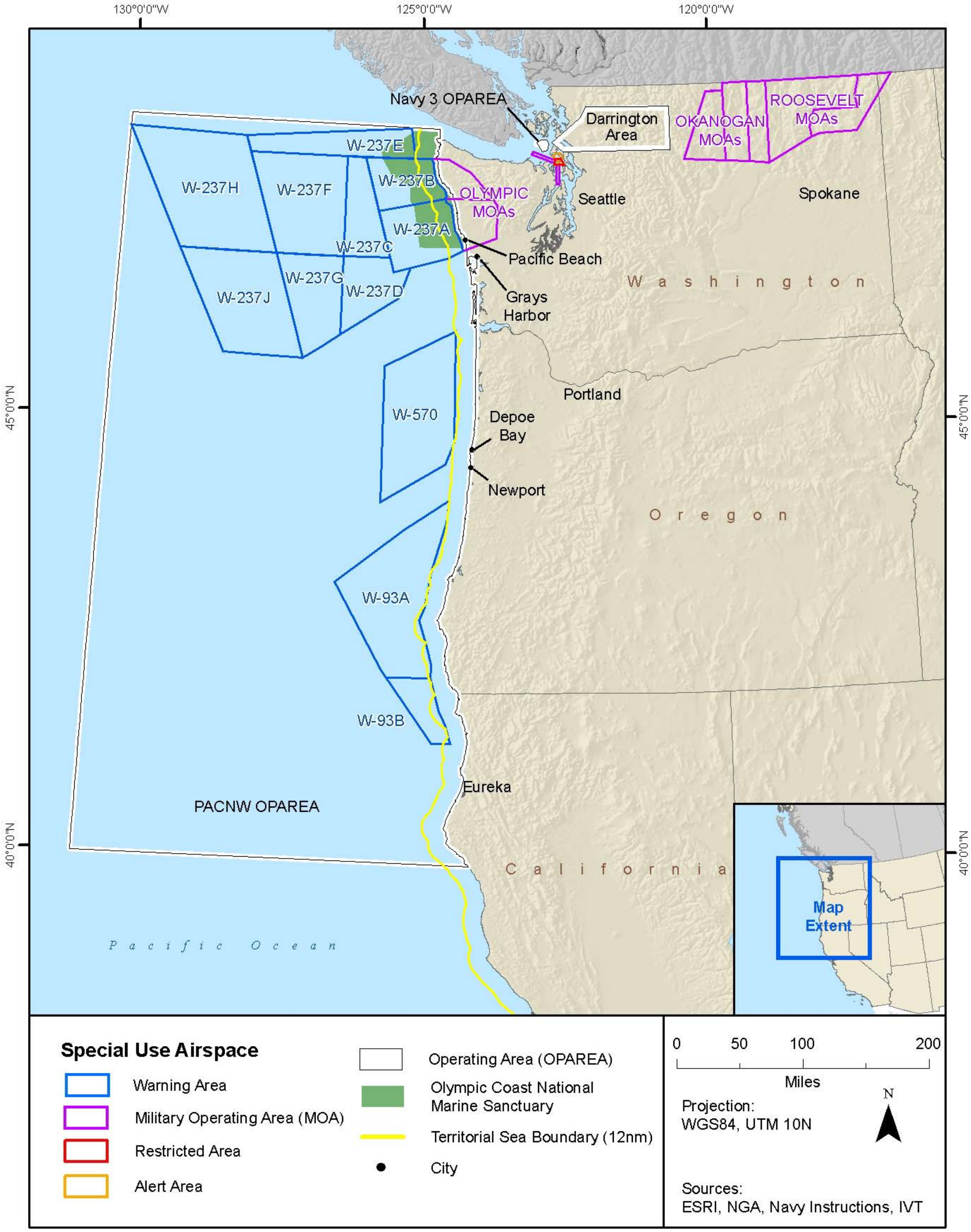

Figure 3.16-1: NWTRC Operating Areas, Alert Areas, and Restricted Areas

Table 3.16-1: NWTRC Operating Areas, Alert Areas, and Restricted Areas

Range/ Training Site	Training Environment	Type of Training Activity	Public Use
PACNW Surface/Subsurface OPAREA	Surface Subsurface Air	Surface Ship Gunnery Exercises (GUNEX), Surface-to-Air Missile Exercises, Air-to-Surface Bombing Exercises (BOMBEX-Sea), Sinking Exercise (SINKEX), Antisubmarine Warfare Tracking Exercises (ASW TRACKEX), Intelligence, Surveillance, and Reconnaissance (ISR), Unmanned Aerial System Research, Development, Test, and Evaluation	When not in use by the Navy, available for public boating, diving, and fishing. The public is informed of danger zone activities through NOTMARs at the USCG website; http://www.navcen.uscg.gov/lnm/d13/, and NOTAMs through the FAA website.
W-237	Surface Subsurface Air	Air Combat Maneuver (ACM), Air-to-Air Missile Firing Exercise, GUNEX, Surface-to-Air Missile Firing Exercise, BOMBEX (Sea), SINKEX, ASW TRACKEX, Electronic Combat (EC), HARM Exercises, ISR, Unmanned Aerial Systems Flight Ops (UAS) Training and UAS RDT&E	Airspace is off limits unless released to FAA. The public is informed of danger zone activities through NOTMARs, and NOTAMs. Surface areas are cleared before commencement of Navy training activities.
W-570	Air	ISR	Airspace is off limits to private and commercial traffic.
W-93	Air	ISR	Same as W-570.
Olympic Military Operating Area (MOA)	Air	ACM, Simulated HARM Missile Firing Exercise (HARMEX)	Same as W-570.
Darrington Area	Air	EC	Same as W-570.
Okanogan MOA	Air	ACM, HARMEX	Same as W-570.
Roosevelt MOA	Air	ACM, HARMEX	Same as W-570.
Admiralty Bay Range (Includes Chinook MOA and R-6701)	Surface Air	UAS RDT&E, MINEX (Historic)	Same as W-570.
Navy 3 OPAREA	Surface	Ship Unit Level Training	Not restricted but presenting a significant hazard to mariners.
Explosive Ordnance Disposal (EOD) Underwater Ranges: -Crescent Harbor -Seaplane Base -Floral Point Demolition Training Range (DTR): -Bangor DTR -Seaplane Base DTR	Land Subsurface	Mine Countermeasures and Land Demolitions (includes underwater detonations and on-land detonations)	Land area is off limits and controlled by fencing. Waters are not restricted. Waters are monitored by Navy personnel prior to exercise to prevent private vessels and divers out of the training area.
OLF Coupeville, Crescent Harbor	Land Surface	Insertion/Extraction	Land area is off limits and controlled by fencing. Waters are not restricted.
Indian Island	Land	Naval Special Warfare Training	Land area is off limits and controlled by fencing.
Survival Area	Land Air	Maneuver training, helicopter training	Land area is off limits and controlled by fencing. Airspace is off limits to private and commercial traffic.

Other designated surface zones within Puget Sound are not continuously restricted. When not in use by the Navy, these areas are accessible by boaters, divers, and fisherman, with nearshore anchorages available. NOTMARs and NOTAMs are issued about hazards of the operation of vessels and aircraft in the vicinity of the NWTRC. Among the surface ranges used by the Navy are those in which Explosive Ordnance Disposal (EOD) personnel conduct underwater demolition training. This training takes place at Crescent Harbor Underwater EOD Range, Indian Island Underwater EOD Range, and Floral Point Underwater EOD Range.

In addition to the air and surface areas, several land ranges are in use in the Inshore Area. On-land demolition training ranges (DTRs) are located at Seaplane Base and at Naval Base Kitsap (NBK) Bangor.

Ordnance Handling

As described in Chapter 2, some NWTRC training activities include use of ordnance. The procedures for handling and storing ordnance are found in Naval Sea Systems Command (NAVSEA) OP 5, *Ammunition and Explosives Ashore: Safety Regulations for Handling, Storing, Production, Renovation, and Shipping* (DoN 2001).

Public Access and Proximity

Table 3.16-1 identifies continuously restricted areas and other designated zones that are not continuously restricted, including nearshore ocean areas that are within hazard areas of onshore training activities. When not in use by the Navy, the NWTRC offshore and nearshore areas are available to civilian vessels (e.g., the Olympic Coast National Marine Sanctuary). NOTMARs and NOTAMs are issued to notify the public about the hazards of operating vessels or aircraft in the vicinity of the NWTRC. Additional current requirements and practices are discussed in the following subsection.

3.16.1.3 Current Requirements and Practices

Navy activities in the OPAREAs comply with numerous established safety procedures to ensure that neither participants nor non-participants engage in activities that would endanger life or property.

Fleet Area Control and Surveillance Facility Safety Procedures

Fleet Area Control and Surveillance Facility (FACSFAC) San Diego has published safety procedures for activities on the offshore and nearshore areas (DoN 1997, 1999, 2004). These guidelines apply to range users.

- Commanders are responsible for ensuring that impact areas and targets are clear prior to commencing hazardous activities.
- In the PACNW OPAREA, the use of underwater ordnance must be coordinated with submarine operational authorities. The coordination also applies to towed sonar arrays and torpedo decoys.
- Aircraft or vessels expending ordnance shall not commence firing without permission of the scheduling authority for their specific range area.
- Firing units and targets must remain in their assigned areas, and units must fire in accordance with current safety instructions.
- Vessels are authorized to fire their weapons only in offshore areas and at specific distances from land, depending on the caliber and range of the weapons fired. The larger the caliber, the farther offshore that the firing must take place.
- The use of pyrotechnic or illumination devices and marine markers such as smoke or dye markers will be allowed only in the assigned areas, to avoid the launch of search and rescue forces when

not required. Aircraft carrying ordnance to or from ranges shall avoid populated areas to the maximum extent possible.

- Aircrews operating in W-237, W-570, and W-93 must be aware that non-participating aircraft are not precluded from entering the area and may not comply with a NOTAM or radio warning that hazardous activities are scheduled or occurring. Aircrews are required to maintain a continuous lookout for non-participating aircraft while operating under visual flight rules in these warning areas.

Navy Standard Operating Procedures

In addition to FACSFAC procedures, the Navy has instituted the following practices for use of the OPAREAs.

Aviation Safety

Aircraft in W-237, W-570, or W-93 fly under visual flight rules and under visual meteorological conditions. This means that the commanders of military aircraft are responsible for the safe conduct of their flight. Prior to releasing any weapons or ordnance, the impact area must be clear of non-participating vessels, people, or aircraft. The officer conducting the exercise (OCE) is ultimately responsible for the safe conduct of range training. A qualified safety officer is assigned to each training event or exercises and can terminate activities if unsafe conditions exist.

Surface Vessel Safety

Surface vessels conduct anti-submarine training against submarines and simulated submarine targets in the OPAREAs. Prior to launching a weapon, vessels are required to determine that all safety criteria have been satisfied, and that the weapons and target recovery conditions and recovery helicopters and boats are ready to be employed.

Submarine Navigation Safety

Submarine navigation safety, while submerged, consists of several methods used to alert submarine navigation crews of potential dangers of collision, both during exercises within warning areas and during transit to and from these exercise areas. Exercise areas are typically closed to sport and commercial fishing vessels during exercises to avoid ensnaring nets being towed by fishing vessels. Closure is communicated through issuance of NOTMARs. The surface is scanned visually and with radar for the presence of such vessels before and during the exercises. During training events or exercises in these offshore areas, weapons delivery events are delayed or cancelled if range areas are not clear. Prior to issuing a “Green Range,” Navy personnel must ensure that the hazard footprint of the ordnance being fired is clear of non-participating surface vessels. During transit to and from exercise areas, submerged submarines use sonar and navigational maps that identify known fishing areas to steer clear of fishing vessels.

Missile Exercise Safety

Safety is the top priority during missile exercises (MISSILEXs). These exercises can be surface-to-surface, subsurface-to-surface, surface-to-air, or air-to-air. A MISSILEX letter of instruction, prepared prior to any missile firing exercise, establishes precise ground rules for the safe and successful execution of the exercise. Any MISSILEX participant who observes an unsafe situation can communicate a “Red Range” order over any voice communication systems.

Aircraft Safety

The DoD established the air installation compatible use zone (AICUZ) program in 1973 to plan for land use compatibility around military air installations, to minimize public exposure to safety hazards from aircraft activities, and to protect the operational capability of an air installation. An AICUZ study analyzes aircraft noise effects, airfield accident potentials, and height and obstruction criteria.

Guidelines for establishing aviation safety zones around helicopter landing zones are identified in Naval Facilities Engineering Command (NAVFAC) P-80.3 and include clear zones and accident potential zones (APZs). Infrequent helicopter activities require designation of a clear zone but not APZs. The clear zone for visual flight rule aircraft is the same as the takeoff safety zone. Takeoff safety zones are the ground areas underneath the aircraft's approach/departure surfaces within 100 feet (30 m) of the ground elevation. This zone is required to be free of obstructions.

Only hazardous activities require exclusive use airspace and these periods are scheduled and broadcast by the Navy through NOTAMs. Navy personnel must ensure that the hazard footprint of the ordnance being fired is clear of non-participating aircraft.

Live and Inert Ordnance Safety

In all cases where live and inert ordnance are expended within the NWTRC, a qualified range safety officer (RSO) is present. Units operating onshore must ensure that the range areas can contain the hazard footprints of the weapons employed. The locations of firing points, impact areas, and surface danger zones form a ground footprint on the land and in the nearshore waters. RSOs ensure that these ground footprints are clear of personnel during activities. After every live-fire event, each participating unit ensures that all weapons are safe and clear of live rounds. The RSOs are also responsible for the emergency medical evacuation of people from the range in case of mishap.

Laser Safety

The Navy has a comprehensive safety program for the use of lasers, which are used for precision range finding and by target designation systems for guided ordnance. Procedures are required to protect individuals from the hazard of severe eye injury due to the nature of the laser light. Members of all units conducting laser training must complete a laser safety course, wear protective goggles, participate in a medical surveillance program, and follow mishap reporting procedures. Laser safety requirements for aircraft require a dry run to ensure that target areas are clear; in addition, during actual laser use, the aircraft run-in headings are restricted to preclude inadvertent lasing of areas where personnel may be present.

Lasers are used occasionally on the offshore, nearshore, and onshore range areas for both precision distance range finding and target designation for guided ordnance. Strict precautions and written instructions are in place and observed by laser users to ensure that no personnel suffer eye injury due to the light energy.

Electromagnetic Radiation Safety

Communications and electronic devices such as radar, electronic jammers, and other radio transmitters produce electromagnetic radiation (EMR). Equipment that produces an electromagnetic field has the potential to generate hazardous levels of EMR. An EMR hazard exists when transmitting equipment generates electromagnetic fields that induce currents or voltages great enough to trigger electro-explosive devices in ordnance, cause harmful effects on people, or create sparks that can ignite flammable substances in the area. This radiation can cause health hazards to people or cause explosive hazards to ordnance or fuels. Hazards are reduced or eliminated by establishing minimum distances from EMR emitters for people, ordnance, and fuels.

EMR is expressed in milliwatts per square centimeter. Its effects are directly proportional to the frequency of the source of EMR. For example, the lower the frequency of the EMR source, the lower the acceptable power density threshold before a potential hazard to human health exists. Likewise, the higher the frequency of the EMR source, the higher the acceptable power density threshold before health effects occur.

Hazards of EMR to personnel, hazards of EMR to ordnance (HERO), and hazards of EMR to fuel have been determined for EMR sources based on frequency and power output.

Sources of EMR include radar, navigational aids, and Electronic Combat (EC). These systems are the same as, or similar to, civilian navigational aids and radars at local airports and television weather stations throughout the United States. EC systems emit EMR similar to that from cell phones, hand held radios, commercial radio, and television stations. Current requirements and practices in place to protect Navy personnel and the public include setting the heights and angles of EMR transmission to avoid direct exposure, posting warning signs, establishing safe operating levels, and activating warning lights when radar systems are operational. To avoid excessive exposures from EMR, military aircraft are operated in accordance with standard procedures that establish minimum separation distances between EMR emitters and people, ordnance, and fuels.

3.16.2 Environmental Consequences

Public safety impacts are considered significant if the general public is substantially endangered as a result of Navy activities on the ranges. For each training activity or group of similar activities, an estimate of risk to the general public was formulated, based on the Navy's current set of safety procedures for range activities. Activities in the NWTRC would be conducted in accordance with guidance provided in Fleet Area Control and Surveillance Facility (FACSFAC) San Diego Instruction 3120.1, *Manual of EASTPAC and MIDPAC Fleet Operating Areas*. The instruction provides operational and safety procedures for all normal range events. Its emphasis is on providing the necessary information to range users so that they can operate safely and avoid affecting nonmilitary activities such as shipping, recreational boating, diving, and commercial or recreational fishing. Several factors were considered in evaluating the effects of the Navy's activities on public safety, including proximity to the public, ownership, access control, scheduling, public notification of events, frequency of events, duration of events, range safety procedures, operational control of training events, and safety history.

3.16.2.1 Approach to Analysis

<u>Data Sources</u>

Available reference materials, including prior environmental assessments (EAs) and environmental impact statements/overseas environmental impact statements (EIS/OEIS), were reviewed and used when activities, policies, equipment, and/or environmental impacts were common to the NWTRC. All current and proposed training activities were examined for the possibility of civilians entering a hazardous training environment that could cause personal injury. Current Navy safety procedures, according to existing Navy instructions, were assessed for whether the procedures would protect the public from hazardous training activities proposed in the alternatives.

<u>Methods</u>

Each alternative analyzed in this EIS/OEIS includes several warfare areas (*e.g.,* Mine Warfare area, Anti-surface Warfare area), and most warfare areas include multiple types of training activities (*e.g.,* surface-to-air gunnery exercise, air-to-surface missile exercise). Likewise, several activities (*e.g.,* weapons firing, target deployment, *etc*.) are accomplished under each area. Accordingly, the analysis is organized by specific activity rather than warfare area or operation (Table 3.16-2).

Table 3.16-2: Potential Stressors Associated with Public Safety

Navy Warfare Area	Activity	Areas	Ordnance	Aircraft/Ship Movement
Anti-Air Warfare	Air Combat Maneuvers	Okanogan, Olympic, and Roosevelt MOAs/ATCAAs	✓	✓
	Air-to-Air Missile Exercise	W-237	✓	✓
	Surface-to-Air Gunnery Exercise	W-237, Pacific Northwest (PACNW) OPAREA	✓	✓
	Surface-to-Air Missile Exercise	W-237, PACNW OPAREA	✓	✓
Anti-Surface Warfare	Surface-to-Surface Gunnery Exercise	W-237, PACNW OPAREA	✓	✓
	Air-to-Surface Bombing Exercise	W-237, PACNW OPAREA	✓	✓
	Sinking Exercise	W-237, PACNW OPAREA	✓	✓
Anti-Submarine Warfare	Antisubmarine Warfare Tracking Exercise – Maritime Patrol Aircraft (MPA)	W-237, PACNW OPAREA	✓	✓
	Antisubmarine Warfare Tracking Exercise - Extended Echo Ranging (EER)	W-237, PACNW OPAREA	✓	✓
	Antisubmarine Warfare Tracking Exercise - Surface Ship	PACNW OPAREA		✓
	Antisubmarine Warfare Tracking Exercise - Submarine	W-237, PACNW OPAREA		✓
Electronic Combat	Electronic Combat (EC) Exercises	W-237A, Darrington Area		✓
Mine Warfare	Mine Countermeasures	Crescent Harbor, Indian Island, Floral Point	✓	✓
	Land Demolitions	DTR Bangor, DTR Seaplane Base	✓	✓
Naval Special Warfare	Insertion / Extraction	Seaplane Base, Naval Outlying Landing Field (OLF) Coupeville, Crescent Harbor		✓
	Naval Special Warfare (NSW) Training	Indian Island		✓
Strike Warfare	High Speed Anti-radiation Missile (HARM) Exercise (Non-firing)	Okanogan, Olympic, and Roosevelt MOAs/ATCAAs, W-237		✓
Support Operations	Intelligence, Surveillance, and Reconnaissance (ISR)	W-237, PACNW OPAREA, including W-570 and W-93.	✓	✓
	Unmanned Aerial Systems (UAS) Research, Development, Test and Evaluation and Training	R-6701 (Admiralty Bay), PACNW OPAREA, W-237		✓

To address potential impacts, the approach to analysis includes characterizing the yearly test and training activities that may contribute to public safety in or near the NWTRC environment. These include missile flights, targets expenditure, ship, boat, and aircraft activities, weapons firing, and items of debris in inert ordnance.

This section of the EIS/OEIS reviews the public safety issues associated with training on the NWTRC. Potential impacts on environmental resources are addressed in other sections of this chapter as appropriate.

3.16.2.2 No Action Alternative

Offshore Area

Under the No Action Alternative Fleet training activities would continue to be conducted in the Offshore Area. Offshore activities can involve expending torpedoes, sonobuoys, or targets from vessels, submarines, or aircraft. The ordnance used in offshore activities includes both live and inert warheads. While activities are in progress, an RSO is always on duty. The RSO can halt an activity if a potentially unsafe condition arises. Range safety officials ensure that projectiles, targets, and missiles are operated safely and that air activities and other hazardous fleet training activities are safely executed in controlled areas.

The U.S. Navy's standard range safety procedures are designed to avoid risks to the public and to Navy activities. When aircraft or surface vessels fire ordnance, range procedures and safety practices ensure that there are no vessels or aircraft in the intended path or impact area of the ordnance. Before any training event would be allowed to proceed, the target area would be determined to be clear using ship sensors, visual surveillance of the range from aircraft and range safety boats, and radar and acoustic data.

The hazard footprint for the ordnance to be used is based on the range of the weapon and includes a large safety buffer to account for the item going off target or functioning prematurely. For activities with a large hazard footprint (e.g., MISSILEXs), special sea and air surveillance measures are taken to search for, detect, and clear the area of intended activities. Aircraft are required to make a preliminary pass over the intended target area to ensure that it is clear of boats, divers, or other non-participants. Aircraft carrying ordnance are not allowed to fly over surface vessels.

For training in which sonobuoys or bombs are released from an aircraft, the aircrew must be able to see the surface of the ocean and visually confirm that the area is clear of boats, aircraft, divers, or other non-participants. If the Navy cannot confirm that the airspace or sea area covered by the target area is clear of non-participants, the activity will either be delayed or cancelled.

Target areas would be cleared of personnel prior to conducting training, so the only public health and safety issue would be if an activity exceeded the safety area boundaries. Risks to public health and safety are reduced, in part, by providing termination systems on some of the missiles. In those cases where a weapon system did not have a flight termination capability, the target area would be determined to be clear of unauthorized vessels and aircraft, based on the flight distance the vehicle can travel plus a 5-mile long area beyond the system performance parameters.

In addition, all training activities must comply with DoD Directive 4540.1, "Use of Airspace by U.S. Military Aircraft and Firings Over the High Seas" (DoD 1981) and Chief of Naval Operations Instruction (OPNAVINST) 3770.4A, "Use of Airspace by U.S. Military Aircraft and Firing Over the High Seas" (DoN 1981), which specify procedures for conducting aircraft activities and for firing missiles and projectiles. The missile and projectile firing areas are to be selected "so that trajectories are clear of established oceanic air routes or areas of known surface or air activity" (DoD 1981).

Some offshore activities use high-frequency active (HFA)and mid-frequency active (MFA) sonar. The effect of sonar on humans varies with the frequency of sonar involved. Of the three types of sonar (high-, mid-, and low-frequency), mid- frequency and low-frequency have the greatest potential to affect humans. The Naval Sea Systems Command Instruction (NAVSEAINST) 3150.2, “Safe Diving Distances from Transmitting Sonar,” is the Navy’s governing document for human divers in relation to mid-frequency active (MFA) sonar systems; it provides procedures for calculating safe distances from active sonars. Such procedures are derived from experimental and theoretical research conducted at the Naval Submarine Medical Research Laboratory and the Navy Experimental Diving Unit. Inputs to those procedures include diver dress, type of sonar, and distance from sonar. The output is represented as a permissible exposure limit (i.e., how long the diver can safely stay at that exposure level). For example, a diver wearing a wetsuit without a hood has a permissible exposure limit of 71 minutes at a distance of 1,000 yards (914 m) from the Navy’s most powerful sonar. At this distance, the sound pressure level received by the diver (received level) would be approximately 190 decibels (dB). At 2,000 yards (1,829 m), or approximately 1 nautical mile (2 km), a diver could operate for over three hours. Exposure to MFA sonar in excess of 190 dB received level could cause slight visual-field shifts, fogging of the faceplate, spraying of water within the mask, and general ear discomfort. Because MFA sonar is used by Navy ships that are underway in the open ocean, away from any know diving locations, and moving at speeds typically greater than 5 knots, it is not plausible that a non-participant diver could be exposed to MFA sonar within 1,000 yards for any significant length of time, certainly not 71 minutes as the Navy allows its divers.

Recreational diving activities within the Offshore Area take place primarily at known diving sites. State and regional parks provide access to many dive sites through boat launches or beach access to deeper water dive sites. The locations of popular dive sites are well documented (Figure 3.16-2), dive boats are typically well marked, and diver-down flags would be visible from the ships conducting the proposed training, so possible interactions between training activities within the offshore areas and scuba diving would be minimized.

The remoteness of the ranges also provides a large degree of isolation from coastal population centers. The Navy temporarily limits public access to areas where there is a risk of injury or property damage. The Navy notifies the public of hazardous activities through the use of NOTAMs and NOTMARs.

Prior public notification of Navy training activities, use of known training areas, avoidance of nonmilitary vessels and personnel, and the remoteness of the offshore areas reduce the potential for interaction between the public and Navy vessels. To date, these generally conservative safety strategies have been successful.

NWTRC and adjacent waters accommodate one type of research, development, test, and evaluation (RDT&E) activity; flight testing of unmanned aerial systems (UASs). There are currently numerous types of UASs employed to obtain intelligence data on threats. UASs are typically flown at altitudes well above 3,000 feet (914 m) in patterns to best collect the required data yet remain beyond the reach of threat weapon systems. The UASs may be controlled by a pilot at a remote location, just as if the pilot were onboard, or may fly a preplanned, preprogrammed route from start to finish. Missions will typically last four to six hours, but vary depending on the scheduled mission training. A UAS presents a unique safety challenge in that there is no pilot onboard the small aircraft, thus limiting its ability to see other aircraft. Although typically equipped with a forward-looking camera that is viewed by a ground crew, the ability to see and avoid other aircraft is still somewhat degraded.

The Scan Eagle UAS is currently tested in the Offshore Area, within W-237. The broad area maritime surveillance (BAMS) system is a future system that will operate at high altitudes (40,000 feet [12,192 m] and higher). The specific UAS to be used for this system has yet to be determined, but it could likely be the Global Hawk or a similar UAS. Under Alternative 1, UAS sorties would increase from 12 to 112, some of which will be flown in W-237. Due to the Navy’s attention to safety for the testing of new systems with large hazard footprints, the effects of increased activities on public safety would be negligible.

UASs are flown into the airspace in R-6701 Bay only after extensive coordination with NASWI air traffic control and the FAA. Due to these strict procedures for RDT&E activities, their effects on public safety are less than significant.

Management of hazardous materials and hazardous wastes in conjunction with Navy training exercises in the Offshore Area is addressed in Section 3.3. No substantial releases of these materials to the environment are anticipated.

Materials expended on the sea ranges during U.S. Navy training activities would include liquid and soluble constituents of concern that would quickly disperse in the water column. These materials also would include solid constituents of concern that would quickly settle to the ocean floor and soon become buried in sediment, coated by corrosion, or encrusted by benthic organisms. Due to the very small quantities of these materials relative to the extent of the sea ranges, the volume of the ocean, and the remoteness of the sea ranges relative to human populations, their concentrations in areas of potential human contact generally would be undetectable.

Current requirements and practices are in place to protect Navy personnel and the public from EMR hazards. These procedures include setting the heights and angles of EMR transmissions to avoid direct exposure, posting warning signs, establishing safe operating levels, and activating warning lights when radar systems are operational. Sources of EMR include radar, navigational aids, and EC. These systems are the same as, or similar to, civilian navigational aids and radars at local airports and television weather stations throughout the United States. EC systems emit EMR similar to that from cell phones, hand held radios, commercial radio, and television stations.

Although extremely rare, some solid training materials expended at sea can migrate ashore where the public could encounter them. Included among these are targets and sonobuoys. Targets are typically recovered after each use. However, expendable targets such as the Expendable Mobile ASW Training Target (EMATT) are not recovered. Designed to scuttle and sink after its run is complete, this target is unlikely to wash ashore. Sonobuoys are also designed to scuttle and sink either when commanded, or when their service life has expired, no greater than 8 hours after being deployed. If either the EMATT or sonobuoy migrates to shore, they pose little risk to the public. There are no fuels, the batteries will have lost all power, and the materials used in their construction are inert or sealed in hard plastic casings. One type of sonobuoy, the Extended Echo Ranging (EER) buoy has explosive charges used to generate acoustic energy in the water. This charge would present a hazard if it failed to detonate and washed ashore. However, these buoys are used far out to sea, and have several redundancies built in that assure the charges detonate when the sonobuoy is scuttled.

Inshore Area

Demolition activities in the Inshore Area would be conducted in accordance with Commander Naval Surface Force, U.S. Pacific Fleet (COMNAVSURFPAC) Instruction 3120.8F (DoN 1993), which specifies detonation procedures for underwater ordnance to avoid endangering the public or impacting other nonmilitary activities, such as shipping, recreational boaters, divers, and commercial or recreational fishermen.

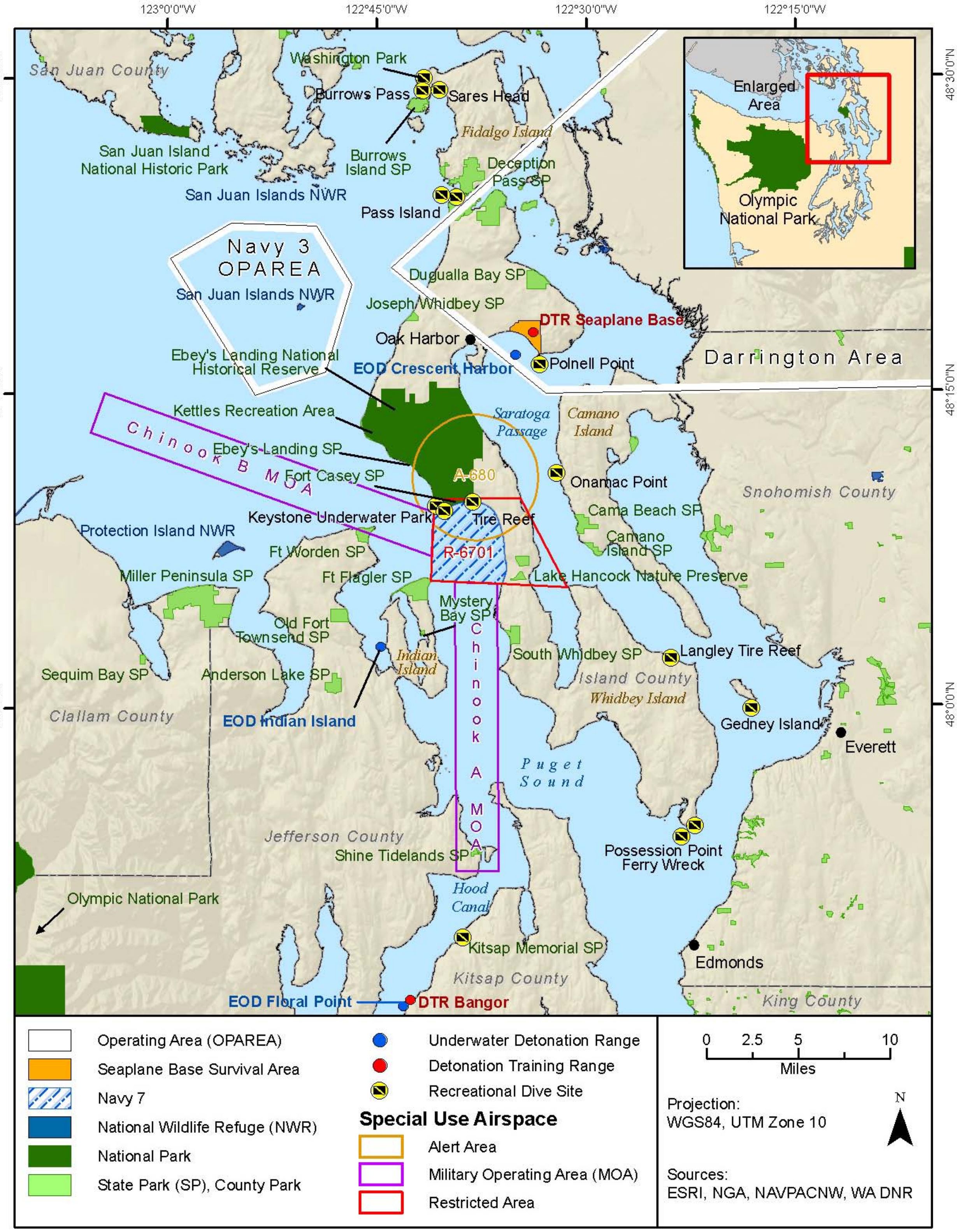

Figure 3.16-2: Recreational Dive Sites and State Park Access within the Nearshore OPAREAs

Recreational diving activities within the Puget Sound take place primarily at known diving sites. State and regional parks provide access to many dive sites through boat launches or beach access to deeper water dive sites. The locations of popular dive sites are well documented (Figure 3.16-2), dive boats are typically well marked, and diver-down flags would be visible from the ships conducting the proposed training, so possible interactions between training activities within the offshore areas and scuba diving would be minimized.

The location of the ranges where underwater and land detonations take place also provides a large degree of isolation from coastal population centers. The land ranges are all on Navy property, and the underwater ranges are just offshore of Navy property. The Navy temporarily limits public access to areas where there is a risk of injury or property damage. The Navy notifies the public of hazardous activities through the use of NOTAMs and NOTMARs.

Prior public notification of Navy training activities, use of known training areas, avoidance of nonmilitary vessels and personnel, and the remoteness of the offshore areas reduce the potential for interaction between the public and Navy vessels. To date, these generally conservative safety strategies have been successful.

The Scan Eagle UAS described above in the Offshore Area section is also currently tested in the Inshore Area, in R-6701. The broad area maritime surveillance (BAMS) system is a future system that will operate at high altitudes (40,000 feet [ft] [12,192 m] and higher). The specific UAS to be used for this system has yet to be determined, but it could likely be the Global Hawk or a similar UAS. Because R-6701 has an upper limit of 5,000 ft, the BAMS UAS would likely operate offshore in W-237. Under Alternative 1, UAS sorties would increase from 12 to 112, some of which will be flown in W-237, some in R-6701. Due to the Navy's attention to safety for the testing of new systems with large hazard footprints, the effects of increased activities on public safety would be negligible.

UASs are flown into the airspace in R-6701 Bay only after extensive coordination with NASWI air traffic control and the FAA. Due to these strict procedures for RDT&E activities, their effects on public safety are less than significant.

Mine Countermeasures

Explosive Ordnance Disposal (EOD) activities at Crescent Harbor, Floral Point, and Indian Island involve mine countermeasures training (MCT). The Crescent Harbor Underwater EOD Range is in the eastern portion of Crescent Harbor west of Polnell Point, EOD Floral Point is in Hood Canal at NBK-Bangor, and EOD Indian Island is west of Indian Island in Port Townsend Bay. Water depths in the range area vary from approximately 40 feet to 90 feet (12 to 27 m).

MCT trains personnel in the destruction of mines, unexploded ordnance, obstacles, and structures. EOD personnel must re-qualify at least monthly in the preparation, placement, and detonation of underwater explosives (NMFS 2008).

The sites at EOD Crescent Harbor and EOD Indian Island are from 1,000 to 7,200 feet from the nearest shoreline (330 to 2,200 meters) and the detonations typically occur in 50 to 60 feet of water (15 to 20 meters) over sandy or muddy bottoms. The MCT site at EOD Floral Point is about 600 feet offshore (183 meters) and charges are placed on a training structure that is 3-8 feet above the bottom (1-3 meters) (NMFS 2008).

At Crescent Harbor where the bulk of training occurs, two blocks of the plastic explosive C-4 are typically used per activity, one at the surface and one at or near the bottom. These charges are attached to an inert mine. For instance, during floating mine demolition training at EOD Crescent Harbor, the charge is attached to a clean metal 55-gallon drum with one or two sand bags inside for ballast. Most of the charges are contained in a copper, aluminum, or plastic pipe or other housing. Although most of the solids are consumed in the explosion, pieces of the mine and the explosive housing may remain. Personnel are instructed to retrieve this debris from the seafloor (NMFS 2008).

Explosive charges used in EOD activities range in size from less 0.5 pound to 20 pounds; 85 percent of the detonations are conducted with 2.5 pound charges. 60 explosive charges would be expended annually (all alternatives) across the three EOD ranges, with EOD Crescent Harbor representing 87 percent of the total expenditure (NMFS 2008). On Land Detonations (also called Land Demolitions)

Land demolitions occur at the Seaplane Base demolition training range (DTR) and at the DTR Bangor (Figure 3.16-2). A typical land demolition training exercise involves disrupting inert improvised explosive devices (IED) using different explosively actuated tools. Typical explosives used are C-4 demolition blocks, DETA sheet, detonating cord, and electric blasting caps. The NEW training limit is 5 pounds at DTR Bangor and 1 pound at the DTR Seaplane Base. Other EOD training occurs outside the DTR Seaplane Base within the Seaplane Base Survival Area, including locating and defusing inert Mk-80 series general purpose bombs.

At the Seaplane Base, the DTR is on a terraced grassy clearing on a hillside immediately north of the road that parallels the Crescent Harbor shoreline. The site is within a secured area of Naval Air Station Whidbey Island (NASWI) and is controlled by the Navy's existing perimeter fence and additional security fencing installed around the clear zone. The "burn pit" includes a 10-foot (3 m) radius enclosure composed of barricades surrounding the detonation point to deflect the explosive energy. A 12-inch layer of sand lines the barricade. Land demolitions at Seaplane Base produce fragmentation measured at 378 feet (115 m) for a 2.5-pound NEW charge. However, sand from a 5-pound NEW charge could theoretically travel up to 1,075 feet (328 m). Therefore, EOD uses a 1,075-ft radius worst-case fragmentation arc. A finding of no significant impact was signed on 22 December 2000 for Seaplane Base EOD training using up to 5-pound NEW charges. Personnel conducting DTR activities are required to follow current requirements and practices in EODMUELEVENINST 3120.1G, 6 September 2005, that include such safety features as raising the bravo flag at the DTR, notifying the quarterdeck prior to activities that the range is hot, and again after activities are completed. There have been no public safety impacts because there is no routine public access to this part of the Seaplane Base.

Detonating explosives can be inherently dangerous to the health and safety of the public if safety precautions are not taken. NAVSEA OP 5 provides a list of explosive safety regulations, precautions, and warnings that must be followed. To mitigate any potential to impact public safety created by the DTR, the following measures are employed:

- A 400-square-foot, barricaded exclusion area is established around the detonation area.
- A restricted area is established outside of the surrounding exclusion area and is clearly marked with explanatory signs.
- Red flags are raised at access points to the restricted area before detonation training activities begin, and they remain raised until activities are completed.
- A Navy qualified and certified safety officer visually checks the exclusion area before each detonation.

Because of the location of the project's training sites and the associated access restrictions, no person other than authorized Navy personnel would be in the affected area. Charges are not detonated when members of the public or others not involved in the training are in the area.

For the remaining NWTRC activities that expend ordnance from aircraft or surface vessels, the Navy uses advance notice and scheduling, and strict on-scene procedures are in place to prevent firing of weapons without first ensuring that the firing danger area is clear of civilian vessels, aircraft, or other non-participants. Aircraft are required to make a preliminary pass over the target prior to dropping any ordnance. If the target area is not clear, aircraft are precluded from dropping their ordnance. This requirement applies to both practice weapons and live bombs. The public is notified of the location, date, and time of hazardous activities via NOTAMs, and NOTMARs.

To ensure that no unauthorized personnel have access to Warning Areas or Restricted Areas during hazardous activities, ground access is strictly controlled using locked gates and visual confirmation that the area is clear of personnel. Red flags are raised at access points to the Restricted Area before detonation training begins, and they will remain raised until activities are completed. For Naval Special Warfare (NSW) activities, the RSO ensures the area is clear.

Naval Special Warfare

There are no local NSW units stationed in the NWTRC. However, Sea, Air, Land (SEAL) units from out of the area regularly train within the NWTRC due to the area's unique qualities, such as low water temperature. Indian Island is used by NSW units to conduct insertion activities. All NSW activities are covert in nature, and no live fire weapons or other ordnance are used.

NSW forces (SEALs and Special Boat Units [SBUs]) train to conduct military activities in five special operations mission areas: unconventional warfare, direct action, special reconnaissance, foreign internal defense, and counterterrorism. Specific training events include insertion/extraction operations to hone individual skills in delivery and withdrawal of personnel and equipment using unconventional methods. SEAL Delivery Vehicle Team ONE (SDVT-1) from Naval Special Warfare Group Three (NSWG-3) in San Diego conducts underwater unit level training (ULT) exercises twice a year within the NWTRC. For two to three weeks during these training detachments, SEALs conduct land-based training at Indian Island. The SEAL Delivery Vehicle (SDV) is launched from Port Townsend, travels for approximately three hours, and delivers four to six SEALs to Indian Island, where over-the-beach (OTB) training occurs. The SEALs also perform special reconnaissance while on the island. The SDV returns two days later to recover the SEALs.

Access control is the key to reducing the risk to the public due to the hazardous nature of NSW training. Since there is no general public access to Indian Island, the activities occurring on the island pose no risk to public safety. For those activities with an offshore or nearshore component, the Navy ensures that the danger area is clear of civilian boats, divers, or aircraft before any hazardous operation commences. Activities are cancelled or delayed if there is any doubt about the safety of the public or the participants. Radio communications are used extensively during training to avoid unsafe situations. The area used for training is isolated by the use of security guards, if necessary. Due to the strictly controlled nature of the NSW training on Indian Island, this training would have no effect on public safety.

Naval Outlying Landing Field Coupeville Airfield Activities

Training activities at Naval Outlying Landing Field (OLF) Coupeville are generally restricted to military aviation flights to practice touch and go landings. OLF Coupeville is an emergency airfield for general aviation traffic if a suitable alternate airfield is not available. No major aircraft accidents have occurred at OLF Coupeville in the last several years.

3.16.2.3 Alternative 1

Offshore Area

Offshore activities proposed under Alternative 1 would have all the components of the No Action Alternative. Additionally, the NWTRC would support an increase in training activities to include force structure changes associated with the introduction of new weapon systems, vessels, and aircraft into the fleet. Under Alternative 1, baseline-training activities would generally be increased. In addition, training associated with force structure changes would be implemented for the EA-18G Growler, guided missile submarine (SSGN), P-8 multimission maritime aircraft (MMA), and UASs. See Chapter 2, Tables 2-9 and 2-10 for greater detail on No Action and Alternative 1 activities.

Force structure changes associated with new weapon systems would include the firing of air-to-air missiles by the EA-18G, new UAS flights in W-237, and the deployment of new sonobuoys by the P-8 MMA. The new sonobuoys pose no new safety hazard and will have no impact on safety. The UAS flights, as many as 100 per year, will take place in a designated warning area well offshore. The air-to-air missile firings present a new hazard to the NWTRC. However, air-to-air missile exercises have been conducted safely by the Navy for years in other range complexes. The safety procedures implemented for those exercises would be equally effective in the NWTRC. The remoteness of the offshore areas, the use of temporary access restrictions, and public notification procedures would substantially reduce potential safety risks during these activities.

Several training activities would experience increases from current levels in support of the Fleet Readiness Training Plan (FRTP). Only the number of training activities would increase; no new types of training would be introduced. Aircraft activities would increase from approximately 3,200 annual activities to 4,000, a 24% increase. Ship and submarine activities would increase from approximately 250 annual activities to 275, a change of 12%. Increases in the number of individual training activities would increase the potential for conflicts with non-participants.

Management of hazardous materials and hazardous wastes in conjunction with U.S. Navy training activities in the OPAREAs is addressed in Section 3.3. No substantial releases of these materials to the environment are anticipated.

All of the Alternative 1 offshore activities, whether resulting from force structure changes or an increase of existing activities, have either been conducted previously in the NWTRC, or have been conducted for years in other Navy range complexes. Given the Navy’s comprehensive, conservative safety procedures and its excellent safety record for these activities, the actual potential for public safety impacts from training activities would remain very low.

Inshore Area

No new Inshore activities are proposed under Alternative 1. Existing activities would continue with a modest increase in annual tempo. The current level of approximately 4,050 annual activities would increase to approximately 4,300, less than a 6% increase. Of significance is a marked decrease in underwater demolitions (Mine Countermeasures). Mine Countermeasures will decrease from 60 annual underwater detonations in the No Action Alternative, to 4 annual detonations.

Alternative 1 would include all NSW training activities described under the No Action Alternative. There would be no increase in NSW activities under Alternative 1.

3.16.2.4 Alternative 2

Offshore Area

Offshore activities proposed under Alternative 2 would have all the components of the No Action Alternative and Alternative 1. Additionally, the NWTRC would support new training activities resulting from several range enhancements.

- New Electronic Combat Threat Simulators/Targets.
  - Approximately 2,500 aircraft flights to the Offshore Area would conduct EC training. This activity is not currently conducted in the Offshore Area.
  - Approximately 275 new EC training activities will be conducted by ships and submarines in the Offshore Area. As there are currently no EC threat simulators that can be detected from offshore, this activity is currently not conducted.
- New Air Target Services.
  - Air-to-Air Missile Exercises will increase from 12 to 24 annual activities (approximate).
  - Surface-to-Air Gunnery Exercises will increase from 80 to 160 annual activities (approximate).
  - Surface-to-Air Missile Exercises will be a new activity. With new air target services in place, aircraft carriers would conduct up to 4 annual missile firings per year.
- New Surface Target Services.
  - Surface-to-Surface Gunnery Exercises will increase from 100 to 180 annual activities (approximate).
- Small Scale Underwater Training Minefield.
  - Mine Avoidance Training will be a new activity. Submarines will conduct 7 exercises per year on the new underwater training minefield. When determining the location of the minefield, the Navy would avoid popular dive sites, shipwrecks, and recreational fishing areas.

In addition to the new and increased activities of the range enhancements, many of the other activities will increase to support the FRTP. In total, annual activities in the Offshore Area will increase to approximately 6,300, an 84% increase over the No Action Alternative. See Chapter 2, Tables 2-9 and 2-10 for greater detail on No Action and Alternative 2 activities.

All of the Alternative 2 offshore activities, whether resulting from the new range enhancements or an increase of existing activities, have either been conducted previously in the NWTRC, or have been conducted for years in other Navy range complexes. As such, they present no unique safety hazards.

Inshore Area

No new Inshore activities are proposed under Alternative 2. Existing activities would continue with a modest increase in annual tempo. The current level of approximately 4,050 annual activities would increase to approximately 4,600, a 12% increase. Of significance is a marked decrease in underwater demolitions (Mine Countermeasures). Mine Countermeasures will decrease from 60 annual underwater detonations in the No Action Alternative, to 4 annual detonations.

Alternative 2 would include all NSW training activities described under the No Action Alternative. There would be no increase in NSW activities under Alternative 2.

3.16.3 Mitigation

No significant impacts have been identified, therefore no mitigation measures are required.

3.16.4 Summary of Effects

Current protective measures are described in Section 3.16.2.1; these procedures minimize the risk of Navy training activities on public safety. Table 3.16-3 summarizes the effects of the No Action, Alternative 1, and Alternative 2.

Table 3.16-3: Summary Effects – Public Safety

Alternative	NEPA (On-Land and U.S. Territorial Waters)	EO12114 (Non-U.S. Territorial Waters)
No Action Alternative	• Range clearance procedures are implemented prior to activities for both land and water range areas. Activities will not proceed unless the range is clear of non-participants. Therefore, there is no risk to public safety.	• Range clearance procedures are implemented prior to activities for range areas in non-U.S. territorial waters. Activities will not proceed unless the range is clear of non-participants. Therefore, there is no risk to public safety.
Alternative 1	• Impacts to public safety would be the same as the No Action Alternative.	• Impacts to public safety would be the same as the No Action Alternative.
Alternative 2 (Preferred Alternative)	• Impacts to public safety would be the same as the No Action Alternative.	• Impacts to public safety would be the same as the No Action Alternative.

Northwest Training Range Complex

Environmental Impact Statement/ Overseas Environmental Impact Statement

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Volume 2

Commander
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1101 Tautog Circle
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4 CUMULATIVE IMPACTS

4.1 PRINCIPLES OF CUMULATIVE IMPACTS ANALYSIS

The approach taken to analyze cumulative impacts (or cumulative effects)[1] for the Proposed Action and Alternatives follows the objectives of the National Environmental Policy Act (NEPA) of 1969, Council on Environmental Quality (CEQ) regulations and CEQ guidance. CEQ regulations (40 Code of Federal Regulations [CFR] §§ 1500-1508) provide the implementing procedures for NEPA. The CEQ regulations define "cumulative effects" as:

> ". . . the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." (40 CFR 1508.7).

CEQ provides guidance on cumulative impacts analysis in *Considering Cumulative Effects Under the National Environmental Policy Act* (CEQ 1997). This guidance further identifies cumulative effects as those environmental effects resulting "from spatial and temporal crowding of environmental perturbations. The effects of human activities will accumulate when a second perturbation occurs at a site before the ecosystem can fully rebound from the effects of the first perturbation." Noting that environmental impacts result from a diversity of sources and processes, this CEQ guidance observes that "no universally accepted framework for cumulative effects analysis exists," while noting that certain general principles have gained acceptance. One such principal provides that "cumulative effects analysis should be conducted within the context of resource, ecosystem, and community thresholds—levels of stress beyond which the desired condition degrades." Thus, "each resource, ecosystem, and human community must be analyzed in terms of its ability to accommodate additional effects, based on its own time and space parameters." Therefore, cumulative effects analysis normally will encompass geographic boundaries beyond the immediate area of the Proposed Action, and a time frame including past actions and foreseeable future actions, in order to capture these additional effects. Bounding the cumulative effects analysis is a complex undertaking, appropriately limited by practical considerations. Thus, CEQ guidelines observe, "[i]t is not practical to analyze cumulative effects of an action on the universe; the list of environmental effects must focus on those that are truly meaningful."

This Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) will analyze the cumulative environmental effects of the Proposed Action and Alternatives by considering the following criteria:

- The area in which the effects of the proposed project will be felt;
- The impacts that are expected in the area from the proposed project;
- Other actions, past, present and reasonably foreseeable that have had or are expected to have impacts in the same area;
- The impacts or expected impacts from these other actions; and
- The overall impact that can be expected if the individual impacts are allowed to accumulate.

For the purposes of determining cumulative effects in this chapter, the Navy reviewed environmental documentation regarding known current and past Federal and non-Federal actions associated with the resources analyzed in Chapter 3. Additionally, projects in the planning phase were considered, including reasonably foreseeable (rather than speculative) actions that have the potential to interact with the

[1] CEQ Regulations provide that the terms "cumulative impacts" and "cumulative effects" are synonymous (40 CFR § 1508.8(b)).

proposed Navy action. The level of information available for different projects varies. The best available science is used in this analysis.

4.1.1 Identifying Geographical Boundaries for Cumulative Impacts Analysis

Geographic boundaries for analyses of cumulative impacts in this Environmental Impact Statement/ Overseas Environmental Impact Statement (EIS/OEIS) vary for different resources and environmental media. For air quality, the potentially affected air quality regions are the appropriate boundaries for assessment of cumulative impacts from releases of pollutants into the atmosphere. For wide-ranging or migratory wildlife, specifically marine mammals and sea turtles, any impacts from the Proposed Action might combine with impacts from other sources within the range of the population. Therefore, identification of impacts elsewhere in the range of a potentially affected population is appropriate. Table 4-1 identifies the geographic scope of this cumulative impacts analysis, by resource area.

Table 4-1: Geographic Areas for Cumulative Impacts Analysis

Resource	Area for Impacts Analysis
Geology and Soils	Seaplane Base Survival Area, Seaplane Base Demolition Training Range (DTR), DTR Bangor, Navy Outlying Field (OLF) Coupeville, Indian Island
Air Quality	Puget Sound-Georgia Air Basin
Hazardous Materials and Hazardous Wastes	Offshore Area, Seaplane Base Survival Area, DTR Seaplane Base, DTR Bangor, Crescent Harbor, Indian Island, and Floral Point Underwater Explosive Ordnance Disposal (EOD) Training Ranges, OLF Coupeville, Darrington Area, and Military Operating Areas (MOAs)
Water Resources	Offshore Area, Seaplane Base Survival Area, DTR Seaplane Base, DTR Bangor, Crescent Harbor, Indian Island, and Floral Point Underwater EOD Training Ranges, and OLF Coupeville
Acoustic Environment – Airborne Sound	Offshore Area, Seaplane Base Survival Area, DTR Seaplane Base, DTR Bangor, Crescent Harbor, Indian Island, and Floral Point Underwater EOD Training Ranges, OLF Coupeville, Darrington Area, and MOAs
Marine Plants and Invertebrates, Fish, Sea Turtles, Marine Mammals, and Sea Birds	Offshore Area, Crescent Harbor, Indian Island, and Floral Point Underwater EOD Training Ranges
Terrestrial Biological Resources and Cultural Resources	Seaplane Base Survival Area, Seaplane Base Demolition Training Range (DTR), DTR Bangor, OLF Coupeville, Indian Island, Darrington Area, and MOAs
Traffic, Socioeconomics, Environmental Justice, and Public Safety	Offshore Area, Seaplane Base Survival Area, DTR Seaplane Base, DTR Bangor, Crescent Harbor, Indian Island, and Floral Point Underwater EOD Training Ranges, OLF Coupeville, Darrington Area, and MOAs

4.1.2 Projects and Other Activities Analyzed for Cumulative Impacts

4.1.2.1 Past, Present, and Reasonably Foreseeable Future Actions

Identifiable present effects of past actions are analyzed, to the extent they may be additive to impacts of the Proposed Action. In general, the Navy lists and/or analyzes the effects of individual past actions only where appropriate; cumulative impacts analysis typically focuses on aggregate effects of past actions. This depends on the availability of data and relevancy of the past effects. Although certain data (e.g., forest cover) may be available for extensive periods in the past (i.e., decades), other data (e.g. water quality) may be available only for much shorter periods. Because the data describing past conditions are usually scarce, the analysis of past effects is often qualitative (CEQ 1997). Also to be analyzed are all reasonably foreseeable future actions that may have impacts additive to the effects of the Proposed

Action. This includes all likely future development of the region even when foreseeable future action is not planned in sufficient detail to permit complete analysis (CEQ 1997). Table 4-2 and Table 4-3 present a summary of past, present, and planned projects with potential cumulative impacts implications.

Table 4-2: Past, Present, and Planned Future Projects in the Offshore Area

Project	Project Description	Project Timeframe		
		Past	Present	Future
OFFSHORE AREA				
Deep Sea Corals Study	Scientists from the National Center for Coastal Ocean Science and the Olympic Coast National Marine Sanctuary (OCNMS) have initiated a study of deep sea coral/sponge assemblages at the OCNMS and their potential vulnerability to anthropogenic activities in the area. The project began in June 2004 with a pilot survey. A follow-up survey was conducted from May 22 to June 4, 2006 to explore other areas of the sanctuary looking for communities of deepwater corals and sponges.	X	X	X
Washington Islands NWR Comprehensive Conservation Plan	In 2007, the USFWS completed a Final Comprehensive Conservation Plan to guide its management and resources within the Flattery Rocks NWR, Quillayute Needles NWR, and Copalis NWR over the next 15 years (USFWS 2005b).	X		
NAVSEA NUWC Keyport Range Extension – Quinault Underwater Tracking Range (QUTR)	In a Draft EIS/OEIS released to the public on September 12, 2008, the Navy proposes to extend the operational areas associated with the Naval Sea Systems Command (NAVSEA) Naval Undersea Warfare Center (NUWC) Keyport Range Complex. The Keyport Range Complex is composed of three geographically distinct range sites: the Keyport Range Site, Dabob Bay Range Complex (DBRC) Site, and the QUTR Site. The Keyport Range Site is not considered to have cumulative implications due to its location, geographically separated from any activities associated with the NWTRC. The DBRC is an inshore component of the extension and the QUTR is an offshore component. The Proposed Action would provide additional operating space at these range sites to better support current and evolving test requirements and range activities conducted by NUWC Keyport. The action would also include small increases in the average annual number of tests and days of testing at the QUTR Site. For purposes of cumulative impacts in the offshore area, only RDT&E activities are being analyzed at the QUTR.			X
Olympic Coast National Marine Sanctuary (OCNMS) Management Plan Update	The OCNMS is beginning a re-examination of management priorities. The OCNMS management plan was development in 1993 and is in need of updating. OCNMS is looking at the state of the sanctuary's resources and priorities and is requesting input from the public. OCNMS will be talking with the public over the next two to three years to decide on how to best manage and protect the sanctuary.			X

Table 4-3: Past, Present, and Planned Future Projects in the Inshore Area

Project	Project Description	Project Timeframe		
		Past	Present	Future
INSHORE AREA				
Naval Surface Warfare Center, Detachment Bremerton Command Consolidation	This action consolidates Naval Surface Warfare Center, Carderock Division Detachment Bremerton activities at Fox Island Laboratory and Detachment Bremerton to Naval Base Kitsap-Bangor in Silverdale, Washington. The project consists of constructing in-water facilities on Carlson Spit, including a new access pier and associated mooring components (e.g., dolphins, anchoring systems). In addition to the in-water facilities, a new structure is being constructed. Approximately 5 acres (2.0 ha) of mature forest are being removed to provide office and laboratory space. Construction of this project began in Spring 2007 with a project completion date scheduled for Fall 2008.		X	
Underwater Surveillance System	The Navy installed an active-acoustic Underwater Surveillance System within the designated Restricted Area at Naval Base Kitsap-Bangor. The purpose of this project was to improve the underwater detection capabilities at Naval Base Kitsap-Bangor to comply with current Navy directives regarding base security. The system operates at the same frequency and range as a commercial "fish finder" and is in operation full time. The system was installed and operational as of April 2006.	X		
Submarine Development Squadron FIVE Detachment Support Facilities	The Navy implemented upgrades to waterfront and shore-based support facilities for its Submarine Development Squadron FIVE Detachment at Submarine Base Bangor (now called Naval Base Kitsap-Bangor). These upgrades were completed in July 2005. Anticipated levels of mission support, and the operational tempo of assigned submarines, require additional shore-side buildings for administration, operations, industrial, and support functions.	X		
Fred Hill Materials Gravel Project	Fred Hill Materials, a materials supply firm based in Poulsbo, is proposing construction of a 4-mi (~6-km) conveyor belt connecting a 781-acre (316-ha) inland gravel mine to a 1,100-ft (335-m) long, 80-ft (24-m) high pier and 900-ft (274-m) long moorage dock. The shipping facility would be on the west shore of Hood Canal, 5 mi (8 km) south of the Highway 104 Hood Canal Bridge. When fully operational, the "pit to pier" operation would mine, transport, and ship an estimated 60,000 tons (54,432 metric tons) of gravel 24 hours per day, loading into barges and ships bound for domestic and foreign ports. Each vessel would travel under or through the opening of the floating Hood Canal Bridge. The company (action proponent) has begun the process of applying for permits. Under the Washington State Environmental Policy Act, an EIS public scoping meeting was held on September 27, 2007 and a Draft EIS is in progress.			X

Table 4-3: Past, Present, and Planned Future Projects in the Inshore Area (continued)

Project	Project Description	Project Timeframe		
		Past	Present	Future
Hood Canal Bridge East-half Replacement and West-half Retrofit Project	The eastern half of the Hood Canal Bridge, located between Kitsap and Jefferson counties at the northern mouth of Hood Canal, is nearing the end of its structural service life. An EA and Supplemental EA were prepared for the project and a FONSI issued in May 2002; construction began in 2006. When completed, the Hood Canal Bridge will have a new, wider, floating section, new approach sections, and transition trusses on the east and west ends. The east-half of the replacement is scheduled to be completed in summer 2009, and west-half retrofitting is scheduled to be completed by December 2010.		X	
Point Whitney Boat Ramp Upgrade	The Washington Department of Fish and Wildlife (WDFW) proposes to expand the existing public boat launch to better accommodate recreational boating access to Dabob Bay. The existing 10-ft (3-m) wide ramp would be widened to 12 ft (4 m) and extended 22 ft (7 m) beyond the end of the existing ramp to a total length of 132 ft (40 m). Potential impacts were identified for Pacific herring and epibenthic organisms and infauna that utilize eelgrass habitat in the boat ramp area. Mitigation measures were outlined in the Final State Environmental Policy Act (SEPA) documentation, dated November 3, 2004, and an addendum to Determination of Non-Significance was signed on September 15, 2005.			X
Hood Canal Dissolved Oxygen Program	The Hood Canal Dissolved Oxygen Program was created to address the historically low DO situation and the effect on marine life. The Program is a partnership of 28 organizations that works with local, state, federal, and Tribal government policy makers to evaluate potential corrective actions that will restore and maintain DO to reduce stress to marine life. A three-year Integrated Assessment and Modeling Study was conducted from 2005-2007 to use marine, freshwater and biota monitoring data and a computer model to quantify the role the various natural processes and human actions are playing to control the concentrations of DO in Hood Canal and to test corrective action scenarios.	X	X	X
Waterfront Restricted Area (WRA) Land/Water Interface (LWI), Naval Base Kitsap-Bangor	This project is to provide security upgrades to the existing Naval Base Kitsap-Bangor WRA by constructing two WRA LWI Barriers, which connect both ends of the WRA enclave to the existing floating barriers. The LWIs will extend from the high water mark to the terminations of the Port Security Barriers (PSB) and will be capable of moving in the full tide range and providing an anchorage for the floating barriers. The project consists of two separate construction features. This project is scheduled to occur in FY12.			X

Table 4-3: Past, Present, and Planned Future Projects in the Inshore Area (continued)

Project	Project Description	Project Timeframe		
		Past	Present	Future
Jefferson County Black Point Master Planned Resort	The Statesman Group of Companies, LTD, and Black Point Properties, LLC, have submitted an application for a Master Planned Resort in the Black Point area called the Pleasant Harbor Marina and Golf Resort on the shore and uplands near Brinnon and the Navy Range at Dabob Bay. The project consists of 253 acres (102 ha), a marina with 290 slips, minor commercial facilities, an 18-hole golf course, and 1,090 residential units designed to serve the visiting public through a "condotel" program, with individual units privately owned but managed as a resort. Also at issue is the likelihood of the resort exchanging property with the Department of Fisheries to enable the construction of a new boat ramp, which would be open to the public. The document addressed potential impacts to shellfishing, water quality, transportation, public services, shorelines, fish and wildlife, rural character, archaeological and cultural resources, and critical areas. A FEIS was published in November 2007 and was included as part of the 2007 Comprehensive Plan Amendment Cycle. The Board of County Commissioners approved the proposal in January 2008.			X
Swimmer Interdiction Security System, naval Base Kitsap-Bangor	The U.S. Navy has proposed to implement a Swimmer Interdiction Security System to meet special U.S. government security requirements for military installations in response to the terrorist attacks of September 11, 2001. The system would protect waterside Navy assets and sailors and would remain in operation as long as valuable naval assets are located at Naval Base Kitsap-Bangor. The Navy examined various alternatives for implementing the system: marine mammals (preferred alternative), combat swimmers, and remotely operated vehicles (ROVs). Under the preferred alternative, specially trained marine mammals and their human teammates would respond rapidly to security alerts by detecting, classifying, and marking the location of underwater objects or interdicting intruders. Humans would work aboard small power boats and marine mammals would be in enclosures. A Draft EIS is currently being prepared and is expected to be available to the public for comment in Fall 2008, with a Record of Decision anticipated for Spring 2009.			X
NAVSEA NUWC Keyport Range Extension – DBRC Site	Refer to the description provided under the offshore projects for the NAVSEA NUWC Keyport Range Extension – QUTR Site. The Proposed Action would provide additional operating space at the DBRC range site to better support current and evolving test requirements and range activities conducted by NUWC Keyport. The action would also include small increases in the average annual number of tests conducted at the site. For purposes of cumulative impacts in the inshore area, only RDT&E activities are being analyzed at the DBRC Site. This Draft EIS/OEIS was released to the public on September 12, 2008.			X

Table 4-3: Past, Present, and Planned Future Projects in the Inshore Area (continued)

Project	Project Description	Project Timeframe		
		Past	Present	Future
Transit Protection System Facilities, Naval Base Kitsap-Bangor	This project is to provide berthing for three types of Transit Protection System vessels and various Port Operations tugs and small craft. In addition, the project will provide the necessary support facilities ashore for the command, administrative, operations, and support functions of the crews and command personnel of associated escort vessels and craft. The project involves the demolition of an existing pier and the installation of piles for the new pier, as well as construction of new facilities. The pier will be located at the site of the existing Magnetic Silencing Facility (MSF). The existing MSF and associated support facilities will be demolished. The proposed development involves several potentially significant issues, including endangered and threatened species, stormwater runoff, demolition material disposal, and the avoidance of impacts to valuable upland natural resources. This project is scheduled to occur in FY11.			X
P-8A Multi-Mission Aircraft (MMA)	The Navy is preparing an EIS for to provide facilities and functions to support the homebasing of 12 P-8A MMA squadrons and one fleet replacement squadron at established maritime patrol homebases. The P-8A would replace the P-3C aircraft. Currently, P-3C patrol squadrons are based at Naval Air Station (NAS) Jacksonville, Florida; NAS Whidbey Island; NAS Brunswick, Maine; and Marine Corps Base Hawaii Kaneohe Bay, with periodic detachments at NAS North Island, California. Under the preferred alternative, four P-8A MMA fleet squadrons would be homebased at NAS Whidbey Island. The transition would begin no later than 2012 and be complete in 2019.			X
EA-18G Growler	The EA-18G Growler is an Airborne Electronic Attack (AEA) aircraft which operates from either an aircraft carrier or from land-bases. The Growler has been developed as a replacement for the United States Navy EA-6B Prowler aircraft which entered service in 1971 and is approaching the end of operational life. The EA-18G Growler fleet will be based at Naval Air Station Whidbey Island, Washington. The transition is under way and is expected to be completed by 2013.			X
The Crescent Bay Salt Marsh and Salmon Restoration Project	The Restoration Project will restore 200 acres of juvenile salmon rearing habitat and other wetland functions to the Crescent Bay marsh, once the largest open barrier island salt marsh (approximately 300 acres) on Whidbey Island in Puget Sound. The restoration site is located on Naval Air Station Whidbey Island. The initial phase of the project includes baseline ecological assessment, restoration design, construction, and one year of post-construction monitoring. A second phase will cover implementation of 10 years of post-construction monitoring and adaptive management.			X

4.1.3 Other Activities

In addition to analyzing past, present, and planned future projects as listed in Table 4-2, following is a description of other activities that were also considered as part of the cumulative impact analysis.

4.1.3.1 Fishing

Commercial and recreational fishing constitutes a significant non-military use of the ocean areas of the NWTRC. As discussed in Section 3.7, the Pacific Fisheries Information Network (PacFIN) maintains commercial catch block data for ocean areas off the coasts of Washington, Oregon, California, Alaska, and British Columbia (PacFIN 2008). The annual catch of fish and invertebrates within Washington waters for 2007 amounted to approximately 180,221,946 pounds (see Table 3.14-1). Within the NWTRC OPAREA, groundfish species encompass the majority of the commercial catch. Groundfish species are categorized in the following groups: flatfish, rockfish, thornyheads, scorpionfish, roundfish, skates, sharks, and chimaeras. Pelagic species are managed under the Coastal Pelagic Species FMP and include several species within six families (anchovies, jacks, herrings, mackerals, squids, and krill). Salmonid species with known or potential occurrence within the NWTRC include five species of Pacific salmon: the chinook, chum, coho, pink, and sockeye; and three species of trout: the cutthroat, steelhead, and bull. For the 2007 annual catch, groundfish accounted for 65.7 percent, pelagic species accounted for approximately 18.7 percent, and Salmon accounted for 14.98 percent (Refer to Table 3.14-1 for detailed list). Other commercial fishing targets include crustaceans (Dungeness crab and shrimp) geoduck, squid, urchins, and other invertebrates.

Fishing can adversely affect fish habitat and managed species. Potential impacts of commercial fishing include over-fishing of targeted species and by-catch, both of which negatively affect fish stocks. Mobile fishing gears such as bottom trawls disturb the seafloor and reduce structural complexity. Indirect effects of trawls include increased turbidity, alteration of surface sediment, removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing (i.e., lost fishing gear continuing to ensnare fish and other marine animals), and generation of marine debris. Lost gill nets, purse seines, and long-lines may foul and disrupt bottom habitats. Recreational fishing also has the potential to affect fish habitats because of the large number of participants and the intense, concentrated use of specific habitats.

Removal of fish by fishing can have a profound influence on individual populations. In a recent study of retrospective data, Jackson et al. (2001) analyzed paleoecological records of marine sediments from 125,000 years ago to present, archaeological records from 10,000 years before the present, historical documents, and ecological records from scientific literature sources over the past century. Examining this longer term data and information, they concluded that ecological extinction caused by overfishing precedes all other pervasive human disturbance to coastal ecosystems including pollution and anthropogenic climatic change.

Natural stresses include storms and climate-based environmental shifts, such as algal blooms and hypoxia. Disturbance from ship traffic and exposure to biotoxins and anthropogenic contaminants may stress animals, weakening their immune systems, and making them vulnerable to parasites and diseases that would not normally compromise natural activities or be fatal.

4.1.3.2 Commercial and Recreational Marine Traffic

A significant amount of ocean traffic, consisting of both large and small vessels, transits through the NWTRC. Washington State handles seven percent of the country's exports and six percent of its imports. Seattle and Tacoma were ranked seventh and tenth, respectively, among U.S. ports with respect to total cargo imported and exported in 2005 (http://www.bts.gov). Taken together, these two ports comprise the nation's third largest "container load center" in the U.S., second only to Los Angeles/Long Beach and New York/New Jersey (www.washingtonports.org). The Ports of Seattle and Tacoma are also an important commercial cargo port. Cruise ships make daily use of Seattle port facilities as well. For commercial vessels, the major trans-oceanic routes transit west from the Puget Sound area bypassing W-

237 or entering the area briefly to the north. Ships also travel southwest to Hawaii entering the warning area briefly to transit (Figure 3.13-2). The approach and departure routes into the Puget Sound can be adjusted depending on Navy activities notification through Notice to Mariners (NOTMARs).

Commercial vessels are sources of pollutants introduced into the waters and air basin of the PSGB. Additionally, commercial vessels are a source of ship strikes on marine mammals, and are implicated in many ship strikes in the PACNW. (Information about ship strikes and other marine mammal stranding events, and about introduction of pollutants into the coastal waters, is provided below).

A very substantial volume of small craft traffic, primarily recreational, occurs throughout the PACNW. Puget Sound has 244 marinas with 39,400 moorage slips and another 331 launch sites for smaller boats (Washington Department of Ecology 2006). Statewide, approximately 180,000 boats are registered, not counting thousands more small boats and watercraft that do not require registration. Because pleasure boats are sources of fuel leaks and toxins from antifouling paints, they constitute a potential environmental concern that has not been quantified. (Information about pollutants and hazardous wastes introduced into the PACNW waters is provided below).

4.1.3.3 Wave/Tidal Energy Plants

In addition to its abundant solar, wind and geothermal resources, the PACNW is also uniquely situated to capture the renewable energy of the ocean. Special buoys, turbines, and other technologies can capture the power of waves and tides and convert it into clean, pollution-free electricity. Like other renewable resources, both wave and tidal energy are variable in nature. Waves are produced by winds blowing across the surface of the ocean. However, because waves travel across the ocean, their arrival time at the wave power facility may be more predictable than wind. In contrast, tidal energy, which is driven by the gravitational pull of the moon and sun, is predictable centuries in advance.

The technologies needed to generate electricity from wave and tidal energy are at a nascent stage, but the first commercial projects are currently under development, including some in the PACNW. Along the Washington coast, offshore from the Makah Indian Reservation a pilot site was established by Thales GeoSolutions (Pacific), Inc. in 2002 to assess the seabed for a possible site for a wave energy park. This permit application with the Federal Energy Regulatory Commission has recently been withdrawn (DJC 2008). Three other permits have been approved by the Federal Energy Regulatory Commission since 2007. Further south on the Oregon Coast, the Coos Bay Offshore Wave Power Plant is also being evaluated for site consideration (NYT 2007). Like most emerging energy technologies, wave and tidal technologies are currently more expensive than traditional generating resources, but with further experience in the field, adequate R&D funding, and proactive public policy support, the costs of wave and tidal technologies are expected to follow the same rapid decrease in price that wind energy has experienced.

4.1.3.4 Ocean Pollution

Environmental contaminants in the form of waste materials, sewage, and toxins are present in, and continue to be released into, the ocean off the PACNW. Polluted runoff, or non-point source pollution, is considered the major cause of impairment of ocean waters. Stormwater runoff from coastal urban areas and beaches carries waste such as plastics and Styrofoam into coastal waters. Sewer outfalls also are a source of ocean pollution in the PACNW. Sewage can be treated to eliminate potentially harmful releases of contaminants; however, releases of untreated sewage occur due to infrastructure malfunctions, resulting in releases of bacteria usually associated with feces, such as *Escerichia coli* and *enterococci*. Bacteria levels are used routinely to determine the quality of water at recreational beaches, and as indicators of the possible presence of other harmful microorganisms.

As recent as 2006, toxic chemicals have been released into sewer systems in the PACNW; a fine of $180,000 was levied against a Redmond fish-food and aquaculture company for dumping toxic chemicals into the sewer drain, failing to separate potentially explosive chemicals and hazardous materials (Seattle

2008a). While such dumping has long been forbidden by law, the practice has left ocean outflow sites contaminated. Superfund cleanup sites have been identified in the Puget Sound and dredge spoils are slated to be dumped within the bay (Seattle 2007). These sites of accumulation are being rectified by Superfund cleanups in the Sound.

Sewage treatment facilities generally do not treat or remove persistent organic pollutants. Plastic and Styrofoam waste in the ocean chemically attracts hydrocarbon pollutants such as Polychlorinated Biphenyls (PCBs) and Dichloro-Diphenyl-Trichloroethane (DDT), which accumulate up to 1 million times more in plastic than in ocean water. Fish, other marine animals, and birds consume these wastes containing elevated levels of toxins. DDT mimics estrogen in its effects on some animals, possibly causing the development of female characteristics in male hornyhead turbots and English sole, according to a study by the Southern California Coastal Water Research Project.

Regulatory activities have made progress in reducing both non-point source pollution such as runoff, and point source pollution such as that which may emanate from sewer outfall sites. In 1998, Washington and Oregon received conditional Federal approval of its Coastal Nonpoint Source Pollution Control Program from the U.S. Environmental Protection Agency and the National Oceanic and Atmospheric Administration (the agencies that administer the Clean Water Act and Coastal Zone Management Act, respectively). The program includes the coordinated participation of the Coastal Commission, the State Water Resources Control Board, and the Regional Water Quality Control Boards. The current plan covers the years 2003 to 2008.

Pollution from vessels is a source of ocean contamination. Sewage, sludge, blackwater, graywater, bilge water, plastics and other trash components and waste materials are routinely discharged from vessels into coastal and ocean waters in the PACNW. Most recently, an international shipping company was fined $7.25 million for dumping oil sludge at sea, the largest penalty for dumping ever assessed in the Pacific Northwest (Seattle 2008b).

Increases in impervious surfaces increase the amount of chemicals, oils and other residues which end up in the human food chain. Impervious surfaces are mainly constructed surfaces - rooftops, sidewalks, roads, and parking lots - covered by impenetrable materials such as asphalt, concrete, brick, and stone. These materials seal surfaces, repel water and prevent precipitation and meltwater from infiltrating soils. Soils compacted by urban development are also highly impervious. They can also lead to impaired freshwater quality that is cleaned up at considerable taxpayer expense. Many of these chemicals attach themselves to the stream bottom (sediment) and to the fatty tissue of fish and other animals. In the case of persistent organic pollutants, or POPs, the chemicals build up with each successive eater in the food chain. In most cases, we are seeing contamination which lasts for over 30 years even if the chemical has stopped being used. Flame retardants (polybrominated diphenyl ethers) and PCBs, are examples.

Increases in impervious surfaces also increase the delivery of bacteria and pathogens - associated with the fecal waste of wild, domestic and human animals. Some of these can cause illness in humans from swimming or contact with contaminated waters or beaches or from eating contaminated shellfish. Potential illnesses and afflictions that can result include general intestinal distress, giardia, hepatitis and a range of other ailments.

4.1.3.5 Coastal Development

“Smart Growth" strategies in both BC and Washington encompass these elements:

- Growth Management
- Land Use Planning and Urban Design
- Economic Incentives
- Demand Management Practices (creating the demand for innovative products and services)

- Watershed and Integrated Natural Resource Management

Washington State adopted the Growth Management Act (GMA) in 1990-1991 (Revised Code of Washington, Title 36, Chapter 36.70A), requiring a comprehensive approach to managing growth. The Act requires:

- Adoption of local and regional plans to manage growth
- Designation and protection of environmentally critical areas
- Consistency between jurisdictions' local plans, and consistency between plans and development regulations, so that adopted policies guide our day-to-day actions

More recent amendments have integrated GMA with other environmental regulations such as the State Environmental Policy Act, to streamline the processes without compromising the protections. Please see the Urbanization and Forest Change indicator for more detail regarding the GMA.

4.1.3.6 Regional Growth Management (Provincial Legislation)

Coastal development intensifies use of coastal resources, resulting in potential impacts on water quality, wildlife and fish habitat, air quality, and intensity of land and ocean use. Coastal development is therefore closely regulated in Washington, Oregon, and California. (See Section 6.1.1 for a detailed discussion of regulation of activities in the coastal zone.) New development in the coastal zone may require a permit from the California Coastal Commission, Washington State's coastal zone management program, Oregon's Coastal Management Plan, or a local government to which permitting authority has been delegated by the Coastal Management Agency. A Coastal Development Permit is generally required for any project in the Coastal Zone that includes:

- the placement of any solid material or structure;
- a change in land use density or intensity (including any land division);
- change in the intensity of water use or access to water; or
- removal of major vegetation.

Some types of development are exempt from coastal permitting requirements, including in many cases, repairs and improvements to single-family homes, certain "temporary events," and, under specified conditions, replacement of structures destroyed by natural disaster.

Local Coastal Programs (LCPs) identify the locations, types, densities and other ground rules for future development in the coastal-zone portions of all cities and counties along the coast. Each LCP includes a land-use plan and its implementing measures (e.g., zoning ordinances). Prepared by local government and approved by the Coastal Commission, these programs govern decisions that affect the conservation and use of coastal resources. While each LCP reflects the unique characteristics of individual local coastal communities, regional and statewide concerns must also be addressed in conformity with the goals and policies of the State Coastal Act.

LCPs are basic planning tools used by local governments to guide development in the coastal zone, in partnership with the Coastal Commission. LCPs contain the ground rules for future development and protection of coastal resources in the coastal cities and counties, including Clallam, Jefferson, San Juan, Skagit, Snohomish, King, Kitsap, Mason, and Grays Harbor Counties. The LCPs specify appropriate location, type, and scale of new or changed uses of land and water. Each LCP includes a land use plan and measures to implement the plan (such as zoning ordinances). Following adoption by a city council or county board of supervisors, an LCP is submitted to the Coastal Commission for review for consistency with Coastal Act requirements.

Coastal development in the PACNW is both intensive and extensive, and the coast adjacent to the NWTRC is densely populated. This development has impacted and continues to impact coastal resources in ROI including through: point source and non-point source pollution; intensive boating and other recreational use; intensive commercial and recreational sport fishing; intensive ship traffic using major port facilities at Seattle, Tacoma, and Everett. Regulation of these activities through the Coastal Development programs discussed above serves primarily to limit new development; however, the coastal zone is already fully developed in many areas, with associated ongoing impacts.

4.1.3.7 Scientific Research

There are currently 30 scientific research permits and General Authorizations for research issued by the National Marine Fisheries Service (NMFS) for cetacean work in the wild in the North Pacific. The most invasive research involves tagging or biopsy while the remainder focuses on vessel and aerial surveys and close approach for photo-identification. Species covered by these permits and authorizations include small odontocetes, sperm whales and large mysticetes. One permit issued to the Office of Protected Resources of NMFS allows for responses to strandings and entanglements of listed marine mammals. NMFS has also issued General Authorizations for commercial photography of non-listed marine mammals, provided that the activity does not rise to Level A Harassment of the animals. These authorizations are usually issued for no more than 1 or 2 years, depending on the project.

The impacts of this type of research are largely unmeasured. However, given the analysis and scrutiny given to permit applications, it is assumed that any adverse effects are largely transitory (e.g., inadvertent harassment, biopsy effects, etc.). Data to assess population level effects from research are not currently available, and even if data were available it is uncertain that research effects could be separately identified from other adverse effects on cetacean populations in PACNW waters.

4.1.3.8 Commercial and General Aviation

The PACNW is served by several large commercial airports. Seattle-Tacoma International Airport (Sea-Tac), Bellingham International (Whatcom County), and Jefferson County International (Jefferson County) are all situated on or nearby the coastline, while Spokane International Airport is situated in Spokane County, approximately 20 miles west of the Idaho border.

Smaller general aviation airports are located throughout the PACNW and increase low altitude traffic. Aircraft operating under visual flight rules (VFR) can fly south along the coast largely unrestrained between Washington and other states and east to inland destinations except by safety requirements and mandated traffic flow requirements. Aircraft operating under Instrument Flight Rules (IFR) clearances, authorized by the FAA, normally fly on the airway route structures. In the PACNW these routes include both high- and low- altitude routes between neighboring airports. Three Control Area Extensions (CAE), that run from the PACNW through the offshore warning areas, facilitate access to the airways to Hawaii and other trans-Pacific locations. All three CAEs follow routes that remain clear of W-237, W-570, and W-93. When any warning areas are active, aircraft on IFR clearances are precluded from entering the areas by the FAA. However, since W-237, W-570, and W-93 are located entirely over international waters, nonparticipating aircraft operating under VFR are not prohibited from entering the area. Examples of aircraft flights of this nature include light aircraft, fish spotters, and whale watchers.

4.1.3.9 Air Quality Factors

In the EPA emission inventories by category for 2004 and projected for 2020, the PSGB includes emissions from aircraft, ships, and commercial boats. Emissions estimates are based on emissions from onshore or nearshore activities. These emissions would account for a small percentage of the overall air emissions budget and in air quality planning because they are assumed to have a negligible effect on the ambient air quality, and because reductions in emissions from these sources would not generate a great improvement in the ambient air quality. The Community Multi-scale Air Quality (CMAQ) modeling system was selected to study ozone and aerosol concentrations and the visibility impacts of the aerosol concentrations in the PACNW. This was undertaken as part of the Northwest Regional Modeling Center (NWRMC) CMAQ demonstration project to demonstrate the applicability of CMAQ to the PACNW and to establish a virtual modeling center accessible to all Northwest air quality stakeholders. The domain encompasses the States of Washington, Oregon, and Idaho, and a large portion of southwestern Canada. Two emission inventories (EI) were developed for this project for the July 1-15, 1996 period. Anthropogenic emissions for the first EI were based upon the National Emission Trend 1996 (NET 1996) database, and biogenic emissions were obtained from the BEIS2 biogenic emissions model. The NET96 data were at a 36 kilometers (km) resolution and required interpolation to the 12 km PACNW domain. Anthropogenic emissions for the second EI were developed as a "ground up" approach by the NWRMC, and biogenic emissions were obtained from the GLOBEIS biogenic emissions model (Washington State 2008).

4.1.4 Habitats of Migratory Marine Animals

Migratory or wide-ranging marine mammals and sea turtles that may be present in the NWTRC may be affected by natural events and anthropogenic activities that occur in areas far removed from the PACNW, on breeding grounds, migration routes, wintering areas, or other habitats within a species' range. Events and activities that affect the habitats of these marine species outside the NWTRC include:

- Disease
- Natural toxins
- Weather and climatic influences
- Navigation errors
- Natural predation
- Fishing
- Hunting (although there are no nesting areas in the NWTRC, sea turtle egg predation is included here)
- Ocean pollution
- Habitat modification or destruction
- Ship traffic

These stressors on marine habitats and associated effects on marine mammals and sea turtles occurring outside the NWTRC are discussed in detail below.

4.2 CUMULATIVE IMPACT ANALYSIS

4.2.1 Geology and Soils

Cumulative impacts on geology and soils would consist of the combined effects of the Proposed Action and other actions and activities that could alter the local topography or disturb surface soils. Under the Proposed Action, potential impacts to soils may arise from direct disturbance from ordnance explosions, contamination of soils from explosive materials, and vehicle and personnel movement. These activities, would contribute locally and incrementally to increased sediment transport and deposition; however, the cumulative effects on local geology would still be negligible relative to the scale of the natural processes within the area of analysis for geology and soils (refer to Table 4-1). Under the Proposed Action, the Navy would continue to implement its' current protective measures. Therefore, the cumulative effects on geology and soils from implementation of the Proposed Action in combination with past, present, or planned projects and other activities would be minimal.

4.2.2 Air Quality

Activities affecting air quality in the region include, but are not limited to, mobile sources such as automobiles and aircraft, and stationary sources such as power generating stations, manufacturing operations and other industry, and the like. The Puget Sound Georgia Air Basin includes emissions from aircrafts, ships, and commercial boats; these emissions are included in the mobile source category. Traditionally, the emission estimates are based on emissions from onshore or nearshore activities. Emission estimates for these sources are summarized in Table 4-4.

Table 4-4: Emissions Estimates

Emission Source	Emissions, tons/year					
	CO	NOx	ROG	SOx	PM_{10}	$PM_{2.5}$
Within U.S. Territory						
Aircraft Operations	1.35	3.68	0.21	0.19	1.87	1.85
Marine Vessel Operations	3.80	4.50	0.34	0.95	0.16	0.16
Ordnance	0.92	0.06	0.00	0.00	0.09	0.09
Ground Vehicles	1.49	0.12	0.08	0.00	0.00	0.00
Total	**7.56**	**8.36**	**0.63**	**1.13**	**2.12**	**2.10**
Outside U.S. Territory						
Aircraft Operations	4.89	21.62	1.09	1.02	10.25	10.15
Marine Vessel Operations	137.98	85.70	12.43	22.57	4.65	4.60
Total	**142.87**	**107.32**	**13.52**	**23.59**	**14.90**	**14.75**

These emissions would account for a small percentage of the overall air emissions budgets for each of the air basins. They do not include marine vessel emissions for vessels operating outside of U.S. territorial waters. These emissions are generally not included in the State Implementation Plan (SIP) emissions budget and in air quality planning because they are assumed to have a negligible effect on the ambient air quality, and because reductions in emissions from these sources would not generate a great improvement in the ambient air quality. Therefore, the cumulative effects on air quality from implementation of the Proposed Action in combination with past, present, or planned projects and other activities would be minimal.

4.2.3 Hazardous Materials and Wastes

Cumulative impacts associated with hazardous materials and wastes would consist of the combined effects of the Proposed Action and other actions and activities (refer to Section 4.1.2 and 4.1.3) that would use large quantities of hazardous materials, or that would otherwise affect the hazardous materials management system.

The Proposed Action would increase releases to the environment of hazardous materials (expended training materials), but these releases are predicted to have no adverse effects (see Section 3.3). The Navy's existing hazardous materials and hazardous wastes management systems responsible for safely storing and transporting these materials would be able to accommodate the anticipated increases in throughput. No substantial adverse effects have been identified.

The primary impact of hazardous materials use in the marine and terrestrial environment would be an increase in the amounts of munitions, petroleum products or other chemicals that are released. Hazardous materials settling out of the water column would contribute to contamination of ocean bottom sediments. Relevant activities would include releases of hazardous constituents from fishing vessels or other ocean vessels and non-point source pollution from terrestrial sources.

Commercial ocean industries, such as fishing and ocean transport, are dispersed over broad areas of the Pacific Ocean. There is no central point of contaminant discharge, but the intensity of ocean uses, and correspondingly the density of hazardous materials discharges, generally declines with increasing distance from the coast. Discharges of hazardous constituents from non-point source runoff and treatment plant outfalls contribute contaminants to the area, mostly affecting the waters within three nautical miles of the coast. Ocean currents and sediment transport processes disperse the released materials over a large area. Overall, the quality of Pacific Ocean waters and bottom sediments offshore are relatively high, indicating that current releases of hazardous materials are generally not causing substantial adverse effects. Releases of hazardous materials under the Proposed Action, along with those of other reasonably foreseeable future projects and activities, would not substantially alter the quantities of these materials being discharged, and thus would not substantially affect resources in the Study Area.

Generally, hazardous materials used on land consist primarily of fuels and other petroleum products; paint, adhesives, glues, other coatings; and other materials used in construction. Use of these materials is closely regulated by local, state, and federal agencies, and off-site releases of substantial quantities of these items is rare. The overall risk of a substantial release of such materials from the Proposed Action or other projects is low.

Hazardous wastes generated aboard vessels engaged in training activities under the Proposed Action would offload those wastes to Navy shore facilities, where they would become part of the overall hazardous waste stream managed by the appropriate Navy facility. Increased levels of training would result in increased throughput of hazardous wastes, but likely would not require additional storage, transport, or disposal facilities ashore for these materials. The Navy's hazardous waste management system and procedures are adequate to accommodate an increase in hazardous waste volumes. Other hazardous waste generators in the region, along with the Navy, would require the services of hazardous waste transporters and treatment, storage, and disposal facilities. While the costs for hazardous waste transport, treatment, storage, and disposal could increase substantially in response to increased cumulative demand, the hazardous waste management industry in the region has sufficient physical capacity to respond to this increased demand.

Therefore, the cumulative effects of hazardous materials uses and hazardous waste generation from the Proposed Action and other reasonably foreseeable future projects and activities on environmental resources and on the regional hazardous wastes treatment, storage, and disposal infrastructure would be minimal.

4.2.4 Water Resources

Cumulative impacts on water resources would consist of the effects of the Proposed Action when added to other projects and actions that affect marine, surface or ground water hydrology; that release potential water pollutants or otherwise result in long-term degradation of marine, surface, or ground water quality; that deposit sediment or debris, alter bathymetry, or disturb ocean bottom sediments; and that have substantial effects on public uses of State or federal waters.

The Proposed Action is expected to have no substantial effects on marine, surface, or ground water quality (see Section 3.4). The Proposed Action would affect marine geology and sediments by creating craters in bottom sediments and depositing training debris on the ocean bottom. The Proposed Action is expected to increase the level of marine sediment disturbance but not to a substantial degree (see Section 3.4). It also is expected to disturb small areas of benthic habitat in combination with underwater detonations required for training. No substantial increases in erosion or off-site sediment transport, or changes in topography are predicted. The Proposed Action would expend training materials (see Table 3.4-32) some of which would not be recovered. However, overall, no substantial adverse effects on marine sediments were identified for the Proposed Action.

The Proposed Action would be consistent with the National Ambient Water Quality Criteria. Releases of potential water contaminants from proposed training activities would be minimal, and no long-term degradation of water quality would occur. Cumulative impacts on marine, surface, or ground water quality and marine sediments would consist of the aggregate effects of the Proposed Action and other military and civilian projects and activities within the Study Area. Navy training would result in materials expended in the water that are considered pollutants; however, compliance with federal and state regulations would limit the release of such pollutants to *de minimis* amounts, which would not result in substantial cumulative effects. In addition, cumulative effects would be negligible relative to the scale of the natural processes operating in the Study Area. Therefore, there would be no cumulative effects on water resources from implementation of the Proposed Action in combination with past, present, or planned projects and other activities within the Study Area.

4.2.5 Acoustic Environment (Airborne)

The Proposed Action activities in the NWTRC Ocean OPAREAs were deemed to have insignificant effects on the marine (airborne) noise environment, due in large part to the absence of human sensitive receptors on these sea ranges. Commercial ship and aircraft traffic, tidal wave generators, and recreational activities all would contribute occasional, short-term noise to small portions of the ocean operating area of the NWTRC. The airborne noises they generate would consist chiefly of short-term intrusive noise events in different locations at different times, similar to those of the Proposed Action. Thus, little or no overlap in location or time of discrete noise events would be expected. Peak and average community noise levels would remain largely unchanged. Additionally, human noise receptors would still be absent. Accordingly, cumulative impacts on the marine noise environment would be less than significant.

Cumulative noise sources on Whidbey Island and within the Puget Sound would include range activities, training, and maintenance activities not included in the Proposed Action. Noise from these activities generally would consist of short-term, intrusive noise events at EOD locations and the airfield. Noise levels from flight activities exceeding ambient background sound levels typically occur beneath main approach and departure corridors, beneath local air traffic patterns around an airfield, and in areas immediately adjacent to parking ramps and aircraft staging areas. As aircraft in flight gain altitude, their noise contribution drops to lower levels, often becoming indistinguishable from the background noise.

A portion of the sound attributable to training and testing events in those portions of the NWTRC closest to shore (within three nautical miles), on shore, or over land results from helicopter flights associated with mine countermeasures training, or insertion/extraction. Helicopter noise associated with mine countermeasures training at Crescent Harbor and insertion/extraction training at Crescent Harbor, Seaplane Base, and OLF Coupeville takes place within the existing higher noise contours established by the EA-6B and newer E/A-18G. Likewise, the replacement aircraft for the P-3 (P-8 MMA) will also operate within these noise contours. Helicopter noise in these areas would be either indistinguishable from the background jet noise or masked by the louder jet noise. Mine Countermeasure (MCM) training at Crescent Harbor takes place at a lesser extent offshore from Indian Island (six percent) and at Floral Point (six percent). Airborne noise associated with MCM activities is limited because the detonations take place underwater.

Sound in the nearshore or overland portions of the Range Complex can also result from higher-altitude, fixed-wing aircraft noise associated with electronic combat and air combat maneuvers throughout the inland Military Operating Areas (MOAs), such as Olympic, Darrington, Okanagan, and Roosevelt. Most overland training flights typically occur at altitudes over 10,000 feet above ground level. As mentioned above, high-altitude flight noise is often indistinguishable from the background noise.

An environmental assessment was prepared for the establishment of the Okanagan MOA in 1976 (U.S. Air Force [USAF] 1976). As stated in the environmental assessment, noise impacts were expected to be minimal in that the areas lie over sparsely populated mountainous forest terrain with minimum altitudes over 5,000 feet above any populated centers (USAF 1976). The frequency of use is spread over a large enough area that recurring passage over the same place is only by chance. Recreation centers were not likely to be affected. Average noise levels could not be computed, since aircraft fly random flight paths within the areas. All aircraft operate at subsonic speed while at low level altitudes and while over land. Supersonic flights and their associated sonic booms are conducted only in the Offshore Area under conditions approved by the Navy. Other MOAs overlie similarly sparsely populated areas, and aircraft passage over the same place is only by chance. Commercial flight paths occur throughout these areas as well but only increase effects with background overhead noise from high altitude fly over. Other recreational aircraft would be found in the areas but only a minor effect would be had by these flights; it would not be likely that recreational aircraft would continue occurring over the same areas because recreational aircraft operate without strict flight paths.

Airborne sound from Navy training in the nearshore or on-land portions of the complex can stem from the occasional land demolition at the Seaplane Base or Naval Base Kitsap (NBK) Bangor detonation training range. Land demolition training occurs primarily at Seaplane Base (94 percent), and has been occurring at Seaplane Base for approximately 15 years. UAS flights from Admiralty Bay would also contribute to noise in this area to a minor extent as well.

While persons on recreational or fishing vessels in the Puget Sound, Straight of Juan de Fuca, Crescent Harbor, Admiralty Bay, and Hood Canal might be exposed to sound generated by military activities, sound levels would be low and would cause mild interference with non-participant vessels in the area of training.

Sensitive receptors are those noise-sensitive areas, including developed and undeveloped areas for land uses such as residences, businesses, schools, churches, libraries, hospitals, and parks. Military personnel are not considered to be sensitive receptors of airborne noise for purposes of environmental impact analysis. The nearest shore-based sensitive receptors would be located in residences and community facilities outside of the Seaplane Base and near Crescent Harbor. Sensitive receptors at these locations may experience occasional noise associated with land demolitions and helicopter flight training in this area. Local noise associated with small airfields in the Puget Sound area as well as commercial aircraft generated from local international airports would also contribute to the overall noise of the area. Recreational watercraft and commercial shipping will also contribute to the noise found in the Puget Sound. Levels will be higher during peak seasons and weekend operation of these vessels.

In the area of airborne sound, the primary impacts of proposed Navy activities are geographically isolated from population centers and otherwise will not affect natural resources. Thus, noise impacts from these proposed activities would be minimal. Therefore, there would be no cumulative effects on the acoustic environment as a result of implementation of the Proposed Action in combination with past, present, or planned projects and other activities within the Study Area.

4.2.6 Marine Plants and Invertebrates

Potential cumulative impacts on marine plants and invertebrates in the NWTRC include releases of chemicals into the ocean, introduction of debris into the water column and onto the seafloor, and mortality and injury of marine organisms near the detonation or impact point of ordnance or explosives.

Materials expended during training include sonobuoys; parachutes and nylon cord; towed, stationary, and remote-controlled targets; inert ordnance; unexploded ordnance, and fragments from exploded ordnance, including missiles, bombs, and shells. Materials include a variety of plastics, metals, and batteries. Unless otherwise noted in the discussion or the table, targets are not recovered. Most of these materials are inert and dense, and will settle to the bottom where they will eventually be covered with sediment or encrusted by physical or biological processes.

Detonated ordnance used in mine countermeasure training produce negligible amounts of solid materials because the bulk of the explosive is consumed in the explosion. Other material effects from commercial and recreational fishing, point-source pollution accumulation, and other non-point source pollution sources would contribute to a much greater extent to the material wastes found in the Puget Sound and northwest areas. The presence of persistent organic compounds such as DDT and PCBs from non-Navy sources are of particular concern. In light of these concerns, Navy activities would have small or negligible potential impacts.

The Proposed Action was evaluated for long-term effects on marine communities that would result from explosions, based on their force, location, and proximity to the bottom. Short-term effects, including increases in local turbidity and the creation of shallow depressions in bottom sediments, were not considered because they disappear relatively quickly under the influence of ocean and tidal currents and the natural sediment transport processes that operate continuously in the ocean and the sound.

Based on the analysis presented in Section 3.6, there would be no long-term changes to species abundance or diversity, no loss or degradation of sensitive habitats, and no effects to threatened and endangered species. None of the potential impacts would affect the sustainability of resources, the regional ecosystem, or the human community. Therefore, there would be no cumulative effects on marine plants and invertebrates as a result of implementation of the Proposed Action in combination with past, present, or planned projects and other activities within the Study Area.

4.2.7 Fish

Potential cumulative impacts of Navy training exercises include the release of hazardous materials into the ocean, introduction of debris into the water column and onto the seafloor, mortality and injury of marine organisms and fish near the detonation or impact point of ordnance or explosives, and physical and acoustic impacts of vessel activity. The overall effect on fish stocks would be negligible additions to impacts of commercial and recreational fishing in the NWTRC Study Area.

The NWRTC Study Area includes critical habitat areas designated for the Puget Sound chinook salmon, Hood Canal summer-run chum salmon, and Coastal-Puget Sound bull trout. Threatened species potentially affected include the Puget Sound chinook salmon ESU, Hood Canal summer-run chum salmon ESU, Coastal-Puget Sound bull trout DPS, and Puget Sound steelhead trout DPS.

Due to the wide geographic separation of most of the activities, Navy activities would have small or negligible potential impact, and their potential impacts are not additive or synergistic. Relatively small number of fish would be killed by shock waves from mines, inert bombs, and intact missiles and targets hitting the water surface. These and other types of activities common to many exercises or tests have less-than-significant effects on fish; aircraft, missile, and target overflights; muzzle blasts from 5-inch guns; releases of munitions constituents; falling debris and small arms rounds; entanglement in military-related debris; and chaff and flares. As described in Section 3.7, there would be no long-term changes in species abundance or diversity, and no loss or degradation of sensitive habitats. Explosive ordnance may result in injury or mortality to individual fish but would not result in impacts to fish populations.

Underwater explosives may result in disturbance, injury, or mortality to ESA-listed salmonid species. However, under the Proposed Action, the total number of underwater detonations would decrease from 60 events to 4 events annually. While a decrease in underwater detonations under the Proposed Action would reduce the likelihood of impacts to salmonid species, effects from underwater detonations would have the potential to affect juvenile populations of salmon and bull trout based on the size of the charge and the distance from the shoreline that the explosions occur. When adults are in the general vicinity of the training areas, they too could be injured or killed as a result.

In June 2008, NMFS issued a Biological Opinion for Navy EOD Operations in three locations in Puget Sound, concluding that EOD is not likely to jeopardize the continued existence of the Puget Sound Chinook salmon, Hood Canal summer-run chum salmon, or Puget Sound steelhead trout. NMFS further concluded that EOD activities are not likely to adversely modify critical habitat of Puget Sound Chinook salmon or Hood Canal summer-run chum salmon (NMFS 2008).

Based on the analysis provided in Section 3.8, impacts to fish from explosions would be possible, but have a low potential for occurrence. While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of underwater detonations and high explosive ordnance use, explosions would not result in impacts to fish populations based on the low number of fish that would be affected. Disturbances to water column and benthic habitats from explosions would be short-term and localized. The Navy conducts a limited number of training activities over a large area (112,241 nm^2 [430,000 km^2]). Habitat disturbance and fish injury and mortality from explosions are reduced by Navy mitigation measures, as discussed in Section 3.7.1.6. Therefore, no long-term changes in species abundance or diversity, no loss or degradation of sensitive habitats, and only potential effects to threatened and endangered species may occur. In addition, based on the analysis provided in Section 3.8, none of the potential impacts would affect EFH, sustainability of resources, the regional ecosystem, or the human community.

Navy activities coupled with other consistent underwater noise sources from commercial and recreational noises would not create a considerable impact (refer to Section 3.8). Therefore, there would be no cumulative effects related to fish as a result of implementation of the Proposed Action in combination with past, present, or planned projects in the Study Area.

4.2.8 Sea Turtles

The only species of sea turtle expected to occur regularly in the NWTRC Study Area is the leatherback turtle (refer to Section 3.8). The Study Area is an important foraging habitat for leatherbacks that nest in Indonesia, although the turtles appear to cluster in different locations within the region during different years (DoN 2007).

Leatherback turtles are globally distributed. Leatherback turtle nesting grounds are located around the world, with the largest remaining nesting assemblages found on the coasts of northern South America and West Africa. The U.S. Caribbean, primarily Puerto Rico and the U.S. Virgin Islands, and southeast Florida support minor nesting colonies, but represent the most significant nesting activity within the United States. Adult leatherbacks are capable of tolerating a wide range of water temperatures, and have been sighted along the entire continental coast of the United States as far north as the Gulf of Maine and south to Puerto Rico, the U.S. Virgin Islands, and into the Gulf of Mexico. The Pacific Ocean leatherback population is generally smaller in size than that in the Atlantic Ocean. Leatherback turtles are endangered throughout their range (NOAA 2007).

Incidental ‘take’ in fishing operations, or bycatch, is one of the most serious threats to sea turtle populations. In the Pacific, NMFS requires measures (e.g., gear modifications, changes to fishing practices, and time/area closures) to reduce sea turtle bycatch in the Hawaii- and California-based pelagic longline fisheries and the California/Oregon drift gillnet fishery.

Because of the high potential for interactions between leatherback turtles and drift gillnet fisheries off the U.S. west coast during periods of warmer water, the NMFS has designated the eastern north Pacific Ocean area as a “Pacific Leatherback Conservation Zone.” (See Figure 3.8-2 in Section 3.8.) Within this zone from August 15 through November 15 every year, fishing with drift gillnets with a mesh size equal to or greater than 14 inches (36 centimeters) is prohibited. The conservation zone is roughly located between Point Conception, California (34 27’N) and northern Oregon (45 N), and is described fully in 50 CFR 660.713(c). The Pacific Leatherback Conservation Zone protects this species from gillnets at the time of the year when they are known to reside off the U.S. west coast.

Sea turtles can be affected by marine debris when it is ingested or they become entangled in debris (e.g., tar balls, plastic bags, plastic pellets, balloons, and ghost fishing gear). Marine pollution from coastal runoff, marina and dock construction, dredging, aquaculture, oil and gas exploration and extraction, increased underwater noise, and boat traffic can also degrade marine habitats used by sea turtles. In addition, sea turtles swimming or feeding at or just beneath the surface of the water are vulnerable to boat and vessel strikes, which can result in serious propeller injuries and death. The nature is which some sea turtle species function within the marine ecosystem is still poorly understood. Global climate change could potentially have an extensive impact on all aspects of a turtle's life cycle, as well as impact the abundance and distribution of prey items. Loss or degradation of nesting habitat resulting from erosion control through beach nourishment and armoring, beachfront development, artificial lighting, and non-native vegetation is a serious threat affecting nesting females and hatchlings (NOAA 2007).

Temporary disturbances associated with NWTRC activities could result in an incremental contribution to cumulative impacts on leatherback turtles. However, protective measures identified in Section 3.8.1.3 would minimize any potential adverse effects on leatherback turtles. Implementation of the Proposed Action is not likely to affect the species’ or stock’s annual rates of recruitment or survival. Therefore, the incremental impacts of the Proposed Action would not present a significant contribution to the effects on leatherback turtles when added to effects from other past, present, and reasonably foreseeable future actions.

4.2.9 Marine Mammals

Risks to marine mammals emanate primarily from ship strikes, exposure to chemical toxins or biotoxins, exposure to fishing equipment that may result in entanglements, and disruption or depletion of food sources from fishing pressure and other environmental factors. Potential cumulative impacts of Navy activities on marine mammals would result from ship strikes, commercial fishing, and various anthropogenic sources.

Stressors on marine mammals and marine mammal populations can include both natural and human-influenced causes listed below and described in the following sections:

Natural Stressors

- Disease
- Natural toxins
- Weather and climatic influences
- Navigation errors
- Social cohesion

Human-Influenced Stressors

- Ship strikes
- Pollution and ingestion
- Noise

4.2.9.1 Natural Stressors

Significant natural causes of mortality, die-offs, and stranding discussed below include disease and parasitism; marine neurotoxins from algae; navigation errors that lead to inadvertent stranding; and climatic influences that impact the distribution and abundance of potential food resources (i.e., starvation) (Table 4-5). Stranding also is caused by predation by other species such as sharks (Cockcroft et al. 1989; Heithaus, 2001), killer whales (Constantine et al. 1998; Guinet et al. 2000; Pitman et al. 2001), and some species of pinnipeds (Hiruki et al. 1999; Robinson et al. 1999).

Disease

Like other mammals, marine mammals frequently suffer from a variety of diseases of viral, bacterial, and fungal origin (Visser et al., 1991; Dunn et al., 2001; Harwood, 2002). Gulland and Hall (2005, 2007) provide a summary of individual and population effects of marine mammal diseases.

Marine Neurotoxins

Some single-celled marine algae common in coastal waters, such as dinoflagellates and diatoms, produce toxic compounds that can bio-accumulate in the flesh and organs of fish and invertebrates (Geraci et al., 1999; Harwood, 2002). Marine mammals become exposed to these compounds when they eat prey contaminated by these naturally produced toxins (Van Dolah, 2005).

Table 4-5: Marine Mammal Unusual Mortality Events in the Pacific Attributed to or Suspected From Natural Causes 1978-2005

Year	Species	Location	Cause
1978	Hawaiian monk seals	NW Hawaiian Islands	Ciguatoxin and maitotoxin
1983	Multiple pinniped species	West coast of U.S., Galapagos	El Nino
1984	California sea lions	California	Leptospirosis
1987	Sea otters	Alaska	Saxitoxin
1995	California sea lions	California	Leptospirosis
1997-98	California sea lions	California	El Nino
1998	California sea lions	California	Domoic acid
1998	Hooker's sea lions	New Zealand	Unknown, bacteria likely
2000	California sea lions	California	Leptospirosis
2000	California sea lions	California	Domoic acid
2000	Harbor seals	California	Unknown; Viral pneumonia suspected
2002	Multispecies (common dolphins, California sea lions, sea otters)	California	Domoic acid
2002	Hooker's sea lions	New Zealand	Pneumonia
2003	Multispecies (common dolphins, California sea lions, sea otters)	California	Domoic acid
2003	Beluga whales	Alaska	Ecological factors
2003	Sea otters	California	Ecological factors
2004	California sea lions	Canada, U.S. West Coast	Leptospirosis
2005	California sea lions; Northern fur seals	California	Domoic acid

Note: Data from Gulland and Hall (2007); citations for each event contained in Gulland and Hall (2007)

Weather Events and Climate Influences

Severe storms, hurricanes, typhoons, and prolonged temperature extremes may lead to local marine mammal strandings (Geraci et al. 1999; Walsh et al. 2001). Storms in 1982-1983 along the California coast led to deaths of 2,000 northern elephant seal pups (Le Boeuf and Reiter 1991). Seasonal oceanographic conditions in terms of weather, frontal systems, and local currents may also play a role in stranding (Walker et al. 2005).

The effect of large-scale climatic changes to the world's oceans and how these changes impact marine mammals and influence strandings are difficult to quantify, given the broad spatial and temporal scales involved, and the cryptic movement patterns of marine mammals (Moore 2005; Learmonth et al. 2006).

The most immediate, although indirect, effect is decreased prey availability during unusual conditions. This, in turn, results in increased search effort required by marine mammals (Crocker et al. 2006), potential starvation if not successful, and corresponding stranding due directly to starvation or succumbing to disease or predation while in a weakened, stressed state (Selzer and Payne 1988; Geraci et al. 1999; Moore, 2005; Learmonth et al. 2006; Weise et al. 2006).

Navigational Error

Geomagnetism- Like some land animals and birds, marine mammals may be able to orient to the Earth's magnetic field as a navigational cue, and areas of local magnetic anomalies may influence strandings (Bauer et al., 1985; Klinowska 1985; Kirschvink et al. 1986; Klinowska 1986; Walker et al., 1992; Wartzok and Ketten 1999).

Echolocation Disruption in Shallow Water- Some researchers believe stranding may result from reductions in the effectiveness of echolocation in shallow water, especially in the pelagic species of odontocetes who may be less familiar with coastlines (Dudok van Heel, 1966; Chambers and James, 2005). For an odontocete, echoes from echolocation signals contain important information on the location and identity of underwater objects and the shoreline. The authors postulate that the gradual slope of a beach may present difficulties to the navigational systems of some cetaceans, since live strandings commonly occur along beaches with shallow, sandy gradients (Brabyn and McLean 1992; Mazzuca et al. 1999; Maldini et al. 2005; Walker et al. 2005). A factor contributing to echolocation interference in turbulent, shallow water is the presence of microbubbles from the interaction of wind, breaking waves, and currents. Additionally, ocean water near the shoreline can have an increased turbidity (e.g., floating sand or silt, particulate plant matter) due to the run-off of fresh water into the ocean, either from rainfall or from freshwater outflows (e.g., rivers and creeks). Collectively, these factors can reduce and scatter the sound energy in echolocation signals and reduce the perceptibility of returning echoes of interest.

Social Cohesion

Many pelagic species such as sperm whales, pilot whales, melon-head whales, false killer whales, and some dolphins occur in groups with strong social bonds between individuals. When one or more animals strand due to any number of causative events, then the entire pod may follow suit out of social cohesion (Geraci et al. 1999; Conner 2000; Perrin and Geraci 2002; NMFS 2007a).

4.2.9.2 Anthropogenic Stressors

During the past few decades there has been an increase in marine mammal mortalities associated with a variety of human activities (Geraci et al. 1999; NMFS 2007a) (Figure 4-1). These activities include fisheries interactions (bycatch and directed catch), pollution (marine debris, toxic compounds), habitat modification (degradation, prey reduction), ship strikes (Laist et al., 2001), and gunshots.

Fisheries Interaction: By-Catch, Directed Catch, and Entanglement

The incidental catch of marine mammals in commercial fisheries is a significant threat to the survival and recovery of many populations of marine mammals (Geraci et al. 1999; Baird et al. 2002; Culik 2002; Carretta et al., 2004; Geraci and Lounsbury 2005; NMFS, 2007a). Interactions with fisheries and entanglement in discarded or lost gear continue to be a major factor in marine mammal deaths worldwide (Geraci et al. 1999; Nieri et al., 1999; Geraci and Lounsbury 2005; Read et al., 2006; Zeeberg et al., 2006). For instance, baleen whales and pinnipeds have been found entangled in nets, ropes, monofilament line, and other fishing gear that has been discarded out at sea (Geraci et al., 1999; Campagna et al., 2007).

Bycatch- Bycatch is the catching of non-target species within a given fishing operation and can include non-commercially used invertebrates, fish, sea turtles, birds, and marine mammals (NRC 2006). Read et al. (2006) attempted to estimate the magnitude of marine mammal bycatch in U.S. and global fisheries. Within U.S. fisheries, between 1990 and 1999, the mean annual bycatch of marine mammals was 6,215 animals. Eighty-four percent of cetacean bycatch occurred in gill-net fisheries, with dolphins and porpoises constituting most of the cetacean bycatch (Read et al., 2006). Over the last decade there was a 40 percent decline in marine mammal bycatch, primarily due to effective conservation measures that were implemented during this time period.

Read et al. (2006) extrapolated data for the same period (1990-1999) and calculated an annual estimate of 653,365 of marine mammals globally, with most of the world's bycatch occurring in gill-net fisheries. With global marine mammal bycatch likely to be in the hundreds of thousands every year, bycatch in fisheries will be the single greatest threat to many marine mammal populations around the world (Read et al. 2006).

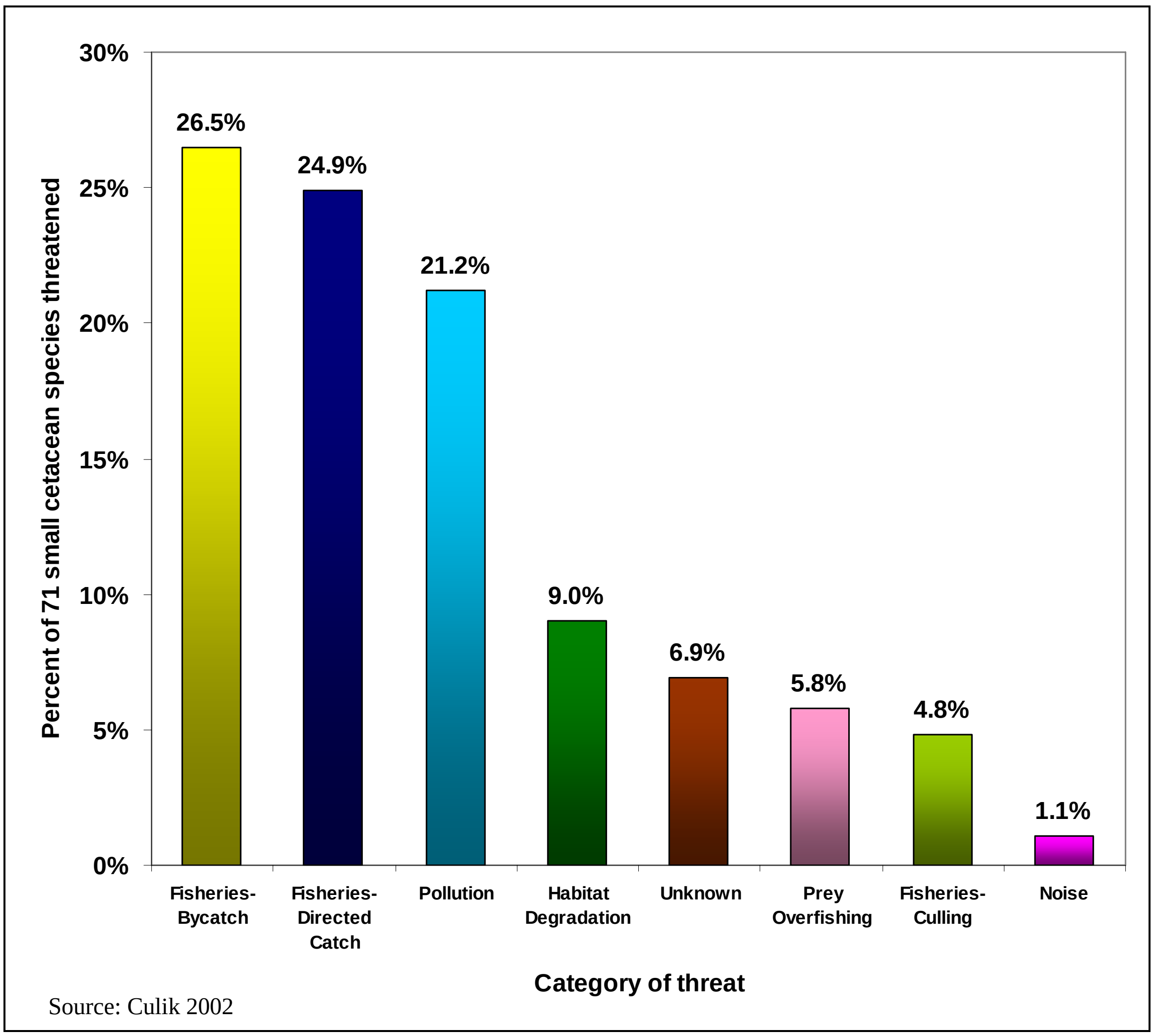

Figure 4-1: Human Threats to World-wide Small Cetacean Populations

Entanglement- Entanglement in active fishing gear is a major cause of death or severe injury among the endangered whales in the action area. Entangled marine mammals may die as a result of drowning, escape with pieces of gear still attached to their bodies, or manage to be set free either of their own accord or by fishermen. Many large whales carry off gear after becoming entangled (Read et al. 2006). When a marine mammal swims off with gear attached, the result can be fatal. The gear may become too cumbersome for the animal or it can be wrapped around a crucial body part and tighten over time. Stranded marine mammals frequently exhibit signs of previous fishery interaction, such as scarring or gear attached to their bodies. For stranded marine mammals, death is often attributed to such interactions (Baird and Gorgone, 2005). Because marine mammals that die due to fisheries interactions may not wash ashore and not all animals that do wash ashore exhibit clear signs of interactions, data probably underestimate fishery-related mortality and serious injury (NMFS, 2005).

From 1998-2005, based on observer records, five fin whales (CA/OR/WA stock), 12 humpback whales (ENP stock), and six sperm whales (CA/OR/WA stock) were either seriously injured or killed in fisheries off the west coast of the U.S. (California Marine Mammal Stranding Network Database 2006).

Ship Strike

Ship strikes of marine mammals are another cause of mortality and stranding (Laist et al., 2001; Geraci and Lounsbury, 2005; de Stephanis and Urquiola, 2006). An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or an animal just below the surface could be cut by a vessel’s propeller. The severity of injuries typically depends on the size and speed of the vessel and the size of the animal (Knowlton and Kraus, 2001; Laist et al., 2001; Vanderlaan and Taggart, 2007).

The growth in commercial ports and associated commercial vessel traffic is a result of the globalization in trade. The Final Report of the NOAA International Symposium on “Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology” stated that the worldwide commercial fleet has grown from approximately 30,000 vessels in 1950 to over 85,000 vessels in 1998 (NRC, 2003; Southall, 2005). It is unknown how international shipping volumes and densities will continue to grow. However, current statistics support the prediction that the international shipping fleet will continue to grow at the current rate or at greater rates in the future. Shipping densities in specific areas and trends in routing and vessel design are as, or more, significant than the total number of vessels. Densities along existing coastal routes are expected to increase both domestically and internationally. New routes are also expected to develop as new ports are opened and existing ports are expanded. Vessel propulsion systems are also advancing toward faster ships operating in higher sea states for lower operating costs; and container ships are expected to become larger along certain routes (Southall, 2005).

While there are reports and statistics of whales struck by vessels in U.S. waters, the magnitude of the risks that commercial ship traffic poses to marine mammal populations is difficult to quantify or estimate. In addition, there is limited information on vessel strike interactions between ships and marine mammals outside of U.S. waters (de Stephanis and Urquiola, 2006). Laist et al. (2001) concluded that ship collisions may have a negligible effect on most marine mammal populations in general, except for regionally-based small populations where the significance of low numbers of collisions would be greater, given smaller populations or populations segments.

U.S. Navy vessel traffic is a small fraction of the overall U.S. commercial and fishing vessel traffic. While U.S. Navy vessel movements may contribute to the ship strike threat, given the lookout and mitigation measures adopted by the U.S. Navy, probability of vessel strikes is greatly reduced. Furthermore, actions to avoid close interaction of U.S. Navy ships and marine mammals and sea turtles, such as maneuvering to keep away from any observed marine mammal and sea turtle are part of existing at-sea protocols and standard operating procedures. Navy ships have up to three or more dedicated and trained lookouts as well as two to three bridge watchstanders during at-sea movements who would be searching for any whales, sea turtles, or other obstacles on the water surface. Such lookouts are expected to further reduce the chances of a collision.

Ingestion of Plastic Objects and Other Marine Debris and Toxic Pollution Exposure

For many marine mammals, debris in the marine environment is a great hazard. Not only is debris a hazard because of possible entanglement, animals may mistake plastics and other debris for food (NMFS, 2007b). Sperm whales have been known to ingest plastic debris, such as plastic bags (Evans et al. 2003; Whitehead 2003). While this has led to mortality, the scale on which this is affecting sperm whale populations is unknown, but Whitehead (2003) suspects it is not substantial at this time.

High concentrations of potentially toxic substances within marine mammals along with an increase in new diseases have been documented in recent years. Scientists have begun to consider the possibility of a link between pollutants and marine mammal mortality events. NMFS takes part in a marine mammal bio-monitoring program not only to help assess the health and contaminant loads of marine mammals, but also to assist in determining anthropogenic impacts on marine mammals, marine food chains, and marine ecosystem health. Using strandings and bycatch animals, the program provides tissue/serum archiving, samples for analyses, disease monitoring and reporting, and additional response during disease investigations (NMFS, 2007).

The impacts of these activities are difficult to measure. However, some researchers have correlated contaminant exposure with possible adverse health effects in marine mammals (Borell 1993; O'Shea and Brownell 1994; O'Hara and Rice 1996; O'Hara et al. 1999).

The manmade chemical PCB (polychlorinated biphenyl), and the pesticide DDT (dichlorodiphyenyltrichloroethane), are both considered persistent organic pollutants that are currently banned in the United States for their harmful effects in wildlife and humans (NMFS, 2007c). Despite having been banned for decades, the levels of these compounds are still high in marine mammal tissue samples taken along U.S. coasts (Hickie et al. 2007; Krahn et al. 2007; NMFS, 2007c). Both compounds are long-lasting, reside in marine mammal fat tissues (especially in the blubber), and can have toxic effects such as reproductive impairment and immunosuppression (NMFS, 2007c).

In addition to direct effects, marine mammals are indirectly affected by habitat contamination that degrades prey species availability, or increases disease susceptibility (Geraci et al., 1999).

U.S. Navy vessel operation between ports and exercise locations has the potential to release small amounts of pollutant discharges into the water column. U.S. Navy vessels are not a typical source, however, of either pathogens or other contaminants with bioaccumulation potential such as pesticides and PCBs. Furthermore, any vessel discharges such as bilgewater and deck runoff associated with the vessels would be in accordance with international and U.S. requirements for eliminating or minimizing discharges of oil, garbage, and other substances, and not likely to contribute significant changes to ocean water quality or to affect marine mammals.

Anthropogenic Sound

As one of the potential stressors to marine mammal populations, noise and acoustic influences may disrupt marine mammal communication, navigational ability, and social patterns, and may or may not influence stranding. Many marine mammals use sound to communicate, navigate, locate prey, and sense their environment. Both anthropogenic and natural sounds may interfere with these functions, although comprehension of the type and magnitude of any behavioral or physiological responses resulting from man-made sound, and how these responses may contribute to strandings, is rudimentary at best (NMFS, 2007). Marine mammals may respond both behaviorally and physiologically to anthropogenic sound exposure (e.g., Richardson et al., 1995; Finneran et al., 2000; Finneran et al., 2003; Finneran et al., 2005). However, the range and magnitude of the behavioral response of marine mammals to various sound sources is highly variable (Richardson et al., 1995) and appears to depend on the species involved, the experience of the animal with the sound source, the motivation of the animal (e.g., feeding, mating), and the context of the exposure.

Marine mammals are regularly exposed to several sources of natural and anthropogenic sounds. Anthropogenic noise that could affect ambient noise arises from the following general types of activities in and near the sea, any combination of which can contribute to the total noise at any one place and time. These noises include: transportation; dredging; construction; oil, gas, and mineral exploration in offshore areas; geophysical (seismic) surveys; sonar; explosions; and ocean research activities (Richardson et al., 1995). Commercial fishing vessels, cruise ships, transport boats, recreational boats, and aircraft, all contribute sound into the ocean (NRC, 2003; NRC, 2006). Several investigators have argued that anthropogenic sources of noise have increased ambient noise levels in the ocean over the last 50 years (NRC 1994, 2003, 2005; Richardson et al., 1995; Jasny et al., 2005; McDonald et al., 2006). Much of this increase is due to increased shipping due to ships becoming more numerous and of larger tonnage (NRC, 2003; McDonald et al., 2006). Andrew et al. (2002) compared ocean ambient sound from the 1960s with the 1990s for a receiver off the California coast. The data showed an increase in ambient noise of approximately 10 decibel (dB) in the frequency range of 20 to 80 Hertz (Hz) and 200 and 300 Hz, and about 3 dB at 100 Hz over a 33-year period.

Sound emitted from large vessels, particularly in the course of transit, is the principal source of noise in the ocean today, primarily due to the properties of sound emitted by civilian cargo vessels (Richardson et al., 1995; Arveson and Vendittis, 2000). Ship propulsion and electricity generation engines, engine gearing, compressors, bilge and ballast pumps, as well as hydrodynamic flow surrounding a ship's hull and any hull protrusions, contribute to a large vessels' noise emissions in the marine environment. Prop-driven vessels also generate noise through cavitation, which accounts much of the noise emitted by a large vessel depending on its travel speed. Military vessels underway or involved in naval activities or exercises, also introduce anthropogenic noise into the marine environment. Noise emitted by large vessels can be characterized as low-frequency, continuous, and tonal. The sound pressure levels at the vessel will vary according to speed, burden, capacity, and length (Richardson et al., 1995; Arveson and Vendittis, 2000). Vessels ranging from 135 to 337 meters generate peak source sound levels from 169 - 200 dB between 8 Hz and 430 Hz, although Arveson and Vendittis (2000) documented components of higher frequencies (10-30 kHz) as a function of newer merchant ship engines and faster transit speeds. Given the propagation of low-frequency sounds, a large vessel in this sound range can be heard 139-463 kilometers away (Ross 1976 in Polefka 2004). U.S. Navy vessels, however, have incorporated significant underwater ship quieting technology to reduce their acoustic signature (as compared to a similarly-sized vessel) and thus reduce their vulnerability to detection by enemy passive acoustics (Southall, 2005).

Shipboard fathometers are another source of sound emitted from ships. Fathometers have acoustic source levels below 201 dB re 1 μPa at 1 m, generally in the high-frequency range. However, fathometers were not considered a sound source stressor given that at this source level (201 dB re 1 μPa at 1 m) or below, a high-frequency ping would attenuate rapidly over distance.

Naval sonars are designed for three primary functions: submarine hunting, mine hunting, and shipping surveillance. There are two classes of sonars employed by the U.S. Navy: active sonars and passive sonars. Most active military sonars operate in a limited number of areas, and are most likely not a significant contributor to a comprehensive global ocean noise budget (ICES 2005).

Both natural and human-induced factors affect the health of marine mammal populations. Temporary disturbance incidents associated with Navy activities on the NWTRC could result in an incremental contribution to cumulative impacts on mammals. Both current protective measures and additional mitigation measures identified in Section 3.9 would be implemented to minimize any potential adverse effects to marine mammals from Navy activities. Impacts associated with the Proposed Action may affect the species through effects on annual rates of recruitment or survival. The Navy is consulting with the NMFS in accordance with the MMPA concerning the potential for impacts to marine mammals resulting from NWTRC activities.

In addition to these activities, Naval Sea Systems Command (NAVSEA) Naval Undersea Warfare Center (NUWC) conducts research, development, test & evaluation (RDT&E) of future navy systems within the Study Area of the NWTRC EIS/OEIS. Based on modeling for NUWC's RDT&E activities (analyzed under a separate EIS/OEIS), estimated acoustic exposures from the use of active acoustic sources are provided in Tables 4-6 and 4-7 for the Dabob Bay Range Complex (DBRC) and the Quinault Underwater Tracking Range (QUTR) sites (see Figure 4-2 and Figure 4-3). Local impacts on marine mammals may be increased with these activities and other past, present, and reasonably foreseeable future actions.

Table 4-6: Estimated Annual MMPA Level B Exposures for Inshore Area - DBRC Site

Species	EL TTS (Level B) Exposures	Risk Function Behavioral Exposures
Killer Whale	0	0
California Sea Lion	0	109
Harbor Seal	1,998	3,320
Total Level B Exposures (by criteria method)	1,998	3,429

Table 4-7: Estimated Annual MMPA Level B Exposures for Offshore Area - QUTR Site

Species	EL TTS (Level B) Exposures	Risk Function Behavioral Exposures
Endangered or Threatened Species		
Blue Whale	0	0
Fin Whale	0	0
Humpback Whale	0	0
Sei Whale	0	0
Sperm Whale	0	0
Killer Whale	0	0
Steller Sea Lion	0	0
Non-ESA Listed Species		
Minke Whale	0	0
Gray Whale	0	0
Dwarf and Pygmy Sperm Whale	0	0
Baird's Beaked Whale	0	0
Mesoplodons	0	0
Risso's Dolphin	0	0
Pacific White Sided Dolphin	0	0
Short Beaked Common Dolphin	0	0
Striped Dolphin	0	0
Northern Right Whale Dolphin	0	0
Dall's Porpoise	0	0
Harbor Porpoise	1	11,282
Northern Fur Seal	0	44
California Sea Lion	0	5

Table 4-7: Estimated Annual MMPA Level B Exposures for Offshore Area - QUTR Site (continued)

Species	EL TTS (Level B) Exposures	Risk Function Behavioral Exposures
Non-ESA Listed Species		
Northern Elephant Seal	0	14
Harbor Seal	23	78
Total Level B Exposures (by criteria method)	24	11,423

4.2.10 Birds

Cumulative impacts on seabirds would consist of the effects of the Proposed Action in conjunction with other projects, actions, and processes that would result in an incremental increase in mortality, disturbance, and habitat modification within the Study Area. Sea bird populations within the NWTRC are affected by direct and indirect perturbations to breeding and foraging locations on the coastal mainland and inshore areas. The single greatest concern is the loss of suitable habitat for nesting and roosting seabirds throughout coastal northwest due to land development and human encroachment. Historically, seabird populations have sustained numerous impacts from pollution and human activities within the PACNORWEST from a variety of sources, including the discharge of hazardous chemicals and sewage. Though the Proposed Action does not directly reduce available seabird habitat within the NWTRC, current seabird populations residing within the Study Area become more susceptible to potential impacts due to the concentrated nature of those populations. By default, open space within military installations in coastal locations has become vital to the persistence of seabird breeding and roosting populations.

Land range operations could affect breeding seabirds if the operational footprint encompassed nesting areas during breeding seasons. Current data on breeding seabird populations that overlap with training operations in or near coastal areas are either unavailable or incomplete, making a comprehensive effects analysis difficult. Though most offshore operations take place in oceanic waters well offshore, are of short duration, and have a small operational footprint, the importance of avoiding sensitive seabird colonies and reducing disturbance should be paramount when accessing new or ongoing training activities.

Training activities concentrated in or near coastal areas or offshore OPAREAs, or taking place at regular intervals, would disturb local seabird roosting colonies. The coastal and offshore OPAREAs within the NWTRC provide suitable seabird habitat adjacent to training areas, allowing potentially affected seabirds adequate alternative locations to avoid interactions with training operations. Continued expansion of commercial and private aircraft and ocean-going vessels through the Range Complex, together with increased NWTRC training activities, elevates the potential for direct and indirect impacts on isolated seabird populations. The control of non-native plants and animals within coastal areas and on islands must continue to be addressed by land owners to ensure further degradation of seabird populations does not occur. Large-scale effects on seabird populations such as global warming, reduced fish populations, and development in other regions or countries are not well defined for individual species but have been attributed to the overall decline of seabirds.

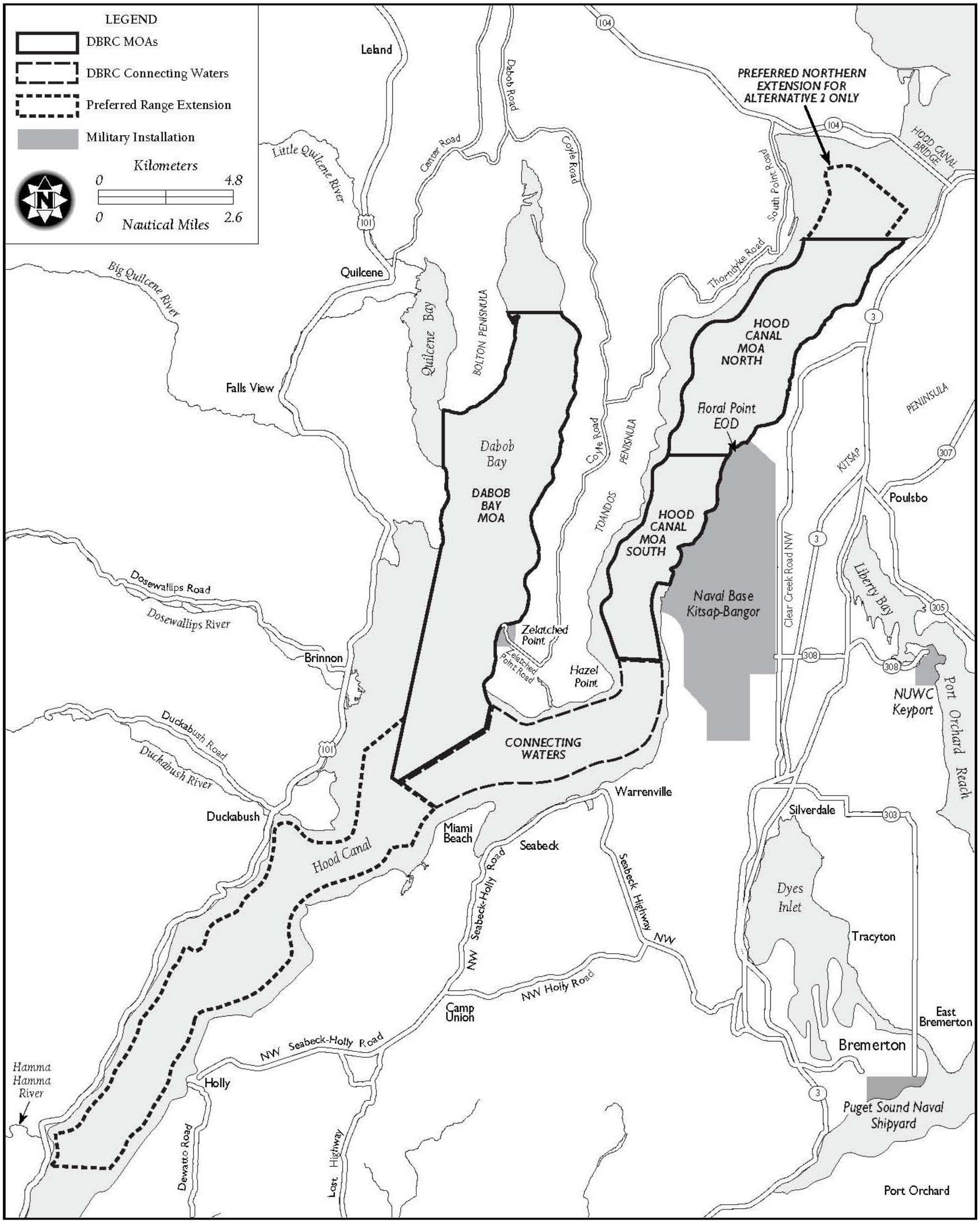

Figure 4-2: Dabob Bay Range Complex Preferred Site Extension Alternative

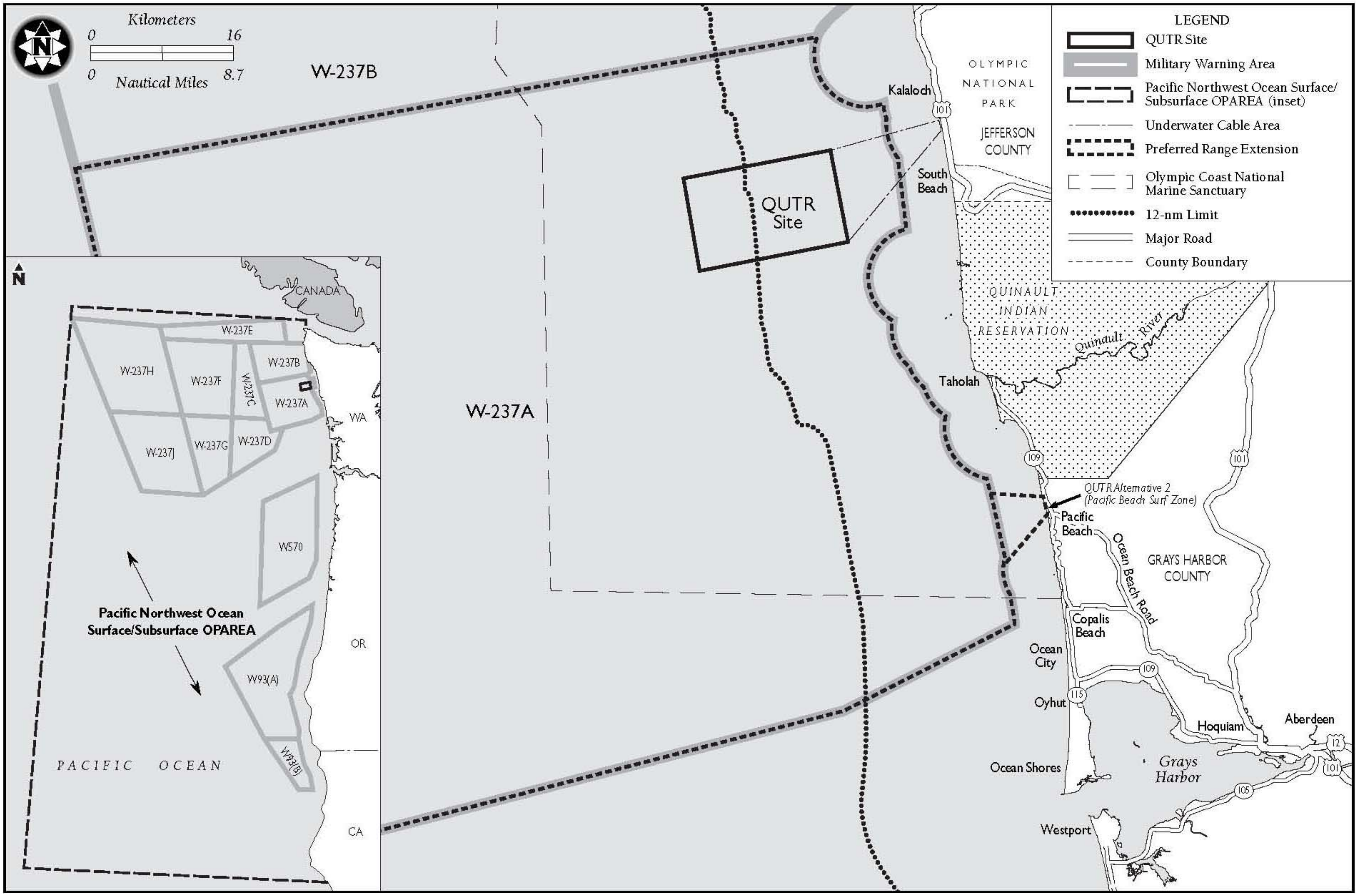

Figure 4-3: Quinault Underwater Tracking Range Preferred Range Extension Alternative

Listed sea bird species in the NWTRC include the Short-tailed Albatross, the Marbeled Murrelet, the California Brown Pelican, and the Western Snowy Plover. In accordance with ESA, under the Proposed Action, vessel movements, aircraft overflights, ordnance use, underwater explosions and detonations, and entanglement may affect but are not likely to adversely affect the listed sea bird species population, overall foraging success, or breeding opportunities. The cumulative impact of the Proposed Action and the identified projects activities in Section 4.1.2 and 4.1.3 could impact individual seabirds, their overall foraging success, and breeding opportunity, but these effects are not likely to adversely affect any seabird population. Therefore, there would be no cumulative effects related to seabirds as a result of implementation of the Proposed Action in conjunction with past, present, or planned projects in the Study Area.

4.2.11 Terrestrial Biological Resources

The analysis for cumulative impacts to terrestrial biology focuses on fire, invasive species, erosion, or habitat modification from past, present and future actions. These actions are evaluated based on the area the individual action encompasses and the value and type of habitat known to occur within the specific footprint. Damage to a resource is considered significant if the area of impact is substantial compared to habitat availability or scarcity, and whether the impacted resource has a special sensitivity status as recognized by resource agencies. An effect is also considered significant if the intensity, duration, or frequency of the action is such that the area cannot recolonize to former species abundance levels; the loss of habitat or habitat value (based on organism density or relative abundance) is considered permanent compared to background variation in these conditions.

Several activities contribute cumulatively to habitat degradation, including disturbance to soils and vegetation, spread of invasive non-native species, erosion and sedimentation, and impacts on native plant species. However, some potential effects of invasive species are difficult to foresee (such as leading to a change in fire frequency or intensity). It is clear, however, that the potential for damage associated with introduction or spread of invasive plant species is high and increases over time with repeated training missions, especially exercises that cover a very large area. This is due to the difficulty in effectively monitoring for invasive establishment and achieving timely control. The Navy is addressing these effects in several important ways including implementation of the NASWI INRMP and the NBC-Bangor INRMP and continued development and implementation of measures to prevent the establishment of invasive plant species by minimizing the potential for introductions of seed or other plant parts (propagules) of exotic species and finding and eliminating incipient populations before they are able to spread (DoN 1996).

Navy projects within the Puget Sound other than the Proposed Action and other activities, such as those identified in Section 4.1.2 and 4.1.3 also could impact terrestrial biological resources. Any such project in the NWTRC would be required to be in compliance with the established INRMP and U.S. Fish and Wildlife Service Biological Opinions issued after Endangered Species Act Section 7 consultation addressing direct, indirect, and cumulative impacts. As identified in Section 3.11, there are numerous potential impacts of the Proposed Action on terrestrial biology on Whidbey and Indian Islands. These impacts have the potential for significant cumulative impact on such resources. Mitigation measures identified in this EIS/OEIS, considered together with any additional mitigation or conservation measures that might be appropriate after Section 7 consultation, however, will substantially mitigate direct, indirect, and cumulative effects of the Proposed Action.

4.2.12 Cultural Resources

Cumulative impacts on cultural resources would consist of the effects of the Proposed Action in combination with other projects, actions, and processes that would result in potential impacts on cultural, archaeological, and historic sites.

This EIS/OEIS determined that the Proposed Action would have little or no potential to impact underwater cultural resources within the Study Area, primarily because most of the Proposed Action's activities were on or above the surface and cultural resources, if any, are on the ocean bottom. Project activities would not generally disturb areas where cultural resources are known or expected to be present. For the same reason, most other ongoing and anticipated ocean activities such as commercial ship traffic, fishing, oil and gas development, or scientific research, would not substantially affect underwater cultural resources.

This EIS/OEIS examined the potential for impacts on cultural, archaeological, and historic sites in the NWTRC OPAREA. Due to the large number of known and estimated cultural sites on Whidbey Island, the use of the island and underwater ranges for training and other Naval Special Warfare activities, the Proposed Action could increase the potential for significant impacts. However, implementation of protective measures as described in Section 3.12.2.1.6 should reduce impacts to a level less than significant. Any activities with the potential for significant impacts on cultural resources will require Section 106 consultation, and would be mitigated as required.

Any proposed construction projects and activity on Whidbey Island as well as on the Olympic Peninsula and Indian Island areas with the potential to disturb cultural resources would be required to evaluate their potential effects and, if necessary, implement mitigation measures similar to those described for the Proposed Action. Where avoidance was practiced, no cumulative effect would result because no contact with the resource would occur. Where data recovery was practiced, the cumulative effect would be that more cultural sites underwent data recovery and removal than would occur under the Proposed Action alone.

4.2.13 Traffic (Airspace)

Cumulative impacts on airspace traffic would consist of the effects of the Proposed Action in combination with other projects, actions, and processes that would result in increased air traffic volumes or conflicts in the Study Area. The region that includes the NWTRC does not propose any expansion of military Special Use Airspace, and would not produce any significant regional cumulative traffic impacts. While hazardous activities in W-237, W-570, and W-93 are in progress, vessel traffic, forewarned through publication of the related Notice to Mariners (NOTMAR) and Notice to Airmen (NOTAM), would avoid the affected area. While hazardous activities occur within the inland Military Operating Areas (MOA), military flight plans are coordinated with Seattle ARTCC. Although the resultant detour might be inconvenient, it would not preclude the affected vessel from arriving at his destination. Coordination with the Federal Aviation Administration on matters affecting airspace significantly reduces or eliminates the possibility of indirect adverse impacts and associated cumulative impacts on civil aviation and airspace use.

4.2.14 Socioeconomics

Cumulative impacts on socioeconomics would consist of the effects of the Proposed Action in combination with other projects, actions, and processes that would result in any significant effect to regional employment, income, housing, or infrastructure. Implementation of the Proposed Action would not produce any significant regional employment, income, housing, or infrastructure impacts. Effects on commercial and recreational fishermen, divers, and boaters would be short-term in nature and produce some temporary access limitations. Some offshore activities, especially if coincident with peak fishing locations and periods, could cause temporary displacement and potential economic loss to individual fishermen. However, most offshore activities are of short duration and have a small operational footprint. Effects on fishermen are mitigated by a series of Navy initiatives, including public notification of scheduled activities, near-real time schedule updates, prompt notification of schedule changes, and adjustment of hazardous operations areas. In selected instances where safety requires exclusive use of a specific area, fishermen may be asked to relocate to a safer nearby area for the duration of the exercise. These measures should not significantly impact any individual fisherman, overall commercial revenue, or public recreational opportunities. Therefore, the Proposed Action would not result in significant cumulative socioeconomic impacts.

4.2.15 Environmental Justice and Protection of Children

Based on the analysis in Section 3.11, implementation of Proposed Action would have no disproportionate effect on minority or low-income population or expose environmental hazards to children. Therefore, no cumulative impacts would occur since the incremental impact of the Proposed Action is not significant when added to effects of the other projects considered for cumulative analysis.

4.2.16 Public Safety

Cumulative impacts on public safety would consist of the combined effects of the Proposed Action and other projects, actions, and processes that would result in increased public health and safety risks. Navy training poses risks to the public primarily through offsite aircraft and vessel activities, underwater detonations, and intrusion of the public into designated training areas. Aircraft and marine vessel support for Navy training activities would increase, but public safety is expected to be maintained through the continued issuance of NOTMARs and NOTAMS (see Section 3.16).

Cumulative impacts on Public Health and Safety would consist of the aggregate effects of the Proposed Action and other projects, actions, and processes that could increase risks to people within the Study Area. Relevant effects in marine areas would include danger from recreational and commercial fishing, ship collisions, and other natural ocean dangers. Relevant effects in terrestrial areas would include danger from hazardous training activities. The cumulative effects of these activities are known only in a very general sense.

Marine, terrestrial, and naval training activities could affect nearby individuals; however this potential is mitigated by thorough USCG regulations on the water, vehicle and traffic laws of surrounding areas, and local ordinances. Navy range clearance measures within the restricted areas and active monitoring for non-participant activity are mitigation measures established by the military to prevent harm. Training and support activities, such as aircraft and watercraft transiting to and from the training areas, have the most potential for impacts on public health and safety.

The Proposed Action and other activities performed and proposed by surrounding commercial, industrial, and recreational interests do not normally increase the risk of impacts on health and public safety resources. The incremental impacts of the Proposed Action do not represent any appreciable contribution to cumulative health and safety risks when added to other past, present, and reasonably foreseeable future actions. Therefore, there would be no cumulative effects on public health and safety from implementation of the Proposed Action when added to past, present, or planned projects in the Study Area.

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5 Mitigation

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5 MITIGATION MEASURES

Effective training in the proposed Northwest Training Range Complex (NWTRC) dictates that ship, submarine, and aircraft participants utilize their sensors and weapon systems to their optimum capabilities as required by the exercise objectives. The Navy recognizes that such use has the potential to cause behavioral disruption of some marine mammal species in the vicinity of training (as outlined in Chapter 3). National Environmental Policy Act (NEPA) regulations require that an Environmental Impact Statement (EIS) include analysis of appropriate mitigation measures not already included in the Proposed Action or alternatives (40 Code of Federal Regulations [CFR] § 1502.14 [h]). Each of the alternatives, including the Proposed Action considered in this EIS/Overseas EIS (OEIS), includes mitigation measures intended to reduce the environmental effects of Navy activities as discussed throughout this EIS/OEIS.

This chapter presents the Navy's standard protective measures in detail, outlining steps that would be implemented to protect marine mammals and federally listed species during training events. These protective measures will mitigate impacts resulting from training. It should be noted that protective measures have been standard operating procedures since 2004 for all levels of training. This chapter also presents a discussion of other measures that have been considered but not adopted because they were determined either: (1) not feasible; (2) to present a safety risk; (3) to provide no known or ambiguous protective benefit; or (4) to have an unacceptable impact on training fidelity.

5.1 CURRENT REQUIREMENTS AND PRACTICES

5.1.1 Geology and Soils

The Navy currently monitors and will continue to monitor the condition of soils and vegetation in its operating areas. It also employs adaptive management to control erosion associated with the existing roads and ranges (DoN 2007). In addition to the site-specific measures above, existing plans and policies are in place to limit the effects of training on the environment at Seaplane Base Whidbey Island (DoN 1996).

The surface layers of disturbed soils have been modified during construction or removed for use as ballast or landfill material. The subsurface characteristics of the original soil have usually not been altered, and control the movement of water on and through the soils. Current Navy protective practices for geological and soil resources include:

- Locate ground-disturbing activities on previously disturbed sites whenever possible.
- Ensure that all project work areas, including transit routes necessary to reach sites, are clearly identified or marked. Restrict vehicular activities to designated/previously identified areas.
- Continue to manage erosion control through the Site Approval Process, whereby the Navy reviews each proposed project for its erosion potential, and involves the natural resource specialist in the process.
- Off-road vehicle use is not permitted except in designated off-road areas or on established trails.

5.1.2 Air Quality

Emissions that may affect air quality are heavily regulated under the Clean Air Act and its implementing regulations, through a comprehensive Federal / State regulatory process (see Section 3.2). Consistent with these regulatory requirements and processes, the Navy has implemented comprehensive air quality management programs to ensure compliance.

5.1.3 Hazardous Materials and Wastes

Releases or discharges of hazardous materials are heavily regulated through comprehensive federal and state processes. In addition, the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) prohibits certain discharges of oil, garbage, and other substances from vessels. The MARPOL convention is implemented by national legislation, including the Act to Prevent Pollution from Ships (33 USC 1901, et seq.) and the Federal Water Pollution Control Act ("Clean Water Act"; 33 USC 1321, et seq.). These and other requirements are implemented by the *Navy Environmental and Natural Resources Program Manual* (OPNAVINST 5090.1C, 2007) and related Navy guidance documents that require hazardous materials to be stored and handled appropriately, both on shore and afloat.

The Navy has also implemented hazardous materials management programs to ensure compliance and provide guidance on handling and disposing of such materials. Navy instructions include stringent discharge, storage, and pollution prevention measures and require facility managers to reduce, to the extent possible, quantities of toxic substances released into the environment. All Navy vessels and facilities have comprehensive programs in place that implement responsible stewardship, hazardous materials management and minimization, pollution prevention, recycling, and spill prevention and response. These and other programs allow Navy ships to retain used and excess hazardous material on board for shore offload within five working days of arrival at a Navy port. All activities can return excess and unused hazardous materials to the Navy's Hazardous Material Minimization Centers. Additional information regarding water discharge restrictions for Navy vessels is provided in Table 3.4-1, Water Resources.

The Navy currently monitors and will continue to monitor the condition of soils and vegetation in its operating areas (DoN 2007b). It also employs adaptive management to control erosion associated with the existing roads and ranges. In addition to the site-specific measures above, existing plans and policies are in place to limit the effects of training on the environment at Seaplane Base Whidbey Island (DoN 1996). Additional information regarding current Navy protective practices for geological and soil resources were previously discussed in Section 5.1.1, within the Geology and Soils section.

5.1.4 Water Resources

Environmental compliance policies and procedures applicable to operations ashore and at sea are identified in Navy instructions that include directives regarding waste management, pollution prevention, and recycling. The Navy's current requirements and practices provide protection for water resources. Measures that reduce potential impacts to water resources include creation and adherence to storm water management plans, erosion control, maintaining vegetative buffers adjacent to waterways, and enforcement of pollution permit requirements (NPDES).

At sea, Navy vessels are required to operate in a manner that minimizes or eliminates any adverse impacts to the marine environment. Environmental compliance polices and procedures applicable to shipboard operations afloat are defined in the *Navy Environmental and Natural Resources Program Manual* (OPNAVINST 5090.1C, 2007), Chapter 4, "Pollution Prevention," and Chapter 22, "Environmental Compliance Afloat"; DoD Instruction 5000.2-R (§C5.2.3.5.10.8, "Pollution Prevention") (DoN, 2003). In addition, provisions in Executive Order (EO) 12856, *Federal Compliance With Right-To-Know Laws and Pollution Prevention Requirements*, and EO 13101, *Greening the Government through Waste Prevention, Recycling, and Federal Acquisition* reinforce the CWA's prohibition against discharge of harmful quantities of hazardous substances into or upon U.S. waters out to 200 nm (371 km), and mandate stringent hazardous waste discharge, storage, dumping, and pollution prevention requirements. Table 3.4-1 provides information on Navy SOPs and BMPs for shipboard management, storage, and discharge of hazardous materials and wastes, and on other pollution protection measures intended to protect water quality. Onshore, policies and procedures related to spills of oil and hazardous materials are detailed in OPNAVISNT 5090.1C, Chapter 12.

Shipboard waste-handling procedures governing the discharge of non-hazardous waste streams have been established for commercial and Navy vessels. These categories of wastes include solids (garbage) and liquids such as “black water” (sewage), “grey water” (water from deck drains, showers, dishwashers, laundries, etc.), and oily wastes (oil-water mixtures). Table 5-1 summarizes the waste stream discharge restrictions for Navy vessels at sea.

Table 5-1: Waste Discharge Restrictions for Navy Vessels

Zone (nm from shore)	Type of Waste	
	Black Water (Sewage)	**Gray Water**
U.S. Waters (0-3 nm)	No discharge.	If vessel is equipped to collect gray water, pump out when in port. If no collection capability exists, direct discharge permitted.
U.S. Contiguous Zone (3-12 nm)	Direct discharge permitted.	Direct discharge permitted.
>12 nm from shore	Direct discharge permitted.	Direct discharge permitted.
Zone	**Oily Waste**	**Garbage (Non-plastic)**
U.S. Waters (0-3 nm)	Discharge allowed if waste has no visible sheen. If equipped with Oil Content Monitor (OCM), discharge < 15 ppm oil.	No discharge.
U.S. Contiguous Zone (3-12 nm)	Same as 0-3 nm.	Pulped garbage may be discharged.
>12 nm from shore	If equipped with OCM, discharge < 15 ppm oil. Vessels with Oil/Water Separator but no OCM must process all bilge water through the oil-water separator.	Direct discharge permitted.
Zone	**Garbage (Plastic) (Non-food-contaminated)**	**Garbage (Plastic) (food-contaminated)**
U.S. Waters (0-3 nm)	No discharge.	No discharge.
U.S. Contiguous Zone (3-12 nm)	No discharge.	No discharge.
12-50 nm from shore	No discharge.	No discharge.
> 50 nm from shore	Retain last 20 days before return to port. Discharge if necessary.	Retain last three days before return to port. Discharge if necessary.

Source: Northern Division 1996; Office of the Chief of Naval Operations 1994

5.1.5 Acoustic Environment (Airborne)

Navy activities in the NWTRC OPAREAs comply with numerous established acoustic control procedures to ensure that neither participants nor non-participants engage in activities that would endanger life or property. SOPs for minimizing airborne noise impacts in the NWTRC fall into two categories; aircraft SOPs and EOD SOPs.

Aircraft SOPs are largely oriented toward safety, which also provide significant noise abatement benefits. For example many SOPs involve flight routing and minimum altitudes. Each of these procedures increases the range of the noise source from human receptors, thus reducing noise impacts. As stated in DoN (2006), all training and operational flights are to be conducted to have a minimum impact on surrounding communities. Each aircrew shall be familiar with the noise profiles of their aircraft and shall be committed to minimizing noise impacts without compromising operational and safety requirements (DoN 2006).

EOD measures include the following for reducing noise impacts during land detonation training:

- Detonation training will be conducted only during normal working hours (8:00 AM to 5:00 PM).
- Detonation training will be conducted only during days when the weather is favorable. Studies have shown that variation of temperature and wind velocity with altitude can cause a noise event to be inaudible at one time (favorable) and audible at another time (unfavorable). Favorable and unfavorable conditions are described in Table 5-2.

Table 5-2. Favorable and Unfavorable Detonation Conditions

Favorable Conditions	Unfavorable Conditions
• Clear skies with billowy cloud formations, especially during warm periods of the day • A rising barometer immediately following a storm	• Days of steady winds of 5-10 mph with gusts of greater velocities (above 20 mph) in any direction • Clear days on which layering of smoke or fog are observed • Cold, hazy or foggy mornings • Days following a day when large extremes of temperature (greater than 20 degrees C) between day and night are noted • Generally high barometer readings with low temperatures

Military personnel who might be exposed to sound in the air from military activities, such as military aircraft, land detonations or at sea detonations heard on the surface of the ocean, are required to take precautions, such as the wearing of protective equipment, to reduce or eliminate potential harmful effects of such exposure. With regard to potential exposure of non-military personnel in the ocean, Puget Sound areas, and inland OPAREAs, precautions are taken pursuant to SOPs to prevent such exposure. These include advance notice of scheduled training activities to the public and the commercial fishing community via the worldwide web, Notices to Mariners (NOTMARs), and Notices to Airmen (NOTAMs). In addition, range safety SOPs ensure that civilians are excluded from, and if necessary removed from areas of military activities, or that military activities do not occur when civilians are present. These procedures have proven to be effective at minimizing potential military / civilian interactions in the course of training or other military activities.

5.1.6 Marine Plants and Invertebrates

The Navy has no existing protective measures in place specifically for marine plants and invertebrates. However, marine plants and invertebrates benefit from measures in place to protect marine mammals and sea turtles (see Section 5.1.8).

5.1.7 Fish

The following protective measures for fish and fish habitat exist for activities involving underwater detonations.

- At the Crescent Harbor and Indian Island Underwater EOD Ranges, during the juvenile salmonid migration season (July 1 through September 30), charges larger than 2.5 pounds will not be used. If it is necessary to use charges larger than 2.5 pounds, and up to 20 pounds, these charges will be detonated at least 3,280 feet from the nearest shoreline.
- At the Floral Point Underwater EOD Range, charges larger than one pound shall not be used during the juvenile salmonid migration season (March 15 through July 1).

5.1.8 Birds

Avoidance of seabirds and their nesting and roosting habitats provides the greatest degree of protective measure from potential impacts within the NWTRC. Currently, the majority of aircraft activities that might affect seabirds are concentrated at NASWI and Outlying Landing Field (OLF) Coupeville where the potential for bird aircraft strikes exists. Pursuant to Navy instruction, measures to evaluate and reduce of eliminate this hazard to aircraft, aircrews, and birds are implemented. Additionally, guidance involving land or water detonations contains instructions to personnel to observe the surrounding area within 600 yds (585 m) for 30 minutes prior to detonation. If birds (or marine mammals or sea turtles) are seen, the operation must be relocated to an unoccupied area or postponed until animals leave the area. Monitoring of seabird populations and colonies by conservation groups and researchers is conducted intermittently within coastal areas and offshore islands with limited support from various military commands. In an effort to reduce potential impacts to marbled murrelets, the Navy will conduct sea bird surveys. The Navy currently surveys for all seabirds and marine mammals that may be within the designated impact zone, the same “go, no go” status will be applicable to murrelets, as well.

5.1.9 Terrestrial Biological Resources

The Navy implements measures to avoid, minimize, or compensate for its effects on biological resources including listed species in the NWTRC. Key management and monitoring activities include continued implementation of the NASWI Integrated Natural Resources Management Plan (INRMP). Further, the Navy proposes to implement additional measures to mitigate the environmental effects of its activities. The following is a comprehensive list of current and proposed mitigation measures intended to reduce effects of military activities on biological resources of Whidbey Island.

5.1.9.1 Threatened and Endangered Species

There are no current protective measures designed specifically for threatened and endangered species.

5.1.9.2 Soils

The Navy will monitor and provide a means for adaptive management of erosion associated with the existing roads and ranges. In addition to the site-specific measures above, existing plans and policies are in place to limit the effects of construction and training on the environment at Seaplane Base Whidbey Island.

Additionally, because OLF Coupeville is managed as a federal property, activities are required to comply with the federal Soil Conservation Act. Federal land owners are required to control and prevent erosion by conducting surveys and implementing conservation measures (Soil Conservation Act, 16 U.S.C. § 5901).

Current Navy protective practices for geological and soil resources include:

- Locate ground-disturbing activities on previously disturbed sites whenever possible.
- Ensure that all project work areas, including transit routes necessary to reach sites, are clearly identified or marked. Restrict vehicular activities to designated/previously identified areas.
- Continue to manage erosion control through the Site Approval Process, whereby the Navy reviews each proposed project for its erosion potential, and involves the Natural Resource Specialist in the process.
- Off-road vehicle use is not permitted except in designated off-road areas or on established trails.

5.1.10 Cultural Resources

Section 3.12.1 details protective measures implemented with regard to cultural resources on Whidbey Island (submerged cultural resources in ocean areas are unaffected by Navy activities). In the open ocean, most of the Pacific Coast Treaty Tribal Fishing Grounds lie within the Olympic Coast National Marine Sanctuary, which is within Warning Areas W237A and W237B.

Base Cultural Resources Programs would strive to preserve and protect their cultural resource sites, including efforts to retain the integrity of cultural sites that, over time, could deteriorate, erode, or be damaged by human actions. Protective measures would include keeping current and future human activities off of known sites, or when this is not possible, minimizing impacts on those sites. Projects would consider the probability for occurrence of hunter-gatherer (prehistoric/protohistoric) resources in areas along the salt-water beaches, shell middens, or eroding shorelines.

Locations and extent of NRHP eligible/listed archaeological resources would not be made public or provided to navy personnel other than on a need to know basis until such time as they may be displayed and interpreted in a manner that provides protection from vandalism. Protective measures would be described in the Historic and Archaeological Resources Protection (HARP) Plan for the individual base, and compatible with HARP goals.

NRHP resources would be managed in a manner that is compatible with the military mission of the individual base and its tenant commands. Navy actions would be planned to avoid potential NRHP resources, including shipwrecks. Natural resources projects that involve ground disturbing activities would be processed through the HARP program manager to avoid damage to historic properties. Resource treatment would be cognizant of the base ICRMP.

Discovery of archaeological evidence of previous human occupation would cause work to stop on any base undertaking, the discovery would be protected from damage, and Federal, State, and tribal authorities would be notified as appropriate. The resource would be evaluated for NRHP significance (36 CFR 800), and mitigation measures developed in consultation with the State Historic Preservation Officer (SHPO) and, as appropriate, the Tribal Historic Preservation Officer (THPO).

For management purposes, sites deemed eligible for the NRHP would be treated in exactly the same manner as sites that are actually listed in the NRHP. Archaeological sites and historic structures and sites that have not been evaluated for NRHP significance would be considered eligible until evaluation is completed, and projects in areas where eligibility for the NRHP has not been determined would require coordination and consultation as proscribed in Section 106 of the NHPA.

Tribal Historic Preservation Officers or appropriate tribal representatives would be contacted prior to Navy undertakings in undeveloped areas. Consultation and coordination would aid in reducing potential impacts of intrusions on traditional practices. Traditional cultural properties would be protected through the Section 106 consultation process.

The Navy has established protective measures to reduce potential effects on cultural and natural resources from training exercises. Some are generally applicable, while others apply to particular geographic areas during specific times of year for certain types of Navy training activities. These measures are based on environmental analyses conducted by the Navy for coastal waters and for land and sea ranges.

Most of these protective measures are focused on protection of the natural environment. Such protective measures also benefit culturally valued natural resources such as salmon and shellfish. Some of the protective measures include use of inert ordnance and passive tracking and acoustical tools, avoidance of sensitive habitats, and visually monitoring areas to ensure significant concentrations of sea life are not present.

Areas along the northwest Washington coastline were designated in 2002 as an area to be avoided (ATBA) by ships and barges carrying oil or hazardous materials and by all ships 1,600 gross tons and above that are solely in transit. The ATBA has helped reduce near shore vessel traffic and traffic within the tribal treaty fishing grounds as well as helping to protect the Olympic Coast National Marine Sanctuary and its resources valued by tribes. This measure is voluntary and places no new requirements on Navy ships.

5.1.11 Traffic

The Navy strives to ensure that it retains access to ocean training areas and special use airspace (SUA) as necessary to accomplish its mission, while facilitating joint military-civilian use of such areas to the extent practicable and consistent with safety. These goals of military access, joint use, and safety are promoted through various coordination and outreach measures, including:

- Publication of NOTAM advising of the status and nature of activities being conducted in W-237, W-570, W-93, and other components of SUA in the NWTRC Study Area.
- Return of SUA to civilian Federal Aviation Administration (FAA) control when not in use for military activities. To accommodate the joint use of SUA, a Letter of Agreement is in place between the Navy and the Seattle Air Traffic Control Center (ARTCC). The LOA defines the conditions and procedures to ensure safe and efficient joint use of waning areas.
- Publication of NOTMAR and other outreach. The Navy provides information about training activities planned for the NWTRC OPAREAs, for publication by the U.S. Coast Guard in NOTMAR. Most such activities occur in offshore OPAREAs.

5.1.12 Socioeconomics

Given the nature and location of Navy activities addressed in this EIS/OEIS, mitigation and protective measures are unnecessary with respect to socioeconomic considerations.

5.1.13 Environmental Justice and Protection of Children

Given the nature and location of Navy activities addressed in this EIS/OEIS, mitigation and protective measures are unnecessary with respect to socioeconomic considerations.

5.1.14 Public Safety

Navy activities in the NWTRC comply with numerous established safety procedures to ensure the safety of participants and the public. Navy range managers have published safety procedures for activities on the offshore and nearshore areas (DoN 1997b, 1999, 2004). These guidelines are directive for range users. They provide, among other measures, that:

- Commanders are responsible for ensuring that impact areas and targets are clear prior to commencing activities that are hazardous.
- Aircraft or vessels expending ordnance shall not commence firing without permission of the OCE for their specific range area.
- Firing units and targets must remain in their assigned areas, and units must fire in accordance with current safety instructions.
- Ships are authorized to fire their weapons only in offshore areas and at specific distances from land, depending on the caliber and range of the weapons fired.
- The use of pyrotechnic or illumination devices and marine markers such as smoke or dye markers will be allowed only in the assigned areas, to avoid the launch of Search and Rescue forces when not required. Aircraft carrying ordnance to or from ranges shall avoid populated areas to the maximum extent possible.

- Aircrews operating in W-237, W-570, and W-93 are aware that non-participating aircraft are not precluded from entering the area and may not comply with a NOTAM or radio warning that hazardous activities are scheduled or occurring. Aircrews are required to maintain a continuous lookout for non-participating aircraft while operating under visual flight rules in the warning areas.

In addition to the above mentioned procedures, the Navy has instituted the following SOPs for use of the NWTRC:

5.1.14.1 Aviation Safety

Potential hazardous operations conducted within a Warning Area are conducted under visual flight rules (VFR) and under visual meteorological conditions. This means that the commanders of military aircraft are responsible for the safe conduct of their flight. Prior to releasing any weapons or ordnance, the impact area must be clear of non-participating vessels, people, or aircraft. The Officer in Charge of the Exercise (OCE) is ultimately responsible for the safe conduct of range training. A qualified Safety Officer is assigned to each training event or exercises and can terminate activities if unsafe conditions exist.

5.1.14.2 Submarine Safety

Vertical separation of at least 100 ft (30.5 m) is required between the top of a submarine's sail and the depth of a surface ship's keel. If a submarine (or submarine simulated target, the MK-30) is at periscope depth, at least a 1,500-yard (yd) (1,372-m) horizontal separation from other vessels must be maintained.

5.1.14.3 Surface Ship Safety

During training events, surface ships are required to obtain a "Green Range," which indicates that all safety criteria have been satisfied, and that the weapons and target recovery conditions and recovery helicopters and boats are ready to be employed.

5.1.14.4 Missile Exercise Safety

Safety is the top priority and paramount concern during missile exercises. These exercises can be surface-to-surface, subsurface-to-surface, surface-to-air, or air-to-air. A Missile Exercise (MISSILEX) Letter of Instruction is prepared prior to any missile firing exercise. This instruction establishes precise ground rules for the safe and successful execution of the exercise. Any MISSILEX participant who observes an unsafe situation can communicate a "Red Range" order over any voice communication systems.

5.2 MITIGATION MEASURES

In order to issue the Marine Mammal Protection Act (MMPA) authorization required for certain activities, it might be necessary for National Marine Fisheries Service (NMFS) to require additional mitigation or monitoring measures beyond those addressed above and elsewhere in the EIS/OEIS. These could include measures considered, but eliminated in the EIS/OEIS, or as yet developed measures. The public will have an opportunity to provide information to NMFS through the MMPA process, both during the comment period following NMFS' Notice of Receipt of the Navy's application for a Letter of Authorization (LOA), and during the comment period following publication of the proposed LOA. NMFS may propose additional mitigation or monitoring measures. Measures not considered in the mitigation and monitoring measures in this EIS/OEIS, but required through the MMPA process, might require evaluation in accordance with the National Environmental Policy Act. In doing so, NMFS may consider "tiering," that is, incorporating this EIS/OEIS during the MMPA process.

Resource areas requiring no additional mitigation measures include Geology and Soils, Air Quality, Hazardous Materials, Water Resources, Acoustic Environment, Marine Plants and Animals, Fish, Birds, Terrestrial Biological Resources, Cultural Resources, Traffic, Socioeconomics, Environmental Justice and Protection of Children, and Public Safety. The following section describes mitigation measures required for Sea Turtles and Marine Mammals.

5.2.1 Sea Turtles and Marine Mammals

As discussed in Section 3.8 and 3.9, the comprehensive suite of current requirements and practices implemented by the Navy to reduce impacts to marine mammals also serves to mitigate potential impacts on sea turtles. In particular, personnel and watchstander training, establishment of turtle-free exclusion zones for underwater detonations of explosives, and pre- and post-exercise surveys, all serve to reduce or eliminate potential impacts of Navy activities on sea turtles that may be present in the vicinity.

This section includes protective and mitigation measures that are followed for all types of exercises; those that are associated with a particular type of training event; and those that apply to a particular geographic region or season. For exercises involving multiple units, the applicable mitigation measures are incorporated into a naval message which is disseminated to all of the units participating in the exercise or training event and applicable responsible commands. Appropriate measures are also provided to non-Navy participants (other DoD and allied forces) to ensure their use by these participants.

5.2.1.1 General Maritime Measures

<u>Personnel Training – Watchstanders and Lookouts</u>

The use of shipboard lookouts is a critical component of all Navy protective measures. Navy shipboard lookouts (also referred to as “watchstanders”) are highly qualified and experienced observers of the marine environment. Their duties require that they report all objects sighted in the water to the officer of the deck (OOD) (e.g., trash, a periscope, marine mammals, sea turtles) and all disturbances (e.g., surface disturbance, discoloration) that may be indicative of a threat to the vessel and its crew. There are personnel serving as lookouts on station at all times (day and night) when a ship or surfaced submarine is moving through the water.

All commanding officers (COs), executive officers (XOs), lookouts, OODs, junior OODs (JOODs), maritime patrol aircraft aircrews, and Anti-submarine Warfare (ASW)/Mine Warfare (MIW) helicopter crews will complete the NMFS-approved Marine Species Awareness Training (MSAT) by viewing the U.S. Navy MSAT digital versatile disk (DVD). MSAT may also be viewed on-line at https://portal.navfac.navy.mil/go/msat. All bridge watchstanders/lookouts will complete both parts one and two of the MSAT; part two is optional for other personnel. Part I of this training addresses the lookout’s role in environmental protection, laws governing the protection of marine species, Navy stewardship commitments and general observation information to aid in avoiding interactions with marine species. Part II focuses on identification of specific species.

- Navy lookouts will undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (Naval Education and Training Command [NAVEDTRA] 12968-D).
- Lookout training will include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, lookouts will complete the Personal Qualification Standard Program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). Personnel being trained as lookouts can be counted among those listed below as long as supervisors monitor their progress and performance.
- Lookouts will be trained in the most effective means to ensure quick and effective communication within the chain of command in order to facilitate implementation of protective measures if marine species are spotted.

Operating Procedures & Collision Avoidance

- Prior to exercises involving multiple units, a Letter of Instruction, Mitigation Measures Message or Environmental Annex to the Operational Order will be issued to further disseminate the personnel training requirement and general marine species protective measures.
- COs will make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.
- While underway, in addition to the three personnel on watch, surface vessels will have at least two lookouts with binoculars; surfaced submarines will have at least one lookout with binoculars. Lookouts already posted for safety of navigation and man-overboard precautions may be used to fill this requirement. As part of their regular duties, lookouts will watch for and report to the OOD the presence of marine mammals and sea turtles.
- On surface vessels equipped with a mid-frequency active sonar, pedestal mounted “Big Eye” (20x110) binoculars will be properly installed and in good working order to assist in the detection of marine mammals and sea turtles in the vicinity of the vessel.
- Personnel on lookout will employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-D).
- After sunset and prior to sunrise, lookouts will employ Night Lookouts Techniques in accordance with the Lookout Training Handbook. (NAVEDTRA 12968-D).
- While in transit, naval vessels will be alert at all times, use extreme caution, and proceed at a “safe speed” so that the vessel can take proper and effective action to avoid a collision with any marine animal and can be stopped within a distance appropriate to the prevailing circumstances and conditions.
- When sea turtles or marine mammals have been sighted in the area, Navy vessels will increase vigilance and take reasonable and practicable actions to avoid collisions and activities that might result in close interaction of naval assets and marine mammals. Actions may include changing speed and/or direction and are dictated by environmental and other conditions (e.g., safety, weather).
- Floating weeds and kelp, algal mats, clusters of seabirds, and jellyfish are good indicators of sea turtles and marine mammals. Therefore, increased vigilance in watching for sea turtles and marine mammals will be taken where these are present.
- Navy aircraft participating in exercises at sea will conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties. Marine mammal detections will be immediately reported to assigned Aircraft Control Unit for further dissemination to ships in the vicinity of the marine species as appropriate where it is reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.
- All vessels will maintain logs and records documenting training operations should they be required for event reconstruction purposes.

5.2.1.2 Measures for Specific Training Events

Mid-Frequency Active Sonar Activities

General Maritime Mitigation Measures: Personnel Training

- All lookouts onboard platforms involved in ASW training events will review the NMFS-approved Marine Species Awareness Training material prior to use of mid-frequency active sonar.
- All COs, XOs, and officers standing watch on the bridge will have reviewed the Marine Species Awareness Training material prior to a training event employing the use of mid-frequency active sonar.
- Navy lookouts will undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (Naval Educational Training [NAVEDTRA], 12968-D).
- Lookout training will include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, lookouts will complete the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). This does not forbid personnel being trained as lookouts from being counted as those listed in previous measures so long as supervisors monitor their progress and performance.
- Lookouts will be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of mitigation measures if marine species are spotted.

General Maritime Mitigation Measures: Lookout and Watchstander Responsibilities

- On the bridge of surface ships, there will always be at least three people on watch whose duties include observing the water surface around the vessel.
- All surface ships participating in ASW training events will, in addition to the three personnel on watch noted previously, have at all times during the exercise at least two additional personnel on watch as marine mammal lookouts.
- Personnel on lookout will be responsible for reporting all objects or anomalies sighted in the water (regardless of the distance from the vessel) to the Officer of the Deck, since any object or disturbance (e.g., trash, periscope, surface disturbance, discoloration) in the water may be indicative of a threat to the vessel and its crew or indicative of a marine species that may need to be avoided as warranted.

Operating Procedures

- All personnel engaged in passive acoustic sonar operation (including aircraft, surface ships, or submarines) will monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action.
- During MFA sonar activities, personnel will utilize all available sensor and optical systems (such as night vision goggles) to aid in the detection of marine mammals.
- Navy aircraft participating in exercises at sea will conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.
- Aircraft with deployed sonobuoys will use only the passive capability of sonobuoys when marine mammals are detected within 200 yds (183 m) of the sonobuoy.
- Marine mammal detections will be immediately reported to assigned Aircraft Control Unit for further dissemination to ships in the vicinity of the marine species as appropriate where it is

reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.

- Safety Zones—When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) within 1,000 yds (914 m) of the sonar dome (the bow), the ship or submarine will limit active transmission levels to at least 6 decibels (dB) below normal operating levels. (A 6 dB reduction equates to a 75 percent power reduction. The reason is that decibel levels are on a logarithmic scale, not a linear scale. Thus, a 6 dB reduction results in a power level only 25 percent of the original power.)
    - Ships and submarines will continue to limit maximum transmission levels by this 6-dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (1829 m) beyond the location of the last detection.
    - Should a marine mammal be detected within or closing to inside 500 yds (457 m) of the sonar dome, active sonar transmissions will be limited to at least 10 dB below the equipment's normal operating level. (A 10 dB reduction equates to a 90 percent power reduction from normal operating levels.) Ships and submarines will continue to limit maximum ping levels by this 10-dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (457 m) beyond the location of the last detection.
    - Should the marine mammal be detected within or closing to inside 200 yds (183 m) of the sonar dome, active sonar transmissions will cease. Sonar will not resume until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yds (457 m) beyond the location of the last detection.
    - Special conditions applicable for dolphins and porpoises only: If, after conducting an initial maneuver to avoid close quarters with dolphins or porpoises, the OOD concludes that dolphins or porpoises are deliberately closing to ride the vessel's bow wave, no further mitigation actions are necessary while the dolphins or porpoises continue to exhibit bow wave riding behavior.
    - If the need for power-down should arise as detailed in “Safety Zones” above, the Navy shall follow the requirements as though they were operating at 235 dB—the normal operating level (i.e., the first power-down will be to 229 dB, regardless of at what level above 235 sonar was being operated).
- Prior to start up or restart of active sonar, operators will check that the Safety Zone radius around the sound source is clear of marine mammals.
- Sonar levels (generally)—Navy will operate MFA sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.
- Helicopters shall observe/survey the vicinity of an ASW training event for 10 minutes before the first deployment of active (dipping) sonar in the water.
- Helicopters shall not dip their sonar within 200 yds (183 m) of a marine mammal and shall cease pinging if a marine mammal closes within 200 yds (183 m) after pinging has begun.
- Submarine sonar operators will review detection indicators of close-aboard marine mammals prior to the commencement of ASW training events involving active mid-frequency sonar.

Surface-to-Surface Gunnery (5-inch, 57 mm, 76 mm, 25 mm and .50 cal explosive rounds)

- Lookouts will visually survey for floating weeds and kelp, and algal mats which may be inhabited by immature sea turtles in the target area. Intended impact shall not be within 600 yds (585 m) of known or observed floating weeds and kelp, and algal mats.
- A 600 yard radius buffer zone will be established around the intended target.
- From the intended firing position, lookouts will survey the buffer zone for marine mammals and sea turtles prior to commencement and during the exercise as long as practicable. Due to the distance between the firing position and the buffer zone, lookouts are only expected to visually detect breaching whales, whale blows, and large pods of dolphins and porpoises.
- When manned, target towing vessels will maintain a lookout. If a marine mammal or sea turtle is sighted in the vicinity of the exercise, the tow vessel will immediately notify the firing vessel in order to secure gunnery firing until the area is clear.
- The exercise will be conducted only when the buffer zone is visible and marine mammals and sea turtles are not detected within the target area and the buffer zone.

Surface-to-Surface Gunnery (non-explosive rounds)

- Lookouts will visually survey for floating weeds and kelp, and algal mats which may be inhabited by immature sea turtles in the target area. Intended impact will not be within 200 yds (183 m) of known or observed floating weeds and kelp, and algal mats.
- A 200-yd (183 m) radius buffer zone will be established around the intended target.
- From the intended firing position, lookouts will survey the buffer zone for marine mammals and sea turtles prior to commencement and during the exercise as long as practicable. Due to the distance between the firing position and the buffer zone, lookouts are only expected to visually detect breaching whales, whale blows, and large pods of dolphins and porpoises.
- When manned, target towing vessels will maintain a lookout. If a marine mammal or sea turtle is sighted in the vicinity of the exercise, the tow vessel will immediately notify the firing vessel in order to secure gunnery firing until the area is clear.
- The exercise will be conducted only when the buffer zone is visible and marine mammals and sea turtles are not detected within the target area and the buffer zone.

Surface-to-Air Gunnery (explosive and non-explosive rounds)

- Vessels will orient the geometry of gunnery exercises in order to prevent debris from falling in the area of sighted marine mammals and sea turtles.
- Vessels will expedite the recovery of any parachute deploying aerial targets to reduce the potential for entanglement of marine mammals and sea turtles.
- Target towing aircraft shall maintain a lookout. If a marine mammal or sea turtle is sighted in the vicinity of the exercise, the tow aircraft will immediately notify the firing vessel in order to secure gunnery firing until the area is clear.

Air-to-Surface Gunnery (explosive and non-explosive rounds)

- If surface vessels are involved, lookouts will visually survey for floating kelp, which may be inhabited by immature sea turtles, in the target area. Impact should not occur within 200 yds (183 m) of known or observed floating weeds and kelp or algal mats.
- A 200 yd (183 m) radius buffer zone will be established around the intended target.

- If surface vessels are involved, lookout(s) will visually survey the buffer zone for marine mammals and sea turtles prior to and during the exercise.
- Aerial surveillance of the buffer zone for marine mammals and sea turtles will be conducted prior to commencement of the exercise. Aerial surveillance altitude of 500 feet to 1,500 ft (152 - 456 m) is optimum. Aircraft crew/pilot will maintain visual watch during exercises. Release of ordnance through cloud cover is prohibited: aircraft must be able to actually see ordnance impact areas.
- The exercise will be conducted only if marine mammals and sea turtles are not visible within the buffer zone.

Air-to-Surface At-Sea Bombing Exercises (explosive and non-explosive bombs and cluster munitions, rockets)

- If surface vessels are involved, lookouts will survey for floating kelp, which may be inhabited by immature sea turtles. Ordnance shall not be targeted to impact within 1,000 yds (914 m) of known or observed floating kelp, sea turtles, or marine mammals.
- A buffer zone of 1,000 yd (914 m) radius will be established around the intended target.
- Aircraft will visually survey the target and buffer zone for marine mammals and sea turtles prior to and during the exercise. The survey of the impact area will be made by flying at 1,500 feet or lower, if safe to do so, and at the slowest safe speed. Release of ordnance through cloud cover is prohibited: aircraft must be able to actually see ordnance impact areas. Survey aircraft should employ most effective search tactics and capabilities.
- The exercises will be conducted only if marine mammals and sea turtles are not visible within the buffer zone.

Air-to-Surface Missile Exercises (explosive and non-explosive)

- Ordnance shall not be targeted to impact within 1,800 yds (1,646 m) of known or observed floating kelp, which may be inhabited by immature sea turtles.
- Aircraft will visually survey the target area for marine mammals and sea turtles. Visual inspection of the target area will be made by flying at 1,500 (457 m) feet or lower, if safe to do so, and at slowest safe speed. Firing or range clearance aircraft must be able to actually see ordnance impact areas. Explosive ordnance shall not be targeted to impact within 1,800 yds (1646 m) of sighted marine mammals and sea turtles.

Underwater Detonations (up to 20-lb charges)

To ensure protection of marine mammals and sea turtles during underwater detonation training, the operating area must be determined to be clear of marine mammals and sea turtles prior to detonation. Implementation of the following mitigation measures continue to ensure that marine mammals would not be exposed to temporary threshold shift (TTS), permanent threshold shift (PTS), or injury from physical contact with training mine shapes during exercises.

Exclusion Zones

All Mine Warfare and Mine Countermeasures activities involving the use of explosive charges must include exclusion zones for marine mammals and sea turtles to prevent physical and/or acoustic effects to those species. These exclusion zones shall extend in a 700-yard (640 m) arc radius around the detonation site.

Pre-Exercise Surveys

For Demolition and Ship Mine Countermeasures activities, pre-exercise survey shall be conducted within 30 minutes prior to the commencement of the scheduled explosive event. The survey may be conducted from the surface, by divers, and/or from the air, and personnel shall be alert to the presence of any marine mammal or sea turtle. Should such an animal be present within the survey area, the exercise shall be paused until the animal voluntarily leaves the area. The Navy will suspend detonation exercises and ensure the area is clear for a full 30 minutes prior to detonation. Additionally, the Navy implements a 30 minute time limit between subsequent detonations during the same activity. Personnel will record any protected species marine mammal and sea turtle observations during the exercise as well as measures taken if species are detected within the exclusion zone.

Post-Exercise Surveys and Reporting

Surveys within the same radius shall also be conducted within 30 minutes after the completion of the explosive event.

If there is evidence that a marine mammal or sea turtle may have been stranded, injured or killed by the action, Navy training activities will be immediately suspended and the situation immediately reported by the participating unit to the OCE, who will follow Navy procedures for reporting the incident to Commander, Pacific Fleet, Commander, Navy Region Northwest, Regional Operations Center (ROC) at 360-315-0123 (24/7) who will immediately contact the Regional environmental Support Office (N40), and the chain-of-command.

Sinking Exercise

The selection of sites suitable for a Sinking Exercises (SINKEXs) involves a balance of operational suitability, requirements established under the Marine Protection, Research and Sanctuaries Act (MPRSA) permit granted to the Navy (40 Code of Federal Regulations § 229.2), and the identification of areas with a low likelihood of encountering Endangered Species Act (ESA) listed species. To meet operational suitability criteria, locations must be within a reasonable distance of the target vessels' originating location. The locations should also be close to active military bases to allow participating assets access to shore facilities. For safety purposes, these locations should also be in areas that are not generally used by non-military air or watercraft. The MPRSA permit requires vessels to be sunk in waters which are at least 1,000 fathoms (3,000 yds / 2742 m)) deep and at least 50 nm from land.

In general, most listed species prefer areas with strong bathymetric gradients and oceanographic fronts for significant biological activity such as feeding and reproduction. Typical locations include the continental shelf and shelf-edge.

SINKEX Mitigation Plan

The Navy has developed range clearance procedures to maximize the probability of sighting any ships or protected species in the vicinity of an exercise, which are as follows:

- All weapons firing would be conducted during the period 1 hour after official sunrise to 30 minutes before official sunset.
- Extensive range clearance activities would be conducted in the hours prior to commencement of the exercise, ensuring that no shipping is located within the hazard range of the longest-range weapon being fired for that event.
- An exclusion zone with a radius of 1.0 nm would be established around each target. This exclusion zone is based on calculations using a 990-pound (lb) H6 net explosive weight high explosive source detonated 5 ft below the surface of the water, which yields a distance of 0.85 nm (cold season) and 0.89 nm (warm season) beyond which the received level is below the 182

decibels (dB) re: 1 micropascal squared-seconds (μPa2-s) threshold established for the WINSTON S. CHURCHILL (DDG 81) shock trials (U.S. Navy, 2001). An additional buffer of 0.5 nm would be added to account for errors, target drift, and animal movements. Additionally, a safety zone, which extends from the exclusion zone at 1.0 nm out an additional 0.5 nm, would be surveyed. Together, the zones extend out 2 nm from the target.

- A series of surveillance over-flights would be conducted within the exclusion zone prior to and during the exercise, and within the safety zone when feasible. Survey protocol would be as follows:
    - Overflights within the exclusion zone would be conducted in a manner that optimizes the surface area of the water observed. This may be accomplished through the use of the Navy's Search and Rescue Tactical Aid, which provides the best search altitude, ground speed, and track spacing for the discovery of small, possibly dark objects in the water based on the environmental conditions of the day. These environmental conditions include the angle of sun inclination, amount of daylight, cloud cover, visibility, and sea state.
    - All visual surveillance activities would be conducted by Navy personnel trained in visual surveillance. At least one member of the mitigation team would have completed the Navy's marine mammal training program for lookouts.
    - In addition to the overflights, the exclusion zone would be monitored by passive acoustic means, when assets are available. This passive acoustic monitoring would be maintained throughout the exercise. Potential assets include sonobuoys, which can be utilized to detect any vocalizing marine mammals (particularly sperm whales) in the vicinity of the exercise. The sonobuoys would be re-seeded as necessary throughout the exercise. Additionally, passive sonar onboard submarines may be utilized to detect any vocalizing marine mammals in the area. The OCE would be informed of any aural detection of marine mammals and would include this information in the determination of when it is safe to commence the exercise.
    - On each day of the exercise, aerial surveillance of the exclusion and safety zones would commence 2 hours prior to the first firing.
    - The results of all visual, aerial, and acoustic searches would be reported immediately to the OCE. No weapons launches or firing would commence until the OCE declares the safety and exclusion zones free of marine mammals and threatened and endangered species.
    - If a marine mammal or sea turtle is observed within the safety zone, the observing aircraft would monitor them to ensure they remain outside of the exclusion zone.
    - If a marine mammal or sea turtle is observed within the exclusion zone is diving, firing would be delayed until the animal is re-sighted outside the exclusion zone, or 30 minutes have elapsed. After 30 minutes, if the animal has not been re-sighted it would be assumed to have left the exclusion zone. This is based on a typical dive time of 30 minutes for traveling listed species of concern. The OCE would determine if the listed species is in danger of being adversely affected by commencement of the exercise.
    - During breaks in the exercise of 30 minutes or more, the exclusion zone would again be surveyed for any protected species. If protected species are sighted within the exclusion zone, the OCE would be notified, and the procedure described above would be followed.
    - Upon sinking of the vessel, a final surveillance of the exclusion zone would be monitored for 2 hours, or until sunset, to verify that no listed species were harmed.

- Aerial surveillance would be conducted using helicopters or other aircraft based on necessity and availability. The Navy has several types of aircraft capable of performing this task; however, not all types are available for every exercise. For each exercise, the available asset best suited for identifying objects on and near the surface of the ocean would be used. These aircraft would be capable of flying at the slow safe speeds necessary to enable viewing of marine vertebrates with unobstructed, or minimally obstructed, downward and outward visibility. The exclusion and safety zone surveys may be cancelled in the event that a mechanical problem, emergency search and rescue, or other similar and unexpected event preempts the use of one of the aircraft onsite for the exercise.
- Every attempt would be made to conduct the exercise in sea states that are ideal for marine mammal sighting, Beaufort Sea State 3 or less. In the event of a 4 or above, survey efforts would be increased within the zones. This would be accomplished through the use of an additional aircraft, if available, and conducting tight search patterns.
- The exercise would not be conducted unless the exclusion zone could be adequately monitored visually.
- In the unlikely event that any listed species are observed to be harmed in the area, a detailed description of the animal would be taken, the location noted, and if possible, photos taken. This information would be provided to NOAA Fisheries via the Navy's regional environmental coordinator for purposes of identification.
- An after action report detailing the exercise's time line, the time the surveys commenced and terminated, amount, and types of all ordnance expended, and the results of survey efforts for each event would be submitted to NOAA Fisheries.

Mitigation Measures Related to Explosive Source Sonobuoys (AN/SSQ-110A)

AN/SSQ-110A Pattern Deployment

- Crews will conduct visual reconnaissance of the drop area prior to laying their intended sonobuoy pattern. This search should be conducted below 1500 ft at a slow speed when operationally feasible and weather conditions permit. In dual aircraft operations, crews may conduct coordinated area clearances.
- Crews shall conduct a minimum of 30 minutes of visual and aural monitoring of the search area prior to commanding the first post (source/receiver sonobuoy pair) detonation. This 30 minute observation period may include pattern deployment time.
- For any part of the briefed pattern where a post will be deployed within 1000 yds of observed marine mammal activity, crews will deploy the receiver ONLY and monitor while conducting a visual search. When marine mammals are no longer detected within 1000 yds of the intended post position, crews will collocate the AN/SSQ-110A sonobuoy (source) with the receiver.
- When operationally feasible, crews will conduct continuous visual and aural monitoring of marine mammal activity, including monitoring of their aircraft sensors from first sensor placement to checking off-station and out of RF range of the sensors.

AN/SSQ-110A Pattern Employment

- Aural Detection:
  - Aural detection of marine mammals cues the aircrew to increase the diligence of their visual surveillance.
  - If, following aural detection, no marine mammals are visually detected, then the crew may continue multi-static active search.

- Visual Detection:
  - o If marine mammals are visually detected within 1000 yds of the AN/SSQ-110A sonobuoy intended for use, then that payload shall not be detonated. Aircrews may utilize this post once the marine mammals have not been re-sighted for 30 minutes or are observed to have moved outside the 1000 yd safety zone.
  - o Aircrews may shift their multi-static active search to another post, where marine mammals are outside the 1000 yd safety zone.

AN/SSQ-110A Scuttling Sonobuoys

- Aircrews shall make every attempt to manually detonate the unexploded charges at each post in the pattern prior to departing the operations area by using the "Payload 1 Release" command followed by the "Payload 2 Release" command. Aircrews shall refrain from using the "Scuttle" command when two payloads remain at a given post. Aircrews will ensure a 1000 yd safety zone, visually clear of marine mammals, is maintained around each post as is done during active search operations.
- Aircrews shall only leave posts with unexploded charges in the event of a sonobuoy malfunction, an aircraft system malfunction, or when an aircraft must immediately depart the area due to issues such as fuel constraints, inclement weather, and in-flight emergencies. In these cases, the sonobuoy will self-scuttle using the secondary method or tertiary method.
- Aircrews ensure all payloads are accounted for. Sonobuoys that cannot be scuttled shall be reported as unexploded ordnance via voice communications while airborne and, upon landing, via Naval message.
- Mammal monitoring shall continue until out of their aircraft sensor range.

5.2.1.3 Conservation Measures

Monitoring: Integrated Comprehensive Monitoring Program

The U.S. Navy is committed to demonstrating environmental stewardship while executing its National Defense mission and is responsible for compliance with a suite of Federal environmental and natural resources laws and regulations that apply to the marine environment. As part of those responsibilities, an assessment of the long-term and/or population-level effects of Navy training activities as well as the efficacy of mitigation measures is necessary. The Navy is developing an Integrated Comprehensive Monitoring Program (ICMP) for marine species in order to assess the effects of training activities on marine species and investigate population trends in marine species distribution and abundance in various range complexes and geographic locations where Navy training occurs. This program will emphasize active sonar training, with AFAST being a major component of the overall monitoring program.

The primary goals of the ICMP are to:

- Monitor Navy training events, particularly those involving MFA sonar and underwater detonations, for compliance with the terms and conditions of ESA Section 7 consultations or MMPA authorizations;
- Collect data to support estimating the number of individuals exposed to sound levels above current regulatory thresholds;
- Assess the efficacy of the Navy's current marine species mitigation;
- Add to the knowledge base on potential behavioral and physiological effects to marine species from mid-frequency active sonar and underwater detonations; and,

- Assess the practicality and effectiveness of a number of mitigation tools and techniques (some not yet in use).

Adaptive Management

Adaptive management principles consider appropriate adjustments to mitigation, monitoring, and reporting as the outcomes of the proposed actions and required mitigation are better understood. NMFS includes adaptive management principles in the regulations for the implementation of the proposed action, and any adaptive adjustments of mitigation and monitoring would be led by NMFS via the MMPA process and developed in coordination with the Navy. Continued opportunity for public input would be included via the MMPA process, as appropriate (i.e. via the "Letter of Authorization" process). The intent of adaptive management here is to ensure the continued proper implementation of the required mitigation measures, to conduct appropriate monitoring and evaluation efforts, and to recommend possible adjustments to the mitigation/monitoring/reporting to accomplish the established goals of the mitigation and monitoring which include:

Mitigation

- Avoidance or minimization of injury or death of marine mammals wherever possible (goals b, c, and d may contribute to this goal).
- A reduction in the numbers of marine mammals (total number or number at biologically important time or location) exposed to received levels of sound associated with the proposed active sonar activities,
- A reduction in the number of times (total number or number at biologically important time or location) individuals would be exposed to received levels,
- A reduction in the intensity of exposures (either total number or number at biologically important time or location) to received levels
- A reduction in effects to marine mammal habitat, paying special attention to the food base, activities that block or limit passage to or from biologically important areas, permanent destruction of habitat, or temporary destruction/disturbance of habitat during a biologically important time.
- For monitoring directly related to mitigation - an increase in the probability of detecting marine mammals, thus allowing for more effective implementation of the mitigation measures (shut-down zone, etc.).

Monitoring

- An increase in the probability of detecting marine mammals, both within the safety zone (thus allowing for more effective implementation of the mitigation) and in general to generate more data to contribute to the effects analyses.
- An increase in our understanding of how many marine mammals are likely to be exposed to levels of MFA sonar/HFA sonar (or explosives or other stimuli) that we associate with specific adverse effects, such as behavioral harassment, TTS, or PTS.
- An increase in our understanding of how marine mammals respond to MFA sonar/HFA sonar (at specific received levels), explosives, or other stimuli expected to result in take and how anticipated adverse effects on individuals (in different ways and to varying degrees) may impact the population, species, or stock (specifically through effects on annual rates of recruitment or survival)
- An increased knowledge of the affected species

- An increase in our understanding of the effectiveness of certain mitigation and monitoring measures

Generally speaking, adaptive management supports the integration of NEPA's principles into the ongoing implementation and management of the Proposed Action, including a process for improving, where needed, the effectiveness of the identified mitigations. Note that any adjustment of mitigation and monitoring would be within the scope of the environmental analyses and considerations presented in this EIS/OEIS.

Research

The Navy provides a significant amount of funding and support to marine research. In the past five years the agency funded over $100 million ($26 million in FY08 alone) to universities, research institutions, federal laboratories, private companies, and independent researchers around the world to study marine mammals. The U.S. Navy sponsors seventy percent of all U.S. research concerning the effects of human-generated sound on marine mammals and 50 percent of such research conducted worldwide. Major topics of Navy-supported research include the following:

- Better understanding of marine species distribution and important habitat areas,
- Developing methods to detect and monitor marine species before and during training,
- Understanding the effects of sound on marine mammals, sea turtles, fish, and birds, and
- Developing tools to model and estimate potential effects of sound.

This research is directly applicable to Fleet training activities, particularly with respect to the investigations of the potential effects of underwater noise sources on marine mammals and other protected species. Proposed training activities employ active sonar and underwater explosives, which introduce sound into the marine environment.

The Marine Life Sciences Division of the Office of Naval Research currently coordinates six programs that examine the marine environment and are devoted solely to studying the effects of noise and/or the implementation of technology tools that will assist the Navy in studying and tracking marine mammals. The six programs are as follows:

- Environmental Consequences of Underwater Sound,
- Non-Auditory Biological Effects of Sound on Marine Mammals,
- Effects of Sound on the Marine Environment,
- Sensors and Models for Marine Environmental Monitoring,
- Effects of Sound on Hearing of Marine Animals, and
- Passive Acoustic Detection, Classification, and Tracking of Marine Mammals.

The Navy has also developed the technical reports referenced within this document, including the Marine Resource Assessment. Furthermore, research cruises by the National Marine Fisheries Service (NMFS) and by academic institutions have received funding from the U.S. Navy.

The Navy has sponsored several workshops to evaluate the current state of knowledge and potential for future acoustic monitoring of marine mammals. The workshops brought together acoustic experts and marine biologists from the Navy and other research organizations to present data and information on current acoustic monitoring research efforts and to evaluate the potential for incorporating similar technology and methods on instrumented ranges. However, acoustic detection, identification, localization, and tracking of individual animals still requires a significant amount of research effort to be considered a reliable method for marine mammal monitoring. The Navy supports research efforts on acoustic monitoring and will continue to investigate the feasibility of passive acoustics as a potential mitigation and monitoring tool.

Overall, the Navy will continue to fund ongoing marine mammal research, and is planning to coordinate long term monitoring/studies of marine mammals on various established ranges and operating areas. The Navy will continue to research and contribute to university/ external research to improve the state of the science regarding marine species biology and acoustic effects. These efforts include mitigation and monitoring programs; data sharing with NMFS and via the literature for research and development efforts; and future research as described previously.

Monitoring: NWTRC Marine Species Monitoring Plan

The Navy has developed a Marine Species Monitoring Plan (MSMP) that provides recommendations for site-specific monitoring for MMPA and ESA listed species (primarily marine mammals) within the NWTRC, including during training exercises. The primary goals of monitoring are to evaluate trends in marine species distribution and abundance in order to assess potential population effects from Navy training activities and determine the effectiveness of the Navy's mitigation measures. The information gained from the monitoring will also allow the Navy to evaluate the models used to predict effects to marine mammals.

By using a combination of monitoring techniques or tools appropriate for the species of concern, type of Navy activities conducted, sea state conditions, and the size of the Range Complex, the detection, localization, and observation of marine mammals and sea turtles can be maximized. The following available monitoring techniques and tools are described in this monitoring plan for monitoring for range events (several days or weeks) and monitoring of population effects such as abundance and distribution (months or years):

- Visual Observations – Vessel-, Aerial- and Shore-based Surveys (for marine mammals and sea turtles) will provide data on population trends (abundance, distribution, and presence) and response of marine species to Navy training activities. Navy lookouts will also record observations of detected marine mammals from Navy ships during appropriate training and test events.

- Acoustic Monitoring – Passive Acoustic Monitoring possibly using towed hydrophone arrays, Autonomous Acoustic Recording buoys and U.S. Navy Instrument Acoustic Range (for marine mammals only) may provide presence/absence data on cryptic species that are difficult to detect visually (beaked whales and minke whales) that could address long term population trends and response to Navy training exercises.

- Additional Methods – Oceanographic Observations and Other Environmental Factors will be obtained during ship-based surveys and satellite remote sensing data. Oceanographic data is important factor that influences the abundance and distribution of prey items and therefore the distribution and movements of marine mammals.

The monitoring plan will be reviewed annually by Navy biologists to determine the effectiveness of the monitoring elements and to consider any new monitoring tools or techniques that may have become available.

5.2.1.4 Coordination and Reporting

The Navy will coordinate with the local NMFS Stranding Coordinator for any unusual marine mammal behavior and any stranding, beached live/dead or floating marine mammals that may occur coincident with Navy training activities.

5.2.1.5 Alternative Mitigation Measures Considered but Eliminated

As described in Chapter 3, Section 3.9 and Appendix E, the vast majority of estimated sound exposures of marine mammals during proposed active sonar activities would not cause injury. Potential acoustic effects on marine mammals would be further reduced by the mitigation measures described above. Therefore, the Navy concludes the proposed action and mitigation measures would achieve the least practical adverse impact on species or stocks of marine mammals.

A determination of "least practicable adverse impacts" includes consideration of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity in consultation with the DoD. Therefore, the following additional mitigation measures were analyzed and eliminated from further consideration:

Augmenting Navy lookouts on Navy vessels providing surveillance of ASW or other training events with non-Navy personnel:

Augmenting Navy lookouts on Navy vessels providing surveillance of ASW or other training events with non-Navy personnel: The protection of marine mammals is provided by a lookout sighting the mammal and prompting immediate action. The premise that Navy personnel cannot or will not do this is unsupportable. Navy lookouts are extensively trained in spotting items at or near the water surface and relaying the information to their superiors who initiate action. Navy lookouts utilize their skills more frequently than many third-party trained non-Navy marine mammal observers. Use of Navy lookouts is the most effective means to ensure quick and efficient communication within the command structure, thus ensuring timely implementation of any relevant mitigation measures. A critical skill set of effective Navy training is communication via the chain of command. Navy lookouts are trained to report swiftly and decisively using precise terminology to ensure that critical information is passed to the appropriate supervisory personnel. Furthermore, available berthing space, integration of non-Navy personnel into the command structure, and security issues would present added challenges.

Employing non-Navy observers on non-military aircraft or vessels:

The Final EIS/OEIS concluded that measures in this category do not result in increased protection to marine mammals because the size of the areas, the time it takes to survey, and the movement of marine mammals preclude real-time mitigation. Recognizing that ASW training events could occur throughout the entire PACNW OPAREA (consisting of approximately 122,400 nm^2 [420,163 km^2]), contiguous ASW events may cover many hundreds of square miles in a few hours. Event participants are usually not visible to each other (separated by many tens of miles) and are constantly in motion. The number of civilian ships and/or aircraft required to monitor the area around these events would be considerable. In addition to practical concerns, surveillance of an exercise area during an event raises safety issues. Multiple, land-based, slow civilian aircraft operating in the same airspace as military aircraft will limit both the time available for civilian aircraft to be in the training area and present a concern should such aircraft experience mechanical problems. Scheduling of civilian vessel or aircraft surveillance also presents concerns, as exercise event timetables cannot be precisely fixed but develop freely from the flow of the tactical situation, thus mimicking real combat action. Waiting for civilian aircraft or vessels to complete surveys, refuel, or be on station would interrupt the necessary spontaneity of the exercise and would negatively impact the effectiveness of the military readiness activity. The Navy is committed to maintaining its marine mammal surveillance capability using both Navy surface and, to the extent that aviation assets are participants in the training activity, aerial monitoring.

Avoiding habitats and complex/steep bathymetry, including seamounts, and employing seasonal restrictions:

Seamounts are used by submarines to hide or mask their presence, requiring the need to train in this complex ocean environment. This is precisely the type of area needed by the Navy to train with MFA sonar. Exercise locations are carefully chosen by planners based on training requirements and the ability of ships, aircraft, and submarines to operate safely. However, the full habitat requirements for most marine mammals in the NWTRC are unknown. Accordingly, there is insufficient information available regarding possible alternative exercise locations or environmental factors that would be less important to marine mammals in the NWTRC. When available, it must be factored with other considerations including safety and access to land ranges and facilities.

Avoidance of the seasonal presence of migrating marine mammals fails to take into account the fact that the Navy's current mitigation measures apply to all detected marine mammals no matter the season. Limiting training activities to fewer than 12 months of the year would not only concentrate all annual training and testing activities into a shorter time period, but would also not meet the readiness requirements of the Navy's mandate to deploy trained forces as might be required by unscheduled real world events.

Avoiding seamounts without exception fails to define scientific parameters for seamounts critical to marine mammals, such as a critical depth from the surface, and it is impossible to establish scientifically what would constitute a buffer that would avoid these areas. In addition, without a scientifically derived definition, there is no means to implement any proposed mitigation measure based on avoidance of seamounts.

Avoidance of steep or complex bathymetry in the NWTRC ignores the fact that there are numerous features and a variety of complex bathymetry in the NWTRC. Many of these areas of complex bathymetry and seamounts are in the very locations where Navy trains, and are valuable to Navy training. The purported need for this suggested mitigation measure is based on findings from other areas of the world that do not have direct application to the unique environment present in the NWTRC (e.g., the circumstances surrounding the 2000 Bahamas mass-stranding event). Ultimately, the Navy needs to train in representative environments, including near seamounts and in areas of steep or complex bathymetry, as submarines use these environments to avoid detection. Not being allowed to conduct exercises in these areas would have an unacceptable impact on training effectiveness.

Avoiding MFA and HFA sonar use within 12 nm from shore or, in the alternative, 15.5 miles (25 kilometers) from the 200-meter isobath:

During a recent major exercise in Hawaii (RIMPAC 2006), this mitigation measure precluded ASW training in the littoral region, which had a significant impact on realism and training effectiveness. There is no scientific evidence that any set distance from the coast is more protective of marine mammals than any other distance. The Navy has also determined that limiting MFA sonar use to outside 12 nm from the coast prevented crew members from gaining critical experience in training in shallow waters, and training in littoral waters. Sound propagates differently in shallower water. In real world events, it is highly likely crew members would be working in these types of areas, and these are the types of areas where diesel-electric submarines would be operating. Without the critical training near shore that ASW exercises provide, crews will not have the experience needed to successfully operate sonar in these types of waters, impacting vital military readiness.

Using MFA and HFA sonar with output levels as low as possible consistent with mission requirements or using active sonar only when necessary:

Operators of sonar equipment are trained to be aware of the environmental variables affecting sound propagation. In this regard, the sonar equipment power levels are always set consistent with mission requirements. Active sonar is only used when required by the mission since it has the potential to alert opposing forces to the sonar platform's presence. The Navy remains committed to using passive sonar and all other available sensors in concert with active sonar to the maximum extent practicable consistent with mission requirements.

Suspending training at night, periods of low visibility and in high sea-states when marine mammals are not readily visible:

It is imperative that the Navy train to be able to operate at night, in periods of low visibility, and in high sea-states using the full potential of MFA or HFA sonar as a sensor. Anti-submarine warfare requires many hours and days for the situation to develop, to be identified and for the forces to respond. It would be extremely impracticable and unrealistic for the Navy's forces at sea to train only in daylight hours or to wait for weather to clear. Naval forces must train during all conditions to ensure they understand how constantly changing environmental conditions (including changes between day and night) affect sonar's capabilities and their ability to detect and maintain contact with submerged objects. The naval forces must constantly identify those changing conditions and adapt to them.

Maneuvering a vessel at night and during restricted visibility is not a simple activity. Navy vessels use radar and night vision devices to detect any object, whether a marine mammal, a periscope of an adversary submarine, trash, debris, or another surface vessel. Under the International Navigation Rules of the Road, periods of fog, mist, falling snow, heavy rainstorm, sandstorms, or any similar events are referred to as "restricted visibility." In restricted visibility, all mariners, including Navy vessel crews, are required to maintain proper look-out by sight and hearing as well as "by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision." Therefore, Navy vessels are required to use all means available in restricted visibility, including sonar and positioning of additional lookouts for heightened vigilance to avoid collision. Navy vessels use radar and night vision goggles to avoid any object, whether a marine mammal, a periscope of an adversary submarine, trash, debris, or another surface vessel. Prohibiting or limiting vessels from using MFA sonar during periods of restricted visibility therefore violates international navigational rules, increases navigational risk, and jeopardizes the safety of the ship and crew.

Reducing power in significant surface ducting conditions:

Surface ducting occurs when water conditions (e.g., temperature layers, lack of wave action) result in sound energy emitted at or near the surface to be refracted back up to the surface, then reflected from the surface only to be refracted back up to the surface so that relatively little sound energy penetrates to the depths that otherwise would be expected. This increases active detection ranges in a narrow layer near the surface, but decreases active sonar detection below the thermocline, a phenomenon that submarines have long exploited. Significant surface ducts are conditions under which ASW training must occur to ensure Sailors learn to identify these conditions, how they alter the abilities of MFA sonar systems, and how to deal with the resulting effects on MFA sonar capabilities. To be effective, the complexity of ASW requires the most realistic training possible. Reducing power in significant surface ducting conditions undermines training realism because the unit would be operating differently than it would during actual warfare.

Additionally, and significantly, the necessary information regarding water conditions in the exercise areas is not uniform and can change over a period of a few hours as the effects of environmental conditions such as wind, sunlight, cloud cover, and tide changes alter surface duct conditions. Across a typical NWTRC exercise area, the determination of "significant surfacing ducting" is continually changing, and this mitigation measure could not be accurately implemented.

Furthermore, surface ducting alone does not increase the risk of MFA sonar impacts to marine mammals. While surface ducting causes sound to travel farther before losing intensity, simple spherical and cylindrical spreading losses result in a received level of no more than 175 dB at 1,000 meters, even in significant surface ducting conditions. There is no scientific evidence that this mitigation measure is effective or that it provides additional protection for marine mammals beyond that afforded by an appropriate safety zone.

Reduction of MFA sonar power levels by 6 dB to 10 dB results in a 50- to 80-percent reduction of detection of submarines in the area due to a decrease in power of 75 to 90 percent. This means reduction of sonar power levels results in an inability to detect submarines at greater distances which reflect real world situations. As submarines are capable of striking ships at distances greater than a powered-down sonar would be able to detect, effective training is compromised.

The requirement under the current MMPA national defense exemption to consider significant surface ducting as part of an aggregate of conditions in planning major exercises does not apply in the NWTRC because those conditions do not exist in the aggregate. Normal safety zone requirements always apply.

Scaling down training to meet core aims:

As with each Navy range complex, the primary mission of the NWTRC is to provide a realistic training environment for naval forces to ensure that they have the capabilities and high state of readiness required to accomplish assigned missions. Modern war and security operations are complex. Modern weaponry has brought both unprecedented opportunity and innumerable challenges to the Navy. Smart weapons, used properly, are very accurate and actually allow the military Services to accomplish their missions with greater precision and far less destruction than in past conflicts. But these modern smart weapons are very complex to use. U.S. military personnel must train regularly with them to understand their capabilities, limitations, and operation. Modern military actions require teamwork between hundreds or thousands of people, and their various equipment, vehicles, ships, and aircraft, all working individually and as a coordinated unit to achieve success. These teams must be prepared to conduct activities in multiple warfare areas simultaneously in an integrated and effective manner. Navy training addresses all aspects of the team, from the individual to joint and coalition teamwork. Training events are identified and planned because they are necessary to develop and maintain critical skills and proficiency in many warfare areas. Exercise planners and Commanding Officers are obligated to ensure they maximize the use of time, personnel and equipment during training. The level of training expressed in the proposed action and alternatives is essential to achieving the primary mission of the NWTRC.

Limiting the active sonar event locations:

Areas where events are scheduled to occur are carefully chosen to provide for the safety of events and to allow for the realistic development of the training scenario including the ability of the exercise participants to develop, maintain, and demonstrate proficiency in all areas of warfare simultaneously. Limiting the training event to a few areas would have an adverse impact to the effectiveness of the training by limiting the ability to conduct other critical warfare areas including, but not limited to, the ability of the Strike Group to defend itself from threats on the surface and in the air while carrying out other activities. Limiting the exercise areas would concentrate all active sonar use, resulting in unnecessarily prolonged and intensive sound levels rather than the more transient exposures predicted by the current planning that makes use of multiple exercise areas. Furthermore, exercises using integrated warfare components require large areas of the littorals and open ocean for realistic and safe training.

Passive acoustic detection and location of marine mammals:

As noted above, the Navy uses its passive detection capabilities to the maximum extent practicable consistent with the mission requirements to alert training participants to the presence of marine mammals in an event location.

Using "ramp-up" of MFA sonar to clear an area prior to the conduct of ASW training events:

Ramp-up procedures involve slowly increasing the sound in the water to levels that would clear an area of marine mammals prior to training at nominal source levels. Ramp-up procedures are not a viable alternative for MFA sonar training events as the ramp-up would alert opponents to the participants' presence, thus undermining training realism and effectiveness of the military readiness activity. When a ship turns its sonar on, area submarines are alerted to its presence. A submarine can hear an active sonar transmission farther away than the surface ship can hear the echo of its sonar off the submarine. Ideally, the surface ship will detect the submarine in time to attack the submarine before the submarine can attack the ship. If the MFA sonar ship starts out at a low power and gradually ramps up, it will give time for the submarine to take evasive action, hide, or close in for an attack before the MFA sonar is at a high enough power level to detect the submarine.

Ramp-up procedures purportedly provide marine mammals the opportunity to leave the area. There is no evidence that ramp-up procedures achieve the desired effect of causing the marine mammal to leave the area. Instead, it is well proven that dolphins ride the bow-waves of all vessels, including those employing MFA sonar, which indicates that some species of marine mammals do not flee.

Implementing vessel speed reduction:

Vessels engaged in training use extreme caution and operate at a slow, safe speed consistent with mission and safety. Ships and submarines need to be able to react to changing tactical situations in training as they would in actual combat. Placing arbitrary speed restrictions would not allow them to properly react to these situations. Training differently than that which would be needed in an actual combat scenario would decrease training effectiveness and reduce the crew's abilities.

Using new technology (e.g., unmanned reconnaissance aircraft, underwater gliders, and instrumented ranges) to detect and avoid marine animals:

Although the Navy works with many new technologies, they presently remain unproven and limited in availability. The Navy has been collecting data using the hydrophones at underwater instrumented ranges to collect passive acoustic data on marine mammals. The Navy is working to develop the capability to detect and localize vocalizing marine mammals using these sensors, but based on the current status of acoustic monitoring science, it is not yet possible to use installed systems as mitigation tools. Similarly, research involving a variety of other methodologies (e.g., underwater gliders, radar, and lasers) is not yet developed to the point where they are effective or could be used as an actual mitigation tool.

Using larger shut-down zones:

The current power down and shut down zones are based on scientific investigations specific to MFA sonar for a representative group of marine mammals. They are based on the source level, frequency, and sound propagation characteristics of MFA sonar. The zones are designed to preclude direct physiological effect from exposure to MFA sonar. Specifically, the current power-downs at 500 yards and 1,000 yards, as well as the 200 yard shut-down, were developed to minimize exposing marine mammals to sound levels that could cause TTS and PTS. These safety zone distances were based on experiments involving distances at which the onset of TTS and PTS were identified. They are also supported by the scientific community. The safety zone the Navy has developed is also based on a lookout's ability to realistically maintain situational awareness over a large area of the ocean, including the ability to detect marine mammals at that distance during most conditions at sea. Requirements to implement procedures when marine mammals are present well beyond 1,000 yards dictate that lookouts sight marine mammals at distances that, in reality, are not always practicable. These increased distances also significantly expand the area that must be monitored to implement these procedures. For instance, if a power down zone increases from 1,000 to 4,000 yards, the area that must be monitored increases sixteen-fold. Increases in safety zones are not based in science, do not provide any appreciable benefit to marine mammals and severely impact realistic ASW training. For example, increasing the shutdown zone for example from 200 yards to 2,187 yards contains 121 times the area of the Navy's current 200-yard shutdown zone. This restriction could increase the number of times that a ship would have to shut down active sonar, impacting realistic training and depriving ships of valuable submarine contact time. Commanders responsible for locating, tracking, and attacking a hostile submarine could lose awareness of the tactical situation through the constant stopping and starting of MFA sonar leading to significant exercise event disruption. Increased shutdowns could allow a submarine to take advantage of the lapses of active sonar, and position itself for an attack.

Restricting the use of MFA sonar during ASW training events while conducting transits between islands (i.e., choke-points):

This restriction is not applicable to training in the NWTRC. A chokepoint is a strategic strait or canal. Although there are over 200 major straits around the world, only a handful are considered to be strategic "chokepoints," such as the Strait of Gibraltar, Panama Canal, Strait of Magellan, Strait of Malacca, Bosporus and Dardanelles, Strait of Hormuz, Suez Canal, and Bab el Mandeb. While chokepoints are relatively few in number, significant quantities of international commerce and naval shipping move through these chokepoints, making them strategically important to the United States because a single quiet diesel submarine can position itself in the chokepoint and effectively block access beyond that point. The primary similarity of these chokepoints is lengthy shorelines that restrict maneuverability. The longer and more narrow the passage, the more likely the chokepoint creates an area of restricted egress for marine mammals.

Adopting mitigation measures of foreign nation navies:

The Navy typically operates in a Strike Group configuration where the group focuses its efforts on conducting air strikes and/or amphibious operations ashore. This requires that the Navy train to what it calls "integrated warfare" meaning that Strike Groups must conduct many different warfare areas simultaneously. These include the ability to defend itself from attacks from submarines, mines, ships, aircraft and missiles. Other nations do not possess the same integrated warfare capabilities as the United States. As a result, many foreign nations' measures are focused solely on reducing what they perceive to be impacts involving ASW. They are not required to locate training areas and position naval forces for the simultaneous and integrated warfare elements that the Navy conducts. As a result, many nations are willing to move training to areas where they believe marine mammals may not exist and do not train in the same bathymetric and littoral environments as the Navy.

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6 Other Considerations

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6 OTHER CONSIDERATIONS REQUIRED BY THE NATIONAL ENVIRONMENTAL POLICY ACT

6.1 CONSISTENCY WITH OTHER FEDERAL, STATE, AND LOCAL PLANS, POLICIES, AND REGULATIONS

Based on an evaluation with respect to consistency with statutory obligations, the Department of the Navy's (DoN) alternatives including the Proposed Action ("Proposed Action") for the Northwest Training Range Complex (NWTRC) Draft Environmental Impact Statement (EIS) / Overseas Environmental Impact Statement (OEIS), hereby referred to as EIS/OEIS, does not conflict with the objectives or requirements of Federal, State, regional, or local plans, policies, or legal requirements. Table 6-1 provides a summary of environmental compliance requirements that may apply.

Table 6-1: Summary of Environmental Compliance for the Proposed Action

Plans, Policies, and Controls	Responsible Agency	Status of Compliance
National Environmental Policy Act (NEPA) of 1969 (42 U.S.C §§ 4321 *et seq*.) Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 C.F.R. §§ 1500-1508) DoN Procedures for Implementing NEPA (32 C.F.R. § 775)	DoN	This EIS/OEIS has been prepared in accordance with NEPA, CEQ regulations and Navy NEPA procedures. Public participation and review is being conducted in compliance with NEPA.
Executive Order 12114, 32 CFR 187, Environmental Effects Abroad of Major Federal Actions	DoN	This EIS/OEIS has been prepared in accordance with EO 12114 as implemented by 32 CFR 187, which requires environmental consideration for actions that may affect the environment outside of U.S. Territorial Waters on the high seas.
Clean Air Act (CAA) (42 USC §§ 7401 *et seq*.) CAA General Conformity Rule (40 C.F.R. § 93[B]) State Implementation Plan (SIP)	U.S. Environmental Protection Agency (USEPA) Washington Department of Ecology Oregon Department of Environmental Quality California Air Resources Board North Coast Unified Air Quality Management District	The Proposed Action would not conflict with attainment and maintenance goals established in SIPs. A CAA conformity determination will not be required because emissions attributable to the alternatives including the Proposed Action would be below *de minimis* thresholds.
Federal Water Pollution Control Act (Clean Water Act [CWA)]) (33 U.S.C. §§ 1344 *et seq.*)	USEPA	No permits are required under the CWA Sections 401, 402, or 404 (b) (1).
Rivers and Harbors Act (33 U.S.C.§§ 401 et seq.)	U.S. Army Corps of Engineers	No permit is required under the Rivers and Harbors Act.

Table 6-1: Summary of Environmental Compliance for the Proposed Action (cont'd)

Plans, Policies, and Controls	Responsible Agency	Status of Compliance
Coastal Zone Management Act (CZMA) (16 C.F.R. §§ 1451 *et seq*.)	Washington State Department of Ecology Oregon Department of Land Conservation and Development California Coastal Commission	See Section 6.1.1, below, for discussion of Navy activities and compliance with the CZMA.
Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §§ 1801-1802)	National Marine Fisheries Service (NMFS)	The Proposed Action would not adversely affect Essential Fish Habitat (EFH) and would not decrease the available area or quality of EFH.
Endangered Species Act (ESA) (16 U.S.C. §§ 1531 et seq.)	DoN U.S. Fish and Wildlife Service (USFWS) NMFS	The EIS/OEIS analyzes potential effects to species listed under the ESA. In accordance with ESA requirements, the Navy will complete consultation under Section 7 of the ESA with NMFS and USFWS on the potential that implementation of the Proposed Action may affect listed species. With regard to NMFS jurisdiction, upon concluding Section 7 consultation, the Navy will adhere to any Biological Opinion (BO). In addition, the Navy will apply for a Letter of Authorization (LOA) (see discussion below re: Marine Mammal Protection Act), which is expected to impose terms and conditions that, when implemented, would make ESA Section 9 prohibitions inapplicable to covered Navy activities. With regard to USFWS jurisdiction over species present in the NWTRC, the Navy will initiate Section 7 consultation and conduct its activities in accordance with any applicable BOs.
Marine Mammal Protection Act (MMPA) (16 U.S.C. §§ 1431 *et seq*.)	NMFS	The MMPA governs activities with the potential to harm, disturb, or otherwise "harass" marine mammals. As a result of acoustic effects associated with mid-frequency active sonar use and underwater detonations of explosives, implementation of the alternatives including the Proposed Action may result in potential Level A (harm) or Level B (disturbance) harassment to marine mammals. Therefore, the Navy will engage NMFS in the regulatory process to determine whether incidental "takes" of marine mammals are likely, and seek a LOA from NMFS to permit takes as appropriate.
The Sikes Act of 1960 (16 U.S.C. §§ 670a-670o, as amended by the Sikes Act Improvement Act of 1997, Pub. L. No. 105-85)	DoD	The alternatives including the Proposed Action would be implemented in accordance with the management and conservation criteria developed in the Sikes Act Integrated Natural Resources Management Plans (INRMP) for Whidbey Island Naval Base Kitsap-Bangor, and Naval Magazine Indian Island.
Migratory Bird Treaty Act (16 U.S.C. §§ 703-712)	USFWS	Implementation of the alternatives including the Proposed Action would not have a significant impact on any population of migratory birds; would comply with the MBTA; and would not require a permit under the MBTA.

Table 6-1: Summary of Environmental Compliance for the Proposed Action (cont'd)

Plans, Policies, and Controls	Responsible Agency	Status of Compliance
The National Marine Sanctuaries Act (16 U.S.C. §§ 1431 et. seq.)	National Oceanic and Atmospheric Administration	Olympic Coast National Marine Sanctuary (OCNMS) lies within the Study Area addressed in this EIS/OEIS. Per OCNMS regulations (15 CFR §922.152(d)(1): "All Department of Defense military activities shall be carried out in a manner that avoids to the maximum extent practicable any adverse impacts on Sanctuary resources and qualities." (i) Except as provided in paragraph (d)(2) [bombing within the sanctuary], the prohibitions of this section do not apply to the following military activities performed by the Department of Defense in W–237A, W–237B, and Military Operating Areas Olympic A and B in the Sanctuary: (A) Hull integrity tests and other deep water tests; (B) Live firing of guns, missiles, torpedoes, and chaff; (C) Activities associated with the Quinault Range including the in-water testing of non-explosive torpedoes; and (D) Anti-submarine warfare operations. (ii) New activities may be exempted from the prohibitions in paragraphs (a) (2) through (7) of this section [discharging material, affecting cultural resources, drilling or altering the seabed, taking protected species, low overflight for certain areas, or interfering with investigation of possible NMS Act violation] by the Director after consultation between the Director and the Department of Defense. If it is determined that an activity may be carried out, such activity shall be carried out in a manner that avoids to the maximum extent practicable any adverse impact on Sanctuary resources and qualities. Civil engineering and other civil works projects conducted by the U.S. Army Corps of Engineers are excluded from the scope of this paragraph (d). Therefore, proposed activities are consistent with those activities currently conducted in the OCNMS, are consistent with those described in the designation document, and are not being changed or modified in a way that would require consultation. Implementation of the alternatives including the Proposed Action would have no effect on sanctuary resources in the off-shore environment of Washington. Review of agency actions under Section 304 of the National Marine Sanctuaries Act is not required.

Table 6-1: Summary of Environmental Compliance for the Proposed Action (cont'd)

Plans, Policies, and Controls	Responsible Agency	Status of Compliance
National Historic Preservation Act (NHPA) (16 U.S.C. §§ 470 *et seq*.)	DoN	The alternatives including the Proposed Action would be implemented in consultation with and under programmatic agreement with the State Historic Preservation Office, and pursuant to the criteria developed in the Integrated Cultural Resources Management Plans (ICRMP) for Whidbey Island.
EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	DoN	The Proposed Action would not result in any disproportionately high adverse human health or environmental effects on minority or low-income populations.
EO 13045, Protection of Children from Environmental Health Risks and Safety Risks	DoN	The Proposed Action would not result in environmental health and safety risks to children.
EO 13112, Invasive Species	DoN	EO 13112 requires agencies to identify actions that may affect the status of invasive species and take measures to avoid introduction and spread of these species. To the extent invasive species management relates to ESA compliance on Whidbey Island, the BO is expected to ensure compliance with EO 13112. This EIS/OEIS also otherwise satisfies the requirement of EO 13112.
EO 13089, Coral Reef Protection	DoN	EO 13089 preserves and protects the biodiversity, health, heritage, social and economic value of U.S. coral reef ecosystems and the marine environments. All Navy actions that may affect U.S. coral reef ecosystems shall: (a) identify their actions that may affect U.S. coral reef ecosystems; (b) utilize their programs and authorities to protect and enhance the conditions of such ecosystems; and (c) to the extent permitted by law, ensure that any actions they authorize, fund, or carry out will not degrade the conditions of such ecosystems. Navy SOPs ensure all precautions are made to comply with required statutes. No resources that are governed by this EO exist within the NWTRC, therefore, mitigation of effects will not be necessary for the protection of resources under EO 13089.
EO 11990, Protection of Wetlands	DoN	Implementation of the alternatives including the Proposed Action would not have a significant impact on wetlands.
EO 12962, Recreational Fisheries	DoN	EO 12962 requires Federal agencies to fulfill certain duties with regard to promoting the health and access of the public to recreational fishing areas. The alternatives including the Proposed Action comply with EO 12962.

6.1.1 Coastal Zone Management Act Compliance

The CZMA of 1972 (16 United States Code [U.S.C.] Section [§] 1451) encourages coastal States to be proactive in managing coastal zone uses and resources. CZMA established a voluntary coastal planning program; participating States submit a Coastal Management Plan (CMP) to National Oceanographic and Atmospheric Administration (NOAA) for approval. Under CZMA, Federal actions are required to be consistent, to the maximum extent practicable, with the enforceable policies of approved CMPs.

CZMA defines the coastal zone (16 U.S.C. § 1453) as extending, "to the outer limit of State title and ownership under the Submerged Lands Act" (i.e., 3 nautical miles [nm] from the shoreline). The coastal zone extends inland only to the extent necessary to control the shoreline. Excluded from the coastal zone are lands the use of which is by law subject solely to the discretion of, or which is held in trust by, the Federal government (16 U.S.C. § 1453). Accordingly, Federal military lands such as Naval Magazine Indian Island are not within the coastal zone.

The States of Washington, Oregon, and California have approved CMPs. The Washington State's Coastal Zone Management Program of 1976 implements Washington's CZMA program and the Washington State Department of Ecology is the lead coastal management agency. The Oregon Department of Land Conservation and Development (DLCD) is the State's designated coastal management agency and is responsible for reviewing projects for consistency with the CMP and issuing coastal management decisions. The California Coastal Commission, through the *California Coastal Act* (CCA) of 1976 (California Public Resources Code, § 30000 et seq) implements California's CZMA program. In general, these programs include policies to protect and expand public access to shorelines, and to protect, enhance, and restore environmentally sensitive habitats, including intertidal and nearshore waters, wetlands, bays and estuaries, riparian habitat, certain woods and grasslands, streams, lakes, and habitat for rare and endangered plants and animals. Chapter 1, Section 1.6.5 through 1.6.5.3 has a complete discussion of Washington's, Oregon's and California's CZMA programs.

The CZMA federal consistency determination process includes a review of the Proposed Action to determine whether it has reasonably foreseeable effects on coastal zone resources or uses, an in-depth examination of any such effects, and a determination on whether those effects are consistent to the maximum extent practicable with the State's enforceable policies. Under the CZMA, the States of Washington, Oregon, and California must provide an opportunity for public comment and involvement in the Federal coastal consistency determination process.

The Navy will submit its Consistency Determination (CCD) to the States of Washington, Oregon, and California in due course. Its preliminary determination, based in large part on the environmental impact analyses presented in this EIS/OEIS, is that the Navy is consistent to the maximum extent practicable with the State's enforceable CZMA policies.

The EIS/OEIS addresses those coastal resources and uses which would be affected by the Proposed Action, although the impact analyses do not specifically distinguish effects within the coastal zone from those effects outside of it. Public access and recreation are discussed in Sections 3.4 (Water Resources) and 3.16 (Public Health and Safety). Marine resources and biological productivity are discussed in Sections 3.6 (Marine Plants and Invertebrates), 3.7 (Fish), 3.8 (Sea Turtles), 3.9 (Marine Mammals), and 3.10 (Sea Birds). Fishing and commercial and recreational economics is discussed in Sections 3.7 (Fish) and 3.14 (Socioeconomics). Cultural resources are discussed in Section 3.12, Cultural Resources.

6.2 RELATIONSHIP BETWEEN SHORT-TERM USE OF MAN'S ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

NEPA requires an analysis of the relationship between a project's short-term impacts on the environment and the effects that these impacts may have on the maintenance and enhancement of the long-term productivity of the affected environment. Impacts that narrow the range of beneficial uses of the environment are of particular concern. This means that choosing one option may reduce future flexibility in pursuing other options, or that committing a resource to a certain use may often eliminate the possibility for other uses of that resource.

The Proposed Action would result in both short- and long-term environmental effects. However, the Proposed Action would not be expected to result in any impacts that would reduce environmental productivity, permanently narrow the range of beneficial uses of the environment, or pose long-term risks to health, safety or the general welfare of the public. The Navy is committed to sustainable range management, including co-use of the NWTRC with the general public and commercial interests to the extent practicable consistent with accomplishment of the Navy mission and in compliance with applicable law. This commitment to co-use will enhance the long-term productivity of the range areas surrounding the NWTRC.

6.3 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

NEPA requires that environmental analysis include identification of "any irreversible and irretrievable commitments of resources which would be involved in the Proposed Action should it be implemented." [NEPA Sec. 102 (2)(C)(v), 42 USC § 4332**].** Irreversible and irretrievable resource commitments are related to the use of non-renewable resources and the effects that the uses of these resources have on future generations. Irreversible effects primarily result from the use or destruction of a specific resource (*e.g.*, energy or minerals) that cannot be replaced within a reasonable time frame. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of the action (*e.g.*, the disturbance of a cultural site). Construction of the shallow water minefield would cause short-term and temporary impacts during construction. Once the minefield is put in place, anchoring points will be carefully chosen by the Navy in order to mitigate any possible effects the laying of the shapes might have on marine resources.

For the alternatives including the Proposed Action, most resource commitments are neither irreversible nor irretrievable. Most impacts are short-term and temporary, or, if long lasting are negligible. This will insure the future management of these resources. No habitat associated with threatened or endangered species would be lost as result of implementation of the Proposed Action. Energy typically associated with construction activities would not be expended and irreversibly lost.

Implementation of the Proposed Action would require fuels used by aircraft, ships, and ground-based vehicles. Since fixed- and rotary-wing flight and ship activities could increase relative, total fuel use would increase. Fuel use by ground-based vehicles involved in training activities would also increase. Therefore, total fuel consumption would increase and this nonrenewable resource would be considered irreversibly lost.

6.4 ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL OF ALTERNATIVES AND MITIGATION MEASURES

Increased training and testing activities associated with both Alternative 1 and Alternative 2 would result in an increase in energy demand over the No Action Alternative. This would result in an increase in fossil fuel consumption, mainly from aircraft, vessels, ground equipment, and power supply. Although the required electricity demands of increased intensity of land-use would be met by the existing electrical generation infrastructure at the NWTRC, the alternatives would result in a net cumulative negative impact on the energy supply.

Energy requirements would be subject to any established energy conservation practices at each facility. No additional power generation capacity other than the potential use of generators would be required for any of the activities. The use of energy sources has been minimized wherever possible without compromising safety, training, or testing activities. No additional conservation measures related to direct energy consumption by the proposed activities are identified.

6.5 NATURAL OR DEPLETABLE RESOURCE REQUIREMENTS AND CONSERVATION POTENTIAL OF VARIOUS ALTERNATIVES AND MITIGATION MEASURES

Resources that will be permanently and continually consumed by project implementation include water, electricity, natural gas, and fossil fuels; however, the amount and rate of consumption of these resources would not result in significant environmental impacts or the unnecessary, inefficient, or wasteful use of resources. Nuclear powered vessels would be a benefit as it decreases use of fossil fuels.

of natural resources would generally increase with implementation of the alternatives.

Pollution prevention is an important component of mitigation of the alternative’s adverse impacts. To the extent practicable, pollution prevention considerations are included.

Sustainable range management practices are in place that protect and conserve natural and cultural resources; and preservation of access to training areas for current and future training requirements, while addressing potential encroachments that threaten to impact range capabilities.

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7 List of Preparers

7 LIST OF PREPARERS

GOVERNMENT PREPARERS

Jere Diersing, Associate General Counsel
Naval Facilities Engineering Command Southwest

Dan Eldredge, CDR, U.S. Navy Judge Advocate
Commander, U.S. Pacific Fleet

Carol Gaasch, CAPT, U.S. Navy Judge Advocate
Navy Region Southwest

Nancy Glazer, Counsel
Naval Facilities Engineering Command Northwest

George Hart, Biologist
Navy Region Northwest

Chip Johnson (U.S. Navy Pacific Fleet)
Marine Species Advisor and Staff Marine Biologist
B.S. Biology, University of North Carolina at Wilmington
M.A. Marine Science, Virginia Institute of Marine Science, College of William and Mary

Kimberly Kler, Project Manager
NAVFAC Northwest, Environmental Planning & Natural Resources Department

Ken MacDowell, Training & Readiness
Commander, U.S. Pacific Fleet

Rich Melaas, Northwest Ranges
Navy Region Northwest

Clark Pitchford, Environmental Engineer
Navy Region Northwest

Carolyn Winters, Project Lead
Commander, U.S. Pacific Fleet

CONTRACTOR PREPARERS

Timberly Belish (Parsons Infrastructure and Technology) Terrestrial Biological Resources
B.S. Environmental Policy & Planning, Virginia Polytechnic Institute and State University
Years of Experience: 3.5

Blair Brownyard (Man Tech SRS Technologies, Inc.), Environmental Analyst
B.A. History, California State University, San Marcos
J.D. Touro Law Center
Years of Experience: 6

Jacklyn Bryant (Parsons Infrastructure and Technology), Assistant Task Order Manager
B.S. Environmental Policy & Planning, Virginia Polytechnic Institute and State University
Years of Experience: 3.5

Jeffery Butts (Parsons Infrastructure and Technology), Airborne Noise
B.A. Environmental Sciences, University of Virginia
Masters-Urban and Regional Planning, Virginia Tech
J.D. Catholic University, Columbus School of Law
Years of Experience: 16

Mark Collins (Parsons Infrastructure and Technology), Marine Biological Resources
B.S. Environmental Science, Ferrum College
Years of Experience: 23

Colleen Conklin (Parsons Infrastructure and Technology), Fish, EFH
B.S. Chemistry, University of South Florida, Tampa
Years of Experience: 23

Matt Hahn (ManTech SRS Technologies, Inc.), Military Operations Specialist
B.A. Business, University of St. Thomas
Years of experience: 17

Lee Monnens (Parsons Infrastructure and Technology), Geology and Soils
B.A. Geology, University of Minnesota Morris
M.S. Geology Iowa State University, Ames Iowa
Years of experience: 28

Gabe Lovasz (ManTech SRS Technologies, Inc.), Lead Geospatial Analyst
Geospatial Intelligence Diploma, National Geospatial Intelligence College
B.S. Information Technology, University of Phoenix
Years of Experience: 8

Wes Norris (Kaya & Associates, Inc.), Acoustic Analysis
B.S. 1976, Geology, Northern Arizona University
Years of Experience: 31

Arthur N. Popper (Environmental Bio Acoustics, LLC), Aquatic Bioacoustician
B.S. Environmental Biology, University of California, Santa Barbara
M.S. Environmental Management, University of San Francisco
Years of Experience: 26

Diane Rhodes (Parsons Infrastructure & Technology), Archaeologist/Cultural Resource Specialist *B.S. Elementary Education/Math and Physical Science. M.A. Anthropology (Archaeology), 1985, University of Colorado, Boulder, Colorado*.
Years of Experience: 28.

Tom Shillito (Parsons Infrastructure and Technology), Hazardous Materials, PHS
B.S. Aerospace Engineering, St. Louis University
M.C.E. Environmental Engineering, Auburn University
Years of Experience: 16

Valorie L. Thompson (Scientific Resources Associated), Air Quality
B.S. Chemistry, Eastern Michigan University
M.S. Chemical Engineering, Purdue University
Ph.D. Chemical Engineering, Purdue University
Years of Experience: 21

Philip Thorson (ManTech SRS Technologies, Inc.), Senior Research Biologist/Marine Mammal Biologist
B.A. Biology, University of California at Santa Cruz
Ph.D. Biology, University of California at Santa Cruz
Years of Experience: 27

Karen Waller (ManTech SRS Technologies, Inc.), Vice President/Quality Assurance
B.S. Public and Environmental Affairs, Indiana University
Years of Experience: 21

Brian D. Wauer (ManTech SRS Technologies, Inc.), Director, Range and Environmental Services
B.S. Administrative Management, University of Arkansas
B.S. Industrial Management, University of Arkansas
Years of Experience: 24

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8 References

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EXECUTIVE SUMMARY

NMFS. 2008. Endangered Species Act Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. United States Navy Explosive Ordnance Disposal Operations, Puget Sound; Whidbey Island, Island County, HUC 171100190301, Port Townsend, Jefferson County, HUC 171100190803, and Bangor, Kitsap County, HUC 171100180801 Washington. June.

Smultea, M.A., J.R. Mobley, Jr., and D. Fertl. 2001. Sperm whale (Physeter macrocephalus) reactions to small fixed-wing aircrafts. Page 200 in Abstracts, Fourteenth Biennial Conference on the Biology of Marine Mammals. 28 November-3 December 2001. Vancouver, British Columbia.

Washington State Department of Ecology 2001. Managing Washington's Coast – Washington's Coastal Zone Management Program. Publication 00-06-029, February 2001.

CHAPTER 1

Department of the Navy. 2002. Navy Environmental and Natural Resources Program Manual, Chapter 28 – Coastal Zone Management. OPNAVINST 5090.1B CH-3.

Washington State Department of Ecology 2001. Managing Washington's Coast – Washington's Coastal Zone Management Program. Publication 00-06-029, February 2001.

CHAPTER 2

DoN 2008. Draft Environmental Impact Statement for the Introduction of the P-8A Multi-Mission Maritime Aircraft into the U.S. Navy Fleet. February 2008.

CHAPTER 3

3.1 GEOLOGY AND SOILS

Burns. 1985. The shape and form of Puget Sound. Washington Sea Grant Program. University of Washington Press. Seattle, WA.

DoN (Department of the Navy). 1996. Integrated Natural Resources Management Plan: Naval Air Station Whidbey Island. Poulsbo, WA, Engineering Field Activity, Northwest. Prepared by EA Engineering, Science, and Technology. Bellevue, WA..

DoN. 2000a. Final Biological Assessment: U.S. Navy Explosive Ordnance Disposal (EOD) Operations, Puget Sound, Washington. Prepared for Engineering Field Activity, Northwest, Naval Facilities Engineering Command, Poulsbo, Washington, by SAIC, Bothell, Washington.

DoN. 2000b. Relocation of the Explosive Ordnance Disposal Demolition Training Range Environmental Assessment. Naval Air Station, Whidbey Island, Seaplane Base, Oak Harbor, WA. Department of the Navy. Prepared by EDAW, Inc., Seattle, WA.

DoN. 2001. Integrated Natural Resources Management Plan: Naval Submarine Base Bangor, Silverdale, Washington.

DoN. 2007. Navy Environmental and Natural Resources Program Manual. OPNAVINST 5090.1C. Chapter 24, Natural Resources Management.

Haan, C.T., B.J. Barfield, and J.C. Hayes. 1994. Design Hydrology and Sedimentology for Small Catchments. Academic Press. San Diego, CA.

Johannessen, J. 1999. Critical Shoreline Areas Relative to Critical Nearshore Habitats at Tala Point to Kala Point, Eastern Jefferson County, Washington. Submitted to Jefferson County Planning Department. Port Townsend, WA.

McGregor, B.A. and T.W. Offield. 1986. The Exclusive Economic Zone: An Exciting New Frontier. U.S. Department of the Interior, U.S. Geological Survey. U.S. Government Printing Office, #1937 192-727. Washington, D.C.

Melbourne, T.I., and F.H Webb. 2003. Slow but not quite silent. Science Vol. 300, No. 5627: 1886-1887

NRCS (Natural Resources Conservation Service). 2008. Helping People Understand Soils. Available on the Internet at: http://soils.usda.gov/.

Renner, R.H. and J.M. Short. 1980. Chemical products of underwater explosions. Naval Surface Weapons Center, Dahlgren, VA. NSWC/WOL. TR 78-87, February.

SCS. Soil Conservation Service. 1958. Soil Survey of Island County, Washington. U.S. Department of Agriculture. Washington Agricultural Experiment Station. Pullman, WA.

SCS (Soil Conservation Service). 1975. Soil Survey of Jefferson County Area, Washington. U.S. Department of Agriculture. Washington Agricultural Experiment Station. Pullman, WA.

SCS. 1980. Soil Survey of Kitsap County Area, Washington. U.S. Department of Agriculture and Washington State Department of Natural Resources. Washington Agricultural Research Center. Pullman, WA.

USEPA (U.S. Environmental Protection Agency). 1996. Soil Screening Guidance: Fact Sheet. Office of Emergency and Remedial Response. Publication 9355.4-14FSA.

3.2 AIR QUALITY

Aircraft Environmental Support Office. 1990. Summary Tables of Gaseous and Particulate Emissions from Aircraft Engines. AESO Report 6-90. June.

Aircraft Environmental Support Office. 1999. Aircraft Emission Estimates: A-6 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9941. May.

Aircraft Environmental Support Office. 1999. Aircraft Emission Estimates: E-2 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9943. May.

Aircraft Environmental Support Office. 1999. Aircraft Emission Estimates: F-14 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9945. May.

Aircraft Environmental Support Office. 1999. Aircraft Emission Estimates: P-3 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9948. May.

Aircraft Environmental Support Office. 1999. Aircraft Emission Estimates: H-60 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9953. June.

Aircraft Environmental Support Office. 2000. Aircraft Emission Estimates: F/A-18 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9933A. March.

Aircraft Environmental Support Office. 2000. Aircraft Emission Estimates: F/A-18 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 9933A. March.

Aircraft Environmental Support Office. 2001. Aircraft Emission Estimates: C-130 Mission Operations Using JP-5. DRAFT. AESO Memorandum Report No. 2000-10, Revision B. January.

California Air Resources Board. 2007a. Current Air Quality Standards. www.arb.ca.gov/research/aaqs/aaqs2.pdf.

California Air Resources Board. 2007b. EMFAC 2007 Model.

California Air Resources Board. 2007c. Speciation Profiles, http://www.arb.ca.gov/ei/speciate/speciate.htm.

CSSI, Inc. 2005. Emissions and Dispersion Modeling System (EDMS) Version 4.3.

JJMA. 2001. Emission Factors for Navy Ships. Personal Communication. May.

Oregon Department of Environmental Quality (ODEQ). 2007. Oregon Administrative Rules, http://www.deq.state.or.us/regulations/rulesandlaws.htm.

U.S. Environmental Protection Agency (USEPA). 1992. Procedures for Emission Inventory Preparation Volume IV: Mobile Sources.

U.S. Environmental Protection Agency (USEPA). 1996. Compilation of Air Pollutant Emission Factors, Fifth Edition, Chapter 3.3, Gasoline and Diesel Engines.

U.S. Environmental Protection Agency (USEPA). 2005. Ambient Air Quality Standards. www.epa.gov/air/oaqps/greenbk/index.html.

U.S. Environmental Protection Agency (USEPA). 2006. Compilation of Air Pollutant Emission Factors, Fifth Edition, Chapter 15, Ordnance Detonation.

Washington Department of Ecology (WDOE). 2007. http://www.ecy.wa.gov/laws-rules/index.html.

3.3 HAZARDOUS MATERIALS

Ankley, G.T. 1996. Evaluation of metal/acid-volatile sulfide relationships in the prediction of metal bioaccumulation by benthic macroinvertebrates. Environmental Toxicology and Chemistry 15:2138-2146.

Borener, S., and J. Maugham, 1998. Volpe AtoN [Aid to Navigation] Battery Scientific Assessment" United States Coast Guard AtoN Battery Scientific Assessment, DOT-VNTSC-CG-98-01. Enclosure 1 in "National Plan for AtoN Battery Recovery and Disposal," COMDTINST 16478.12. U.S. Department of Transportation, U.S.Coast Guard. Available on the Internet at: http://www.uscg.mil/directives/.

CFMETR. (Canadian Forces Maritime Experimental and Test Ranges). 2005. CFMETR Environmental Assessment. Environmental Sciences Group. Royal Military College of Canada. Kingston, Ontario.

Crecelius, E. 2001. Concentrations of Metals in Sediment and Water of Dabob Bay. Prepared for NAVSEA Undersea Warfare Center Division, Keyport, WA, by Battelle Marine Sciences Laboratory, Sequim, WA. March.

DoN. (Department of the Navy). 1996. Program Executive Office Undersea Warfare, Program Manager for Undersea Weapons. Environmental Assessment of the Use of Selected Navy Test Sites for Development Tests and Fleet Training Exercises of the MK 48 Torpedoes. CONFIDENTIAL.

DoN. 2000. Relocation of the Explosive Ordnance Disposal Demolition Training Range. Final Environmental Assessment. Naval Air Station, Widbey Island, Seaplane Base, Oak Harbor, WA. Department of the Navy. Prepared by EDAW, Inc. Seattle, WA.

DoN. 2001. Churchill Shock Trials: Final Environmental Impact Statement, Shock Trial of the USS17 Winston S. Churchill (DDG-81). Washington, D.C. Naval Sea Systems Command. 597p.

DoN. 2006a. Final Environmental Assessment Operations at the Bloodsworth Island Range, Maryland. Naval Air Systems Command. Patuxent, MD.

DoN. 2006b. Archival Search Report For Certain Northeast Range Complex Training/Testing Ranges. Prepared for NAVFAC Atlantic.

DoN. 2008a. Draft Undersea Warfare Training Range Overseas Environmental Impact Statement / Environmental Impact Statement. Naval Facilities Engineering Command Atlantic. Norfolk, VA.

DoN. 2008b. Draft Atlantic Fleet Active Sonar Training Environmental Impact Statement / Overseas Environmental Impact Statement. Naval Command, Atlantic Division. Norfolk, VA.

DoN. 2008c. Draft Southern California Range Complex Environmental Impact Statement / Overseas Environmental Impact Statement. Naval Command, Atlantic Division. San Diego, CA

Green, D., S. Cross, and M. Muirhead. 1996. Environmental Assessment of the Operational Testing Exercises at the Canadian Forces Maritime Experimental and Test Ranges, Nanoose, British Columbia. Pacific Marine Technology Centre, Victoria British Columbia, Canada.

Global Security. 2008. Available on the Internet at: http://www.globalsecurity.org/.

Hanson, W.C. 1974. Ecological Considerations of Depleted Uranium Munitions. Report LA-5559. Los Alamos Scientific Laboratory of the University of California. Los Alamos, NM.

Hoffsommer, J.C., D.J. Glover, and J.M. Rosen. 1972. Analysis of Explosives in Sea Water and in Ocean Floor Sediment and Fauna. Naval Ordnance Laboratory. White Oak, MD.

IUPAC/NIST (International Union of Pure and Applied Chemistry/National Institute of Standards and Technology). 2008. Available on the Internet at http://srdata.nist.gov/solubility/sol_main_search.aspx/.

Janes. 2005. Jane's ammunition handbook: 5-inch 54-calibre naval gun ammunition.

Janes. 2006. Jane's air-launched weapons: Mk 80 series general purpose bombs (Mk 81, 82, 83, 84 and BLU-110/111/117).

Klassen, R.D. and P.R. Roberge. 2005. Corrosion Aspects of the Release of Lithium Battery Contents in a Marine Environment. Environmental Sciences Group. Kingston, Ontario, Canada.

Kszos, L. A., J. J. Beauchamp, and A. J. Stewart. 2003. Toxicity of lithium to three freshwater organisms and the antagonistic effect of sodium. Ecotoxicology, Vol 12, No 5.

MBARI. (Monterey Bay Area Research Institute). 2008. Available on the Internet at: www.mbari.org/chemsensor/pteo.htm.

NFEC (Naval Facilities Engineering Command). 1993. Report on Continuing Action: Standard Range Sonobuoy Quality Assurance Program, San Clemente Island, California. NFEC Southwest Division. San Diego, CA.

NMFS (National Marine Fisheries Service). 2008. Endangered Species Act – Section 7 Consultation Biological Opinion And Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. United States Navy Explosive Ordnance Disposal Operations, Puget Sound, Washington. Seattle, WA.

NOAA (National Oceanic and Atmospheric Administration). 2008. Screening Quick Reference Tables at http://response.restoration.noaa.gov/.

Ordnance Shop, The. 2007. Mk 58 MOD 1 Marine Location, Marker. http://www.ordnance.org/mk58.htm. Accessed February 2008.

Rand Corporation. 2005. Unexploded ordnance cleanup costs: Implications of alternative protocols. Santa Monica, CA.

Renner R.H. and J.M. Short. 1980. Chemical products of underwater explosions. Report TR 78-87. Naval Surface Weapons Center. NSWC/WOL. Dahlgren, VA.

Toque, C. 2006. Marine Environmental Depleted Uranium Survey Report – Kirkcudbright Training Area – 2004. Environmental Sciences Department, Institute of Naval Medicine. Gosport, UK.

USACE (U.S. Army Corps of Engineers). 2003. Estimates for Explosives Residue from the Detonation of Army Munitions. ERDC/CRREL TR-03-16. Prepared for Strategic Environmental Research and Development Program. Arlington, VA. by Cold Regions Research and Engineering Laboratory. Hanover, NH.

USACE. 2007. Explosives Residues Resulting from the Detonation of Common Military Munitions: 2002-2006. ERDC/CRREL TR-07-2. Prepared for Strategic Environmental Research and Development Program. Arlington, VA. by Cold Regions Research and Engineering Laboratory. Hanover, NH.

USAF (U.S. Air Force). 1999. Cape San Blas Final Programmatic Environmental Assessment. Air Armament Center, 46 30 TW/XPE Range Environmental Planning Office, Eglin Air Force Base, Florida.

USCG. (U.S. Coast Guard). 1994. Aids to Navigation (AtoN) Battery Release Reporting Requirements. COMDTINST 16478.10. Available on the Internet at: http://www.uscg.mil/directives/.

USEPA. 2006. National Recommended Aquatic Life Criteria. Office of Water. Office of Science and Technology, 4304T. Available on the Internet at: http://www.epa.gov/waterscience/ criteria/nrwqc-2006.pdf.

USEPA. 2008. Toxicity Characteristic Leaching Procedures (TCLP) for VOCs, SVOCs, Chlorinated Pesticides and Herbicides, and Metals by SW-846 Method 1311 and Analysis. Available on the Internet at: http://epa.gov/region09/qa/pdfs/dqi/tclp.pdf.

3.4 WATER RESOURCES

Airamé, S., S. Gaines, and C. Caldow. 2003. Ecological linkages: Marine and estuarine ecosystems of central and northern California. Silver Spring, Maryland: NOAA, National Ocean Service. 164 pp.

Baker, E.T. and B.M. Hickey. 1986. Contemporary Sedimentation Processes In and Around An Active West Coast Submarine Canyon. Marine Geology 71: 15-34.

Barnes, C.A., A.C. Duxbury, and B.A. Morse. 1972. Circulation and selected properties of the Columbia River effluent at sea. Pages 41-80. In: Bioenvironmental Studies of the Columbia River Estuary and Adjacent Ocean Regions. Alverson, D.L. and A.L. Pruter, eds. University of Washington Press. Seattle, WA.

Barth, J.A., S.D. Pierce, and R.J. Cowles. 2005. Mesoscale structure and its seasonal evolution in the northern California Current System. Deep-Sea Research II 52:5-28.

Barth, J.A. and R.L. Smith. 1997. Coastal ocean circulation off Oregon: Recent observations of spatial and temporal variability. Pages 57-68. In: Estuarine and Ocean Survival of Northeastern Pacific Salmon: Proceedings of the Workshop. Emmett, R.L. and M.H. Schiewe, eds. NOAA Technical Memorandum NMFS-NWFSC-29.

Berdeal, I.G., B.M. Hickey, and M. Kawase. 2002. Influence of wind stress and ambient flow on a high discharge river plume. Journal of Geophysical Research 107(C9),3130,doi:10.1029/ 2001JC000932.

Boesch, D.F., D.M. Anderson, R.A. Horner, S.E. Shumway, P.A. Tester, and T.E. Whitledge. 1997. Harmful algal blooms in coastal waters: Options for prevention, control and mitigation. NOAA Coastal Ocean Program Decision Analysis Series No. 10. Silver Spring, Maryland: NOAA Coastal Ocean Office. 46 pp. + appendix.

Borener, S., and J. Maugham. 1998. “Volpe AtoN [Aid to Navigation] Battery Scientific Assessment.” United States Coast Guard AtoN Battery Scientific Assessment, DOT-VNTSC-CG-98-01. Enclosure 1 in “National Plan for AtoN Battery Recovery and Disposal,” COMDTINST 16478.12. U.S. Department of Transportation, U.S.Coast Guard.

Bottom, D.L., C.A. Simenstad, J. Burke, A.M. Baptista, D.A. Jay, K.K. Jones, E. Casillas, and M.H. Schiewe. 2005. Salmon at river's end: The role of the estuary in the decline and recovery of Columbia River salmon. NOAA Technical Memorandum NMFS-NWFSC-68:1-246.

Burger, A.E. 2003. Effects of the Juan de Fuca eddy and upwelling on densities and distributions of seabirds off southwest Vancouver Island, British Columbia. Marine Ornithology 31:113-122.

Burns, R. 1985. The shape and form of Puget Sound. Washington Sea Grant Program. University of Washington Press. Seattle, WA.

Cannon, G.A. 1983. An overview of circulation in the Puget Sound estuarine system. National Oceanic and Atmospheric Administration Technical Memorandum ERL-PMEL-48:1-30. Pacific Marine Environmental Laboratory. Seattle, WA.

CFMETR (Canadian Forces Maritime Experimental and Test Ranges). 2005. CFMETR Environmental Assessment. Environmental Sciences Group. Royal Military College of Canada. Kingston, Ontario.

Crandell, D.R., D.R. Mullieneaux, and H.H. Waldorn. 1965. Age and origin of the Puget Sound trough in western Washington. Pages B132-B136. In: Geological Survey Research 1965: Chapter B. U.S. Geological Survey Professional Paper 525-B.

Crecelius, E. 2001. Concentrations of metals in Sediment and Water of Dabob Bay. Prepared for NAVSEA Undersea Warfare Center Division, Keyport, WA, by Battelle Marine Sciences Laboratory, Sequim, WA. March.

Dailey, M.D., J.W. Anderson, D.J., Reish, and D.S. Gorsline. 1993. The Southern California Bight: Background and Setting. Pages 1-18. In: Ecology of the Southern California Bight. M.D. Dailey, D.J. Reish, and J.W. Anderson, eds. University of California Press. Berkeley, CA.

DoN (Department of the Navy). 1996. Integrated Natural Resources Management Plan: Naval Air Station Whidbey Island. Poulsbo, WA, Engineering Field Activity, Northwest. Prepared by EA Engineering, Science, and Technology. Bellevue, WA.

DoN. 2000. Relocation of the Explosive Ordnance Disposal Demolition Training Range. Final Environmental Assessment. Naval Air Station, Widbey Island, Seaplane Base, Oak Harbor, WA. Department of the Navy. Prepared by EDAW, Inc. Seattle, WA.

DoN. 2001. Integrated Natural Resources Management Plan: Naval Submarine Base Bangor, Silverdale, WA.

DoN. 2002. Environmental Assessment for ongoing and future operations at U.S. Navy Dabob Bay and Hood Canal Military Operating Areas. Northwest Naval Facilities Engineering Command. Prepared by EDAW, Inc. Seattle, WA., and Polaris Applied Sciences. Kirkland, WA.

DoN. 2007. Northwest Training Range Comprehensive Management Plan. Department of the Navy. Commander, US Fleet Forces; Commander, US Pacific Fleet; and Northwest Naval Facilities Engineering Command.

DoN. 2008. Atlantic Fleet Active Sonar Training Environmental Impact Statement/ Overseas Environmental Impact Statement. Naval Command, Atlantic Division. Norfolk, VA.

Douglas, A.V., D.R. Cayan, and J. Namias. 1982. Large-scale changes in North Pacific and North American weather patterns in recent decades. Monthly Weather Review 110:1851-1862.

Ebbesmeyer, C.C., J.M. Cox, and B.L. Salem. 1991. 1875 floatable wreckage driven inland through the Strait of Juan de Fuca. Pages 75-85. In: Puget Sound Research '91 Proceedings, Volume 1. Olympia, WA.

Salomons, W. and U. Forstner. 1984. Metals in the Hydrocycle. Springer-Verlag. Berlin.

Fox, C.G. and R.P. Dziak. 1998. Hydroacoustic detection of volcanic activity on the Gorda Ridge, February-March 1996. Deep-Sea Research II 45(12):2513-2530.

Gramling, J. 2000. Ballast water and shipping patterns in Puget Sound: Considerations for siting of alternative ballast water exchange zones. Olympia, Washington: Puget Sound Water Quality Action Team.

Green, D., S. Cross, and M. Muirhead. 1996. Environmental Assessment of the Operational Testing Exercises at the Canadian Forces Maritime Experimental and Test Ranges, Nanoose, British Columbia. Pacific Marine Technology Centre, Victoria British Columbia, Canada.

Greenland, D. 1998. Variability and stability of climatic/oceanic regimes in the Pacific Northwest. Pages 91-179. In: Change in Pacific Northwest coastal ecosystems: Proceedings of the Pacific Northwest Coastal Ecosystems Regional Study Workshop. McMurray, G.R. and R.J. Bailey, eds. Troutdale, Oregon. NOAA Coastal Ocean Program Decision Analysis Series No. 11. Silver Spring, MD.

Hameedi, M.J., A.S. Pait, and R.A.Warner. 2002. Environmental Contaminant Monitoring in the Gulf of Maine. A discussion paper presented at the Northeast Coastal Monitoring Summit, Durham, NH. Available on the Internet at: http://www.gulfofmaine.org/nciw/ec- monitoring.pdf .

Hayslip, G., L. Edmond, V. Partridge, W. Nelson, H. Lee, F. Cole, J. Lamberson , and L. Caton. 2006. Ecological Condition of the Estuaries of Oregon and Washington. EPA 910-R-06-001. U.S. Environmental Protection Agency, Office of Environmental Assessment, Region 10, Seattle, WA.

Hickey, B.M. and N.S. Banas. 2003. Oceanography of the U.S. Pacific Northwest coastal ocean and estuaries with application to coastal ecology. Estuaries 26(4B):1010-1031.

Hickey, B.M. 1979. The California Current System--Hypotheses and facts. Progress in Oceanography 8:191-279.

Hickey, B.M. 1998. Coastal oceanography of western North America from the tip of Baja California to Vancouver Island. Pages 345-393. In: The sea. Robinson, A.R. and K.H. Brink, eds. Volume 11, Chapter 12. John Wiley & Sons, Inc. New York, NY.

Hickey, B.M., L.J. Pietrafesa, D.A. Jay, and W.C. Boicourt. 1998. The Columbia River plume study: Subtidal variability in the velocity and salinity fields. Journal of Geophysical Research 103(C5):10339-10368.

Hickey, B.M., R.E. Thomson, H. Yih, and P.H. LeBlond. 1991. Velocity and temperature fluctuations in a buoyancy-driven current off Vancouver Island. Journal of Geophysical Research 96(C6):10507-10538.

Holbrook, J.R., R.D. Muench, D.G. Kachel, and C. Wright. 1980. Circulation in the Strait of Juan de Fuca: Recent oceanographic observations in the eastern basin. NOAA Technical Report ERL 4012-PMEL 33:1-42.

Huyer, A. 1983. Coastal upwelling in the California Current system. Progress in Oceanography 12:259-284.

Huyer, A., R. L. Smith and J. Fleischbein. 2002. The coastal ocean off Oregon and Northern California during 1997-8 El Niño. Progress in Oceanography: 54, 311-341.

Island County. 1998. Island County Comprehensive Plan: 2. Water Resources Element. Coupeville, WA.

IUPAC/NIST (International Union of Pure and Applied Chemistry/National Institute of Standards and Technology). 2008. Available on the Internet at: http://srdata.nist.gov/solubility/sol_main_search.aspx/.

Janes. 2005. Jane's ammunition handbook: 5-inch 54-calibre naval gun ammunition.

Janes. 2006. Jane's air-launched weapons: Mk 80 series general purpose bombs (Mk 81, 82, 83, 84 and BLU-110/111/117).

Jones, M.A. 1985. Occurrence of Groundwater and Potential for Sea Water Intrusion, Island County, Washington. USGS Water Resources Investigations Report 85-4046.

Kennett, J. 1982. Marine Geology. Prentice-Hall, Inc. Englewood Cliffs, NJ.

Klassen, R.D. and P.R. Roberge. 2005. Corrosion Aspects of the Release of Lithium Battery Contents in a Marine Environment. Environmental Sciences Group. Kingston, Ontario, Canada.

Kszos, L. A., J. J. Beauchamp, and A. J. Stewart. 2003. Toxicity of lithium to three freshwater organisms and the antagonistic effect of sodium. Ecotoxicology, Vol 12, No 5.

Kulm, L. D., and G. A. Fowler. 1974. Oregon continental margin structure and stratigraphy: A test of the imbricate thrust model. Pages 261-284. In: The Geology of Continental Margins. Burke, C.A., and C. L. Drake, eds. Springer-Verlag. New York, NY.

Kulm, L.D., ., E. Suess, J.C. Moore, B. Carson, B.T. Lewis, S.D. Ritger, D.C. Kadko, T.M. Thornburg, R.W. Embley, W.D. Rugh, G.J. Massoth, M.G. Langseth, G.R. Cochrane, and R.L. Scamman. 1986. Oregon Subduction Zone: Venting, Fauna, and Carbonates. Science, Vol. 231, No. 4738: 561-566

Leahy, J.G. and R.R. Colwell. 1990. Microbial Degradation of Hydrocarbons in the Environment. Microbiological Reviews, Vol. 54, No. 3: 305-315.

Mantua, N.J., S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society 78(6):1069-1079.

McGowan, J. A., D.R. Cayan, and L.M. Dorman. 1998. Climate-ocean variability and ecosystem response in the northeast Pacific. Science, Vol. 281, No. 5374: 210-217.

McGregor, B.A. and T.W. Offield. 1986. The Exclusive Economic Zone: An Exciting New Frontier. U.S. Department of the Interior, U.S. Geological Survey. U.S. Government Printing Office, #1937 192-727. Washington, D.C.

Melbourne, T.I., and F.H Webb. 2003. Slow but not quite silent. Science Vol. 300, No. 5627: 1886-1887

Miller, A.J. 1996. Recent advances in California Current modeling: Decadal and interannual thermocline variations. CalCOFI (California Cooperative Oceanic Fisheries Investigations) Reports 37:69-79.

NEP (National Estuary Program). 2007. U.S. Environmental Protection Agency. Coastal Condition Report. Available on the Internet at: http://www.epa.gov/owow/oceans/nepccr/index.html.

Newton, J., C. Bassin, A. Devol. M. Kawase, W. Ruef, M. Warner, D. Hannafious, and R. Rose. 2007. Hypoxia in Hood Canal: An overview of status and contributing factors. Hood Canal Dissolved Oxygen Program’s Integrated Assessment and Modeling Study. University of Washington and the Hood Canal Salmon Enhancement Group. Olympia, WA.

NFEC (Naval Facilities Engineering Command). 1993. Report on Continuing Action: Standard Range Sonobuoy Quality Assurance Program, San Clemente Island, California. Southwest Division. San Diego, CA.

Nittrouer, C.A. 1978. The Process of Detrital Sediments Accumulation in a Continental Shelf Environment: An Examination of the Washington Shelf. Ph.D. Diss., University of Washington. Seattle, WA.

NMFS (National Marine Fisheries Service). 2008. Endangered Species Act – Section 7 Consultation Biological Opinion And Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. United States Navy Explosive Ordnance Disposal Operations, Puget Sound, Washington. Seattle, WA.

NOAA (National Oceanic and Atmospheric Administration). 1998. Estuarine Eutrophication Survey, Volume 5: Pacific Coast Region. Office of Ocean Resources Conservation and Assessment, Rockville, MD.

NOAA. 2008. Screening Quick Reference Tables. Available on the Internet at http://response.restoration.noaa.gov/.

NOAA and WDOE. (Washington State Department of Ecology). 1999. Sediment quality in Puget Sound, Year 1 - Northern Puget Sound. NOS NCCOS CCMA No. Technical Memo No. 139 and WSDE Publication No. 99-347:1-221.

NOAA and WDOE. 2002. Sediment quality in Puget Sound, Year 3 - Southern Puget Sound. NOS NCCOS CCMA Technical Memo No. 153 and WSDE Publication No. 02-03-033:1-296.

Norris, J.G. and T. Hutley. 1997. Habitat utilization/water quality study Port Townsend Bay, Washington. Prepared for Port Townsend Marine Science Center. Port Townsend, WA.

Ott, M.W. and C. Garrett. 1998. Frictional estuarine flow in Juan de Fuca Strait, with implications for secondary circulation. Journal of Geophysical Research 103(C8):15657-15666.

Palsson, W.A., S. Hoffmann, P. Clarke, and J. Beam. 2003. Results from the 2001 transboundary trawl survey of the southern Strait of Georgia, San Juan Archipelago and adjacent waters. Washington Department of Fish and Wildlife. Mill Creek, WA.

Pease, C.H., R.J. Stewart, and J.E. Overland. 1979. Report on FY-78 numerical modeling in the Strait of Juan de Fuca and Puget Sound. NOAA Technical Report ERL MESA-38:1-32.

Porter, S., D.A. Vanko, and A.M. Ghazi. 2000. Major and trace element compositions of secondary clays in basalts altered at low temperature, eastern flank of the Juan de Fuca Ridge. Proceedings of the Ocean Drilling Program, Scientific Results 168:149-157.

PSAT. Puget Sound Action Team. 2000. Status and Trends of Key Indicators of Puget Sound's Health. Seattle, WA.

PSWQMP (Puget Sound Water Quality Management Plan). 2000. Puget Sound Action Team. Olympia, WA.

Rand Corporation. 2005. Unexploded ordnance cleanup costs: implications of alternative protocols. Santa Monica, CA.

Renner, R.H. and J.M. Short. 1980. Chemical products of underwater explosions. Naval Surface Weapons Center. Dahlgren, VA. NSWC/WOL. TR 78-87.

Rogers, A.D. 1994. The biology of seamounts. Pages 304-364. In: Advances in Marine Biology. Blaxter, J.H. and A.J. Southward, eds. Volume 30. Academic Press. San Diego, CA. .

Shepard, F.P. and K.O. Emery. 1941. Submarine topography off the California coast: Canyons and tectonic interpretation. Geological Society of America. Baltimore, MD.

Stout, H.A., B. B. McCain, R. D. Vetter, T. L. Builder, W. H. Lenarz, L. L. Johnson, and R.D. Methot. 2001. Status Review of Copper Rockfish, Quillback Rockfish, and Brown Rockfish in Puget Sound, Washington. NOAA Technical Memorandum NMFS-NWFSC-46.

Strickland, R. and D.J. Chasan. 1989. Coastal Washington: A synthesis of information. Washington Sea Grant Program, University of Washington. Seattle, WA.

SWRCB (State Water Resources Control Board). 2008. Available on the Internet at: http://www.waterboards.ca.gov/water_issues/programs/ocean/asbs.shtml.

Tanimoto, Y., N. Iwasaka, K. Hanawa, and Y. Toba. 1993. Characteristic variations of sea surface temperature with multiple time scales in the North Pacific. Journal of Climate 6:1153-1160.

Thomson, R.E. 1994. Physical oceanography of the Strait of Georgia-Puget Sound-Juan de Fuca Strait system. Pages 36-100 in Wilson, R.C.H., R.J. Beamish, F. Aitkens, and J. Bell, eds. Review of the Marine Environment and the Biota of Strait of Georgia, Puget Sound and Juan de Fuca Strait. Canadian Technical Report of Fisheries Aquatic Sciences 1948.

Thompson, B., J. Dixon, S. Shoeter, and D. J. Reish. 1993. Benthic Invertebrates. Pages 369-440. In: Ecology of the Southern California Bight. M.D. Dailey, D.J. Reish, and J.W. Anderson, eds. University of California Press. Berkeley, CA.

Thurman, H.V. 1997. Introductory Oceanography. 8th ed. Upper Saddle River, New Jersey: Prentice Hall.

Trenberth, K.E. 1990. Recent observed interdecadal climate changes in the northern hemisphere. Bulletin of the American Meteorological Society 71(7):988-993.

UNDS (Uniform National Discharge Standards). 2008. Available on the Internet at: http://unds.bah.com/Phase_I.html.

USACE (U.S. Army Corps of Engineers). 2003. Estimates for Explosives Residue from the Detonation of Army Munitions. ERDC/CRREL TR-03-16. Prepared for Strategic Environmental Research and Development Program. Arlington, VA. by Cold Regions Research and Engineering Laboratory. Hanover, NH.

USACE. 2007. Explosives residues resulting from the detonation of common military munitions, 2002-2006.

USEPA (U.S. Environmental Protection Agency). 1998. EPA's Contaminated Sediment Management Strategy. EPA-823-R-98-001.

USEPA. 2000. Clean Water Action Plan: National Coastal Condition Report. Office of Research and Development/Office of Water. Washington D.C. EPA-620-R-00-004.

USEPA. 2001. Equilibrium Partitioning Sediment Guidelines (ESGs) for the Protection of Benthic Organisms: Metal Mixtures (Cadmium, Copper, Lead, Nickel, Silver and Zinc). EPA-822-R-00-005. EPA Office of Water.

USEPA. 2004. National Coastal Condition Report II. Office of Research and Development/Office of Water. Washington D.C. EPA-620-R-03-002.

USEPA. 2006. National Recommended Aquatic Life Criteria. Office of Water. Office of Science and Technology, 4304T. Available on the Internet at: http://www.epa.gov/waterscience/ criteria/nrwqc-2006.pdf.

USEPA. 2007. National Water Quality Inventory: Report to Congress. 2002 Reporting Cycle. Office of Water. Washington D.C. EPA-841-R-07-001. Available on the Internet at: http://www.epa.gov/305b/2002report/.

USEPA. 2008a. Puget Sound Georgia Basin Ecosystem. Marine Water Quality. Available on the Internet at: http://www.epa.gov/region10/psgb/indicators/ marine_wq/.

USEPA. 2008b. Region 10: the Pacific Northwest. Clean Water Act §303(d) List of Impaired Waters. Available on the Internet at: http://yosemite.epa.gov/R10/WATER.NSF/TMDLs/CWA+303d+List/.

USEPA. 2008c. Where You Live: Find No-Discharge Programs. Ocean Regulatory Program. Available on the Internet at: http://www.epa.gov/owow/oceans/regulatory/vessel_sewage/vs_nodischarge_map.html.

USEPA. 2008d. Toxicity Characteristic Leaching Procedure (TCLP) for VOCs, SVOCs, Chlorinated Pesticides and Herbicides, and Metals by SW-846 Method 1311 and Analysis Available on the Internet at: http://epa.gov/region09/qa/pdfs/dqi/tclp.pdf.

USGS. U.S. Geological Survey. 2000. Water Quality in the Puget Sound Basin, Washington and British Columbia, 1996–98. J.C. Ebbert, S.S. Embrey, R.W. Black, A.J. Tesoriero, and A.L. Haggland. USGS Circular 1216.

van Geen, A., R.K. Takesue, J. Goddard, T. Takahashi, J.A. Barth, and R.L. Smith. 2000. Carbon and nutrient dynamics during coastal upwelling off Cape Blanco, Oregon. Deep-Sea Research II 47(5-6):975-1002.

WDFW. Washington Department of Fish and Wildlife. 1997. Final Joint WDFW/Tribal Wild Salmonid Policy. Olympia, WA. Available on the Internet at: http://wdfw.wa.gov/fish/wsp/joint/final/fwsp01.htm.

WDOE (Washington Department of Ecology). 1997. Chapter 173-201A, Washington Administrative Code. Water Quality Standards for Surface Waters of the State of Washington. Olympia, WA. Available on the Internet at: http://apps.leg.wa.gov/wac/.

WDOE. 2002. Washington State Marine Water Quality: 1998 through 2000. Report 02-03-056. Olympia, WA.

WDOE. 2008a. Areas Indicating or Susceptible to Eutrophication. Available on the Internet at: http://www.ecy.wa.gov/programs/eap/mar_wat/eutrophication.html.

WDOE. 2008b. Candidate List of Impaired and Threatened Waterbodies, the 303(d) List. Olympia, WA. Available on the Internet at: http://www.ecy.wa.gov/programs/wq/303d/2008/index.html.

Yen, P.P.W., W.J. Sydeman, K.H. Morgan, and F.A. Whitney. 2005. Top predator distribution and abundance across the eastern Gulf of Alaska: Temporal variability and ocean habitat associations. Deep-Sea Research II 52:799-822.

3.5 ACOUSTIC ENVIRONMENT

DoN (Department of the Navy). 1998. Tomahawk Flight Test Operations on the West Coast of the United States Final Environmental Impact Assessment for Naval Air Warfare Center Weapons Division. Naval Facilities Engineering Command, Southwest Division, San Diego.

DoN. 2001. Overseas Environmental Assessment for the Improved Extended Echo Ranging System Training Operations. September 2001.

DoN. 2004. OPNAV Instruction 3710.7T –The Naval Air Training and Operating Procedures Standardization (NATOPS) General Flight and Operating Instructions. 01 March 2004.

DoN. 2005a. Final Environmental Assessment for Replacement of EA-6B Aircraft with E/A-18G Aircraft at Naval Air Station Whidbey Island, Washington. January 2005.

DoN. 2005b. Final Overseas Environmental Assessment for Sinking Exercise (SINKEX). July 2005.

DoN. 2007. Overseas Environmental Assessment: Air Routine Training Exercises in East and Gulf Coast Operation Areas and Seaward. January 2007.

Ewbank, R. 1977. The Effects of Sonic Booms on Farm Animals. Vet Annu. 17:296-306.

FICON (Federal Interagency Committee on Noise). 1992. Federal Agency Review of Selected Airport Noise Analysis Issues. Washington, DC: Federal Interagency Committee on Noise.

Harris, Cyril M., editor-in-chief. 1979. Handbook of Noise Control. 2nd Edition. McGraw-Hill Book Company. August 1979.

Investigative Science and Engineering, Inc (IES). 1997. Noise Measurements of Various Aircraft and Ordnance at San Clemente Island. 1997.

Melaas, R. Community Planning Liaison Officer, NAS Whidbey Island. Memorandum dated 13 March 2000.

NASWI (Naval Air Station Whidbey Island). 1993. Environmental Assessment for the Detonation Training Range at Seaplane Base, Oak Harbor, Washington. 07 July 1993.

NASWI. 2006. NAS Whidbey Instruction 3770.1C – Pacific Northwest Operations Area (OPAREA) Manual. 17 March 2006.

NAVAIR (Naval Air Systems Command). 2005. Final Overseas Environmental Assessment of Testing the Hellfire Missile System's Integration with the H-60 Helicopter. May 2005.

Office of Marine Programs. 2006. Discovery of Sound in the Sea. Graduate School of Oceanography. University of Rhode Island.

USAF (United States Air Force). 1976. Environmental Assessment for the Okanagan Military Operating Area. 25 Air Division / NORAD Region (ADCOM). 26 November 1976.

USEPA (United States Environmental Protection Agency). 1978. Protective Noise Levels. Office of Noise Abatement and Control, Washington, DC.

Urick, R. 1983. Principles of underwater sound for engineers, 3rd Edition, Peninsula Publishing.

Urick, R.J. 1972. Noise signature of an aircraft in level flight over a hydrophone in the sea. Journal of the Acoustical Society of America 52, 993-999.

Willie, P.C. and Geyer, D. 1984. Measurements on the origin of the wind-dependent ambient noise variability in shallow water. J. Acoust. Soc Am. 75, 173-185.

Wyle Laboratories, Inc. (Wyle). 2004. Operational Noise Comparison between EA-6B and EA-18G at NAS Whidbey Island and OLF Coupeville, Wyle Report WR-04-08, Arlington, Virginia, March 2004.

3.6 MARINE PLANTS AND INVERTEBRATES

Airamé, S., S. Gaines, and C. Caldow. 2003. Ecological linkages: Marine and estuarine ecosystems of central and northern California. Silver Spring, Maryland: NOAA, National Ocean Service. 164 pp.

Bailey, A., H. Berry, B. Bookheim, and D. Stevens. 1998. Probability-based estimation of nearshore habitat characteristics. Pages 580-588. In: Proceedings of Puget Sound Research '98 Conference. Puget Sound Water Quality Action Team, Olympia, WA.

Batchelder, H.P., C.A. Edwards, and T.M. Powell. 2002. Individual-based models of copepod populations in coastal upwelling regions: implications of physiologically and environmentally influenced diel vertical migration on demographic success and nearshore retention. Prog. Oceanogr., 53: 307-333.

Beaulieu, S.E. 2001a. Life on glass houses: sponge stalk communities in the deep sea. Marine Biology 138:803-817.

Beaulieu, S.E. 2001b. Colonization of habitat islands in the deep sea: recruitment to glass sponge stalks. Deep-Sea Research I 48:1121-1137.

Boden, B.P., M.W. Johnson, and E. Brinton. 1955. The Euphausiacea (Crustacea) of the North Pacific. University of California Press. Berkeley, CA.

Bowlby, E., J. Hyland, M.S. Brancato, C. Cooksey, and S. Intelmann. 2005. Preliminary Discoveries of Scleractinian Coral Lophelia pertusa and other Deep-sea Coral and Sponge Communities in the Olympic Coast National Marine Sanctuary. Third International Symposium on Deep-Sea Corals Science and Management. Miami, FL.

Brancato, M.S. 2005. Infaunal populations and Olympic Coast, NMS. Pages 25-26. In: The Big Eddy: Proceedings of the Western Juan de Fuca Symposium. 10-11 May 2004. Canadian Parks and Wilderness Society British Columbia Chapter. Sidney, British Columbia.

Brancato, M.S. and E. Bowlby. 2005. Survey of fishing gear and fiber optics cable impacts to benthic habitats in the Olympic Coast National Marine Sanctuary. American Fisheries Society Symposium 41:629-630.

Brancato, M.S., P Etnoyer, E. Bowlby, and J. Hyland. 2006. Deep Sea Coral Habitat in Olympic Coast National Marine Sanctuary. Olympic National Marine Sanctuary. Olympia, WA.

Brouns, J.J.W.M. and F.M.L. Heijs. 1986. Production and biomass of the seagrass Enhalus acoroides (L.f.) royle and its epiphytes. Aquatic Botany 25:21-45.

Chess, J.R. and E.S. Hobson. 1997. Benthic invertebrates of four southern California marine habitats prior to onset of ocean warming in 1976, with lists of fish predators. NOAA Technical Memorandum NMFS-SWFSC-243:1-110.

Chester, A.J., D.M. Damkaer, D.B. Dey, G.A. Heron, and J.D. Larrance. 1980. Plankton of the Strait of Juan de Fuca, 1976-1977. Interagency Energy/Environment R&D Program Report. U.S. Environmental Protection Agency, Office of Environmental Engineering and Technology, Washington, D.C., EPA-600/7-80-032.

Conway, K.W., J.V. Barrie, and M. Krautter. 2005. Geomorphology of unique reefs on the western Canadian shelf: Sponge reefs mapped by multibeam bathymetry. Geo-Marine Letters 25:205-213.

Cook, A.E., J.A. Shaffer, and B. Dumbauld. 1998. Olympia Oyster Stock Rebuilding Plan for Washington State. Pages 525-530. In: Proceedings of Puget Sound Research 1998. Puget Sound Water Quality Action Team, Olympia, WA.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79/31. Prepared for the U.S. Fish and Wildlife Service, Office of Biological Services. Washington, D.C.

Dayton, P.K. 1985. Ecology of Kelp Communities. Ann. Rev. Ecol. Syst. 16:215-245.

den Hartog, C. 1970. The Seagrasses of the World. Amsterdam, The Netherlands: North-Holland Publishers.

Dethier, M.N. 1988. A Survey of Intertidal Communities of the Pacific Coastal Area of Olympic National Park, Washington. Prepared for the Use of the National Park Service and Cooperating Agencies.

DoN (Department of the Navy). 1996. Integrated Natural Resources Management Plan. Naval Air Station Whidbey Island. Engineering Field Activity, Northwest – U.S. Navy. EA Engineering, Science, and Technology. Bellevue, WA.

DoN. 2001. Naval Submarine Base Bangor Integrated Natural Resources Management Plan. U.S. Department of the Navy. Silverdale, WA.

DoN. 2002. Environmental assessment for the ongoing and future operations at U.S. Navy Dabob Bay and Hood Canal Military Operating Areas. Poulsbo, Washington: Engineering Field Activity Northwest, Naval Facilities Engineering Command. Prepared by EDAW, Inc., Seattle, Washington and Polaris Applied Sciences, Kirkland, WA.

DoN. 2006. Marine Resources Assessment for Pacific Northwest Operating Area. Pacific Division, Naval Facilities Engineering Command. Pearl Harbor, HI. Contract N62470-02-D-9997, CTO 0029. Prepared by Geo-Marine, Inc. Plano, TX.

DoN. 2007. Navy Environmental and Natural Resources Program Manual. OPNAVINST 5090.1C. Washington, D.C.

Dumbauld, B.R. 1985. The distributional ecology of zooplankton in East Passage and the Main Basin of Puget Sound. Masters Thesis, University of Washington, Seattle, WA, 210 p.

Estrada, M., and D. Blasco. 1979. Two phases of the phytoplankton community in the Baja California upwelling. Limnology and Oceanography 24:1065-1080.

Etnoyer, P. and L. Morgan. 2003. Occurrences of habitat-forming deep sea corals in the Northeast Pacific Ocean: A report to NOAA's office of habitat conservation. Redmond, Washington: Marine Conservation Biology Institute. 34 pp.

Fautin, D.G., T.R. White, and K.E. Pearson. 2002. Two new species of deep-water corallimorpharia (Cnidearia: Anthozoa) from the northeast Pacific, Corallimorphus denhartogi and C. pilatus. Pacific Science 56(2): 113-124.

Fisher, C.R., I.R. MacDonald, R. Sassen, C.M. Young, S.A. Macko, S. Hourdez, R.S. Carney, S. Joye, and E. McMullin. 2000. Methane ice worms: Hesiocaeca methanicola colonizing fossil fuel reserves. Naturwissenschaften 87:184-187.

Fonseca, M.S., W.J. Kenworthy, and G.W. Thayer. 1998. Guidelines for the Conservation and Restoration of Seagrasses in the United States and Adjacent Waters. Decision analysis Series No. 12. Coastal Ocean Office, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. Washington, D.C.

Foster, M.S. and D.R. Schiel. 1985. The ecology of giant kelp forests in California: A community profile. Biological Report. 85(7.2). U.S. Fish and Wildlife Service. 152 pp.

Freiwald, A., J.H. Fosså, T. Koslow, and J.M. Roberts. 2004. Cold-water coral reefs: Out of sight-no longer out of mind. Cambridge, United Kingdom: UNEP-WCMC.

Gardner, Fred, Ed. 1981. Washington Coastal Areas of Major Biological Significance. Washington Department of Ecology. Olympia, WA.

Giles, S.L., and J.R. Cordell. 1998. Zooplankton composition and abundance in Budd Inlet, Washington. Pages 634-642. In: Proceedings of Puget Sound Research '98 Conference. Puget Sound Water Quality Action Team, Olympia, WA.

Graham, M.H. 1997. Factors determining the upper limit of giant kelp, Macrocystis pyrifera Agardh, along the Monterey Peninsula, central California, USA. Journal of Experimental Marine Biology and Ecology 218:127-1 49.

Grassle, J.F. 1991. Deep-sea benthic biodiversity. Bioscience 41: 464-69.

Hain, S. and E. Corcoran. 2004. The status of the cold-water coral reefs of the world. Pages 115-133. In: Status of coral reefs of the world: 2004. Volume 1. Wilkinson, C., ed. Australian Institute of Marine Science. Townsville, Australia.

Hardy, J.T. 1993. Phytoplankton. Pages 233-265. In: Ecology of the Southern California Bight. M.D. Dailey, D.J. Reish, and J.W. Anderson, eds. University of California Press. Berkeley, CA.

Hessler, R.R. and P.F. Lonsdale. 1991. Biogeography of Mariana Trough hydrothermal vent communities. Deep-Sea Research 38(2):185-199.

Hourigan, T.F., S.E. Lumsden, G. Door, A.W. Bruckner, S. Brooke, and R.P. Stone. 2007. State of Deep Coral Ecosystems of the United States: Chapter 3 – Pacific Coast. National Marine Fisheries Service. National Oceanic and Atmospheric Administration. Silver Springs, MD.

Hutchinson, I. 1988. Estuarine marsh dynamics in the Puget Trough: implications for habitat management. Pages 455-462. In: Proceedings of the first annual meeting on Puget Sound research,. Puget Sound Water Quality Authority, Seattle, WA.

Hyland, J., C. Cooksey, E. Bowlby, M.S. Brancato, and S. Intelmann. 2005. A Pilot Survey of Deepwater Coral/Sponge Assemblages and their Susceptibility to Fishing/Harvest Impacts at the Olympic Coast National Marine Sanctuary (OCNMS). Cruise Report for NOAA Ship McARTHUR II Cruise AR-04-04: Leg 2. NOAA Technical Memorandum NOS NCCOS 15. NOAA/NOS Center for Coastal Environmental Health and Biomolecular Research, Charleston, SC.

IUCN (International Union for Conservation of Nature). 2008. IUCN Red List of Threatened Species. Available on the Internet at: http://www.iucnredlist.org/search/details.php/61743/summ.

Kideys, A.E. 2002. Fall and rise of the Black Sea ecosystem. Science 297: 1482–1483.

Kojima, S. 2002. Deep-sea chemoautosynthesis-based communities in the Northwestern Pacific. Journal of Oceanography 58:343-363.

Kozloff, E.N. 1993. Seashore life of the Northern Pacific Coast.University of Washington Press. Seattle, WA.

Laetz, C. 1998. Marine benthic invertebrate communities near King County's wastewater outfalls. Pages 754-759. In: Proceedings of the Puget Sound Research '98 Conference. Strickland, R., ed. Seattle, Washington, 12-13 March 1998. Puget Sound Water Quality Action Team. Olympia, WA.

Landry, M.R., C.J. Lorenzen. 1989. Abundance, distribution, and grazing impact of zooplankton on the Washington Shelf. Pages 175–210. In: Coastal Oceanography of Washington and Oregon. Landry, M.R., Hickey, B.M. eds. Elsevier, New York, NY.

Lane, R.C. and W.A. Taylor. 1997. Washington's Wetland Resources. U.S. Geological Survey Water-Supply Paper 2425.

Larson, E.M., E. Rodrick, and R. Milner, Technical Editors. 1995. Management Recommendations for Washington's Priority Species. Volume I: Invertebrates. Washington Department of Fish and Wildlife. Olympia, WA.

Levings, C.D. and R.M. Thom. 1994. Habitat changes in Georgia Basin: implications for resource management and restoration. Canadian Technical Report of Fisheries and Aquatic Sciences 1948:330–349.

Leys, S.P., K. Wilson, C. Holeton, H.M. Reiswig, W.C. Austin, and V. Tunnicliffe. 2004. Patterns of glass sponge (Porifera, Hexactinellida) distribution in coastal waters of British Columbia, Canada. Marine Ecology Progress Series 283:133-149.

Lie, U. 1974. Distribution and structure of benthic assemblages in Puget Sound, Washington. Mar. Biol. 26:203-223.

Lissner, A., ed. 1988. Biological reconnaissance of selected benthic habitats within three California OCS planning areas: Final report on review of recovery and recolonization of hard substrate communities of the outer continental shelf. OCS Study MMS 88-0034. Minerals Management Service. San Diego, CA.

Llansó, R.J. 1998. The distribution and structure of soft-bottom macrobenthos in Puget Sound in relation to natural and anthropogenic factors. Pages 760-771. In: Proceedings of the Puget Sound Research '98 Conference. Strickland, R., ed. Seattle, Washington, 12-13 March 1998. Puget Sound Water Quality Action Team. Olympia, WA.

Llansó, R.J., S. Aasen, and K. Welch. 1998. Marine Sediment Monitoring Program, II. Distribution and structure of benthic communities in Puget Sound 1989-1993. Publication No. 98-328. Washington Department of Ecology. Olympia, WA.

McConnaughey, B.H. 1970. Introduction to Marine Biology. C.V. Mosby Company, St. Louis, MO.

Miller, B.S., C.A. Simenstad, J.N. Cross, K.L. Gresh, and S.N. Steinfort. 1980. Nearshore fish and macroinvertebrate assemblages along the Strait of Juan de Fuca including food habits of the common nearshore fish: Final report of three years' sampling, 1976-1979. EPA-600/7-80-027. Prepared for MESA (Marine Ecosystems Analysis) Puget Sound Project and the U.S. Environmental Protection Agency. 226 pp.

MPAC (Marine Protected Areas Center). 2008. Available on the Internet at: http://mpa.gov/helpful_resources/faq.html.

NMFS (National Marine Fisheries Service). 2008. Endangered Species Act – Section 7 Consultation Biological Opinion And Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. United States Navy Explosive Ordnance Disposal Operations, Puget Sound, Washington. Seattle, WA.

OCNMS (Olympic Coast National Marine Sanctuary). 1993. Final Environmental Impact Statement. Sanctuaries and Reserves Division. National Oceanic and Atmospheric Administration, U.S. Department of Commerce. Washington, D.C.

O'Dor, R.K. 2003. The unknown ocean: The baseline report of the census of marine life research program. Consortium for Oceanographic Research and Education. Washington, D.C. 28 pp.

Ohman, M.D. 1990. The demographic benefits of diel vertical migration of zooplankton. Ecol. Monogr. 60:257-281.

Perry, M.J., J.P. Bolger and D.C. English. 1989. Primary Production in Washington Coastal Waters. In: Coastal Oceanography of Washington and Oregon. M.R. Landry and B.M. Hickey, eds. Elsevier Applied Science. NewYork, NY.

Peter-Contesse, T. and B. Peabody. 2005. Reestablishing Olympia oyster populations in Puget Sound, Washington. Seattle, Washington: Washington Sea Grant Program, University of Washington.

Phillips, R.C. and E.G. Meñez. 1988. Seagrasses. Smithsonian Contributions to the Marine Sciences 34:1-104.

Proctor, C.M., J.C. Garcia, D.V. Galvin, T. Joyner, G.B. Lewis, L.C. Loehr, and A.M. Massa. 1980. An ecological characterization of the Pacific Northwest coastal region. Volume 3 of 5: Characterization atlas: Zone and habitat descriptions. U.S. Fish and Wildlife Service, Biological Services Program. FWS/OBS-79/11 through 79/15. 435 pp.

PSMFC (Pacific States Marine Fisheries Commission). No date. Shellfish of the Pacific Northwest. StreamNet Project. Portland, OR.

Reed, D.W., Y. Fujita, M.E. Delwiche, D.B. Blackwelder, P.P. Sheridan, T. Uchida, and F.S. Colwell. 2002. Microbial communities from methane hydrate-bearing deep marine sediments in a forearc basin. Applied and Environmental Microbiology 68(8):3759-3770.

Roberts, S. and M. Hirshfield. 2004. Deep-sea corals: Out of sight, but no longer out of mind. Frontiers in Ecology and the Environment 2(3):123-130.

Rodríguez, S.R. 2003. Consumption of drift kelp by intertidal populations of the sea urchin Tetrapygus niger on the central Chilean coast: Possible consequences at different ecological levels. Marine Ecology Progress Series 251:141-151.

Schmitt, C., J. Schweigert, and T.P. Quinn. 1994. Anthropogenic influences on fish populations of the Georgia Basin. Pages 218-252. In: Review of the Marine Environment and Biota of Strait of Georgia, Puget Sound, and Juan de Fuca Strait. R.C.H. Wilson, R.J. Beamish, F.Aitkens, and J. Bell, eds. Can. Tech. Rep. Fish. Aquat. Sci.1948, 390 pp.

Seliskar, D.M. and J.L. Gallagher. 1983. The ecology of tidal marshes of the Pacific Northwest coast: A community profile. FWS/OBS-82/32. Washington, D.C.: U.S. Fish and Wildlife Service, Division of Biological Services. 65 pp.

Shaffer, J.A. 1998. Kelp bed habitats of the Inland Waters of Western Washington. Pages 353-362. In: Proceedings of Puget Sound Research '98 Conference. March 12-13,. Puget Sound Water Quality Action Team, Olympia, WA.

Sheard, K. 1953. Taxonomy, distribution and development of Euphausiacea (Crustacea). Rep. Brit. N.Z. Antarctic Res. Exped. Ser. B 8: 1-72.

Simenstad, C. A., K. L. Fresh, and E. O. Salo. 1982. The role of Puget Sound and Washington coastal estuaries in the life history of Pacific salmon: an unappreciated function. Pages 343-364. In: Estuarine Comparisons. V.S. Kennedy, ed. Academic Press, New York, NY.

Smith D. 1977. A Guide to Marine Coastal Plankton and Marine Invertebrate Larvae. Kendall/Hunt Publishing Company, Dubuque, IA.

Smith, C.R., A.R. Baco, A. Hannides, and D. Ruplinger. 2003. Chemosynthetic habitats on the California slope: Whale-, wood- and kelp-falls compared to vents and seeps. Page 1 in Biogeography and Biodiversity of Chemosynthetic Ecosystems: Planning for the Future. UNESCO UNESS Workshop. Southampton, England. June 16-18.

Steelquist, R.U. 1987. Washington's Coast. Washington Geographic Series. Farcountry Press. Helena, MT.

Strub, P.T., C. James, A.C. Thomas, and M.R. Abbott. 1990. Seasonal and nonseasonal variability of satellite-derived surface pigment concentration in the California Current. J. Geophys. Res., 95, 11501-11530.

Sutor, M.M., T.J. Cowles, W.T. Peterson, and S.D. Pierce. 2005. Acoustic observations of finescale zooplankton distributions in the Oregon upwelling region. Deep-Sea Research II 52(1-2): 109-121.

Thayer, G.W., K.A. Bjorndal, J.C. Ogden, S.L. Williams, and J.C. Zieman. 1984. Role of larger herbivores in seagrass communities. Estuaries 7(4A):35 1-376.

Thurman, H.V. 1997. Introductory Oceanography. 8th ed. Upper Saddle River, New Jersey: Prentice Hall. Tickell, W.L.N. 2000.

USACE (U.S. Army Corps of Engineers). 2008. Regulatory Program – Frequently Asked Questions. Available on the Internet at: http://www.usace.army.mil/cw/cecwo/reg/reg_faq.htm

Waaland, J.R. 1977. Common Seaweeds of the Pacific Coast. Pacific Search Press, Seattle, WA. 120pp.

WDFW (Washington Department of Fish and Wildlife). 2008. Species of Concern in Washington State. Available on the Internet at: http://wdfw.wa.gov/wlm/diversty/soc/soc.htm.

WDNR (Washington Department of Natural Resources). 2008. Washington State ShoreZone Inventory – Summary of Key Findings. Available on the Internet at: http://www.dnr.wa.gov/Publications/aqr_nrsh_shrzne_sum_find.pdf.

3.7 FISH

Allen, M.J. and G.B. Smith. 1988. Atlas and zoogeography of common fishes in the Bering Sea and northeastern Pacific. NOAA Technical Report NMFS 66:1-151.

Amoser, S., and F. Ladich. 2003. “Diversity in noise-induced temporary hearing loss in otophysine fishes.” Journal of the Acoustical Society of America 113(4):2170-2179.

Amoser, S. and F. Ladich. 2005. “Are hearing sensitivities of freshwater fish adapted to the ambient noise in their habitats?” Journal of Experimental Biology 208:3533-3542.

Anchor Environmental L.L.C. and People for Puget Sound. 2002. Final report: Northwest Straits nearshore habitat evaluation. Prepared for Northwest Straits Commission (NWSC), Mt. Vernon, Washington. 38 pp.

Aplin, J.A. 1947. “The effect of explosives on marine life.” California Fish and Game 33:23-30.

Astrup, J. 1999. “Ultrasound detection in fish – a parallel to the sonar-mediated detection of bats by ultrasound-sensitive insects?” Comparative Biochemistry and Physiology Part A 124:19-72.

Astrup, J., and B. Møhl. 1993. “Detection of intense ultrasound by the cod Gadus morhua.” Journal of Experimental Biology 182:71-80.

Bailey, K.M., R.C. Francis, and P.R. Stevens. 1982. The life history and fishery of Pacific whiting, Merluccius productus. CalCOFl Reports XXIII:81-98.

Bargmann, G. 1998. Forage fish management plan: A plan for managing the forage fish resources and fisheries of Washington. Olympia, Washington: Washington Department of Fish and Wildlife.

Bargmann, G. and J. Schweigert. 2005. Management of forage fish in Puget Sound and the Georgia Basin. PSAT (Puget Sound Action Team) and Georgia Basin Action Plan, eds. Proceedings of the 2005 Puget Sound Georgia Basin Research Conference. 29-31 March 2005. Washington State Convention and Trade Center, Seattle, Washington.

Barnes, J.T., S.L. Owen, and L.D. Jacobsen. 2001. Thornyheads. Pages 374-377 in Leet, W.S., C.M. Dewees, R. Klingbeil, and E.J. Larson, eds. California's living marine resources: A status report. California Department of Fish and Game SG01-11.

Berry, H. and R. Ritter. 1995. Puget Sound intertidal habitat inventory 1995: Vegetation and shoreline characteristics classification methods. Olympia, Washington: Washington State Department of Resources. 30 pp.

Borener, S. and J. Maugham. 1998. “Volpe AtoN [Aid to Navigation] Battery Scientific Assessment.” United States Coast Guard AtoN Battery Scientific Assessment, DOT-VNTSC-CG-98-01. Enclosure 1 in “National Plan for AtoN Battery Recovery and Disposal,” COMDTINST 16478.12. U.S. Department of Transportation, U.S.Coast Guard. http://www.uscg.mil/ccs/cit/cim/directives/CI/CI_16478_12.pdf.

Brennan, J.S. and K.F. Higgins. 2003. Fish species composition, timing and distribution in nearshore marine waters: A synopsis of 2001-2001 beach surveys in King County, WA. Droscher, T.W. and D.A. Fraser, eds. Proceedings of the 2003 Georgia Basin/Puget Sound Research Conference, Vancouver, British Columbia, 31 March - 3 April 2003.

Buckworth, R. 1996. The pelagic "box". Fisheries Centre Research Reports 4(1):67-69.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-27:1-261.

Butler, J.L., L.D. Jacobson, J.T. Barnes, and H.G. Moser. 2003. Biology and population dynamics of cowcod (Sebastes levis) in the southern California Bight. Fishery Bulletin 101:260-280.

Casillas, E., L. Crockett, Y. deReynier, J. Glock, M. Helvey, B. Meyer, C. Schmitt, and M. Yoklavich. 1998. Essential fish habitat west coast groundfish--Appendix. Seattle, Washington: National Marine Fisheries Service.

Casper, B.M and D.A. Mann. 2006. “Evoked potential audiograms of the nurse shark (Ginglymostoma cirratum) and the yellow stingray (Urobatis jamaicensis).” Environmental Biology of Fishes 76:101-108.

Casper, B.M., P.S. Lobel, and H.Y. Yan. 2003. “The hearing sensitivity of the little skate, Raja erinacea: A comparison of two methods.” Environmental Biology of Fishes 68:371-379.

Coker, C.M., and E.H. Hollis. 1950. “Fish mortality caused by a series of heavy explosions in Chesapeake Bay.” Journal of Wildlife Management 14:435-445.

Coombs, S. and Montgomery, J. C. 1999. The enigmatic lateral line system. In Comparative Hearing: Fishes and Amphibians (ed. A. N. Popper and R. R. Fay), pp. 319–362. New York: Springer-Verlag.

Coombs, S. and A.N. Popper. 1979. “Hearing differences among Hawaiian squirrelfish (family Holicentridae) related to differences in the peripheral auditory system.” Journal of Comparative Physiology A 132:203-207.

Culik, B.M., S. Koschinski, N. Tregenza, and G.M. Ellis. 2001. “Reactions of harbour porpoises Phocoena phocoena and herring Clupea harengus to acoustic alarms.” Marine Ecology Progress Series 211:255-260.

DeLacy, A.C., B.S. Miller, and S.F. Borton. 1972. Checklist of Puget Sound fishes. Washington Sea Grant Program Report WSG 72-3. Seattle, Washington: Division of Marine Resources University of Washington.

Dahlgren. 2000. Noise blast test results aboard USS Cole. Report from Dahlgren Division, Naval Surface Warfare Center, to Commander-in Chief, U.S. Atlantic Fleet (N3).

DoN (Department of the Navy). 2000. Final biological assessment: U.S. Navy explosive ordnance disposal (EOD) operations, Puget Sound, Washington. Prepared for Engineering Field Activity, Northwest, Naval Facilities Engineering Command, Poulsbo, Washington, by SAIC, Bothell, Washington.

DoN (Department of the Navy). 2001a. Naval Submarine Base Bangor, Silverdale, Washington: Integrated natural resources management plan. Naval Submarine Base Bangor.

DoN. 2001b. Final Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active LFA (SURTASS/LFA) Sonar. Washington, D.C. Available at www.surtass-lfa-eis.com/Download/index.htm.

DoN. 2006. Marine Resource Assessment for the Pacific Northwest Operating Area, Final Report. Commander, U.S. Pacific Fleet. September 2006.

DoN (Department of the Navy). 2007. United States Navy. Whales and Sonar. http://www.whalesandsonar.navy.mil.

Dunning, D.J., Q.E. Ross, P. Geoghegan, J.J. Reichle, J.K. Menezes, and J.K. Watson. 1992 . "Alewives avoid high-frequency sound." North American Journal of Fisheries Management 12:407-416.

Egner S.A., and D.A. Mann. 2005. "Auditory sensitivity of sergeant major damselfish Abudefduf saxatilis from post-settlement juvenile to adult." Marine Ecology Progress Series 285:213-222.

Emmett, R.L., S.A. Hinton, S.L. Stone, and M.E. Monaco. 1991. Distribution and abundance of fishes and invertebrates in west coast estuaries. Volume II: Species life history summaries. ELMR Report No. 8. Rockville, Maryland: NOAA/NOS Strategic Environmental Assessments Division. 329 pp.

Engås, A., and S. Løkkeborg. 2002. "Effects of seismic shooting and vessel-generated noise on fish behaviour and catch rates." Bioacoustics 12:313-315.

Engås, A., S. Løkkeborg, E. Ona, and A.V. Soldal. 1996. "Effects of seismic shooting on local abundance and catch rates of cod (Gadus morhua) and haddock (Melanogrammus aeglefinus)." Canadian Journal of Fisheries and Aquatic Sciences 53:2238-2249.

Enger, P.S. 1981. "Frequency discrimination in teleosts-central or peripheral?" In Hearing and Sound Communication in Fishes, eds. W.N. Tavolga, A.N. Popper, and R.R. Fay, 243-255. New York: Springer-Verlag.

ESG (Environmental Sciences Group). 2005. Canadian Forces Maritime Experimental and Test Ranges Environmental Assessment Update. Royal Military College of Canada.

Frankenstein, G. 2000. Blooms of ulvoids in Puget Sound. Olympia, Washington: Puget Sound Water Quality Action Team.

Garrison, K.J. and B.S. Miller. 1982. Review of the early life history of Puget Sound fishes. Contract number 80-ABA-3680. Seattle, Washington: Fisheries Research Institute, University of Washington.

Gaspin, J.B. 1975. "Experimental investigations of the effects of underwater explosions on swimbladder fish, I: 1973 Chesapeake Bay tests." Navel Surface Weapons Center Technical Report NSWC/WOL/TR 75-58, White Oak Laboratory, Silver Spring, Maryland.

Gearin, P.J., M.E. Gosho, J.L. Lakke, L. Cooke, R.L. Delong, and K.M. Hughes. 2000. "Experimental testing of acoustic alarms (pingers) to reduce bycatch of harbour porpoise, Phoceoena phocoena, in the state of Washington." Journal of Cetacean Research and Management 2(1):1-9.

Goertner, J. F., M. L. Wiley, G. A. Young, and W. W. McDonald. 1994. Effects of underwater explosions on fish without swimbladders. Naval Surface Warfare Center, Dahlgren Division, White Oak Detachment, Silver Spring, MD. NSWC TR 88-114.

Govoni, J.J., L.R. Settle, and M.A. West. 2003. "Trauma to juvenile pinfish and spot inflicted by submarine detonations." Journal of Aquatic Animal Health 15:111-119.

Gregory, J. and P. Clabburn. 2003. "Avoidance behaviour of Alosa fallax fallax to pulsed ultrasound and its potential as a technique for monitoring clupeid spawning migration in a shallow river." Aquatic Living Resources 16:313-316.

Hart, J.L. 1973. Pacific fishes of Canada. Ottawa, Ontario: Fisheries Research Board of Canada.

Hastings, M.C., A.N. Popper, J.J. Finneran, and P.J. Lanford. 1996. "Effects of low-frequency underwater sound on hair cells of the inner ear and lateral line of the teleost fish Astronotus ocellatus." Journal of the Acoustical Society of America 99(3):1759-1766.

Hastings, M.C. and A.N. Popper. 2005. "Effects of Sound on Fish." Report prepared by Jones & Stokes for California Department of Transportation, Contract No. 43A0139, Task Order 1.

Hawkins, A.D., and A.D.F. Johnstone. 1978. "The hearing of the Atlantic salmon, Salmo solar." Journal of Fish Biology 13:655-673.

Healey, M.C. 1991. Life history of chinook salmon (Oncorhynchus tshawytscha). Pages 311-393 in Groot, C. and L. Margolis, eds. Pacific salmon life histories. Vancouver, British Columbia: UBC Press.

Helser, T. E., A. E. Punt, and R. D. Methot. 2004. A generalized linear model analysis of a multi-vessel fishery resource survey. Fish. Res. 70: 239–250.

Herrera Environmental Consultants Inc. 2005. Marine shoreline sediment survey and assessment, Thurston County, Washington. Prepared for Thurston Regional Planning Council, Olympia, Washington.

Higgs, D.M., D.T.T. Plachta, A.K. Rollo, M. Singheiser, M.C. Hastings, and A.N. Popper. 2004. "Development of ultrasound detection in American shad (Alosa sapidissima)." Journal of Experimental Biology 207:155-163.

Iversen, R.T.B. 1967. "Response of the yellowfin tuna (Thunnus albacares) to underwater sound." In Marine Bio-Acoustics II, ed. W.N. Tavolga, 105-121. New York: Pergamon Press.

Iversen, R.T.B. 1969. "Auditory thresholds of the scombrid fish Euthynnus affinis, with comments on the use of sound in tuna fishing." Proceedings of the FAO Conference on Fish Behaviour in Relation to Fishing Techniques and Tactics, October 1967. FAO Fisheries Reports No. 62 Vol. 3. FRm/R62.3.

Johnson, K.A., M.M. Yoklavich, and G.M. Cailliet. 2001. Recruitment of three species of juvenile rockfish (Sebastes spp.) on soft benthic habitat in Monterey Bay, California. CalCOFI Reports 42:153-166.

Johnson, O.W., W.S. Grant, R.G. Kope, K. Neely, F.W. Waknitz, and R. S. Waples. 1997. Status review of chum salmon from Washington, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-NWFSC-32, 280p.

Jorgensen, R., N. O. Handegard, H. Gjøsæter, and A. Slotte. 2004. Possible vessel avoidance behaviour of capelin in a feeding area and on a spawning ground. Fisheries Research 69: 251-261.

Jørgensen, R., K.K. Olsen, I.B. Falk-Petersen, and P. Kanapthippilai. 2005. "Investigations of potential effects of low frequency sonar signals on survival, development and behaviour of fish larvae and juveniles." The Norwegian College of Fishery Science, University of Tromsø, N-9037 Tromsø Norway.

Keevin, T.M., G.L. Hempen, and D.J. Schaeffer. 1997. "Use of a bubble curtain to reduce fish mortality during explosive demolition of Locks and Dam 26, Mississippi River." In Proceedings of the Twenty-third Annual Conference on Explosives and Blasting Technique, Las Vegas, Nevada, International Society of Explosive Engineers, Cleveland, Ohio, 197-206.

Kenyon, T.N. 1996. "Ontogenetic changes in the auditory sensitivity of damselfishes (Pomacentridae)." Journal of Comparative Physiology A 179:553-561.

Knudsen, F.R., P.S. Enger, and O. Sand. 1992. "Awareness reactions and avoidance responses to sound in juvenile Atlantic salmon, Salmo salar." Journal of Fish Biology 40:523-534.

Knudsen, F.R., P.S. Enger, and O. Sand. 1994. "Avoidance responses to low frequency sound in downstream migrating Atlantic salmon smolt, Salmo salar." Journal of Fish Biology 45:227-233.

Knudsen, F. R., C. B.Schreck, S. M. Knapp, P. S. Enger, and O. Sand. 1997. Infrasound produces flight and avoidance response in Pacific juvenile salmonids. J. Fish Biol. 51, 824-829.

Kruse, G. H., Tyler, A. V. 1983. Simulation of temperature and upwelling effects on the English sole Parophrys vetulus spawning season. Can. J. Fish. aquat. Sci. 40: 230-237.

Kszos, L.A. and A.J. Stewart. 2003. Review of lithium in the aquatic environment: distribution in the United States, toxicity and case example of groundwater contamination. Ecotoxicology. 12: 439-447.

Kvadsheim, P.H., and E.M. Sevaldsen. 2005. "The potential impact of 1-8 kHz active sonar on stocks of juvenile fish during sonar exercises." FFI/Report-2005/01027.

Ladich, F. and A.N. Popper. 2004. "Parallel Evolution in Fish Hearing Organs." In Evolution of the Vertebrate Auditory System, Springer Handbook of Auditory Research, eds. G.A. Manley, A.N. Popper, and R.R. Fay, 95-127. New York: Springer-Verlag.

Ladich, F. and Bass, A. H. 2003. Underwater sound generation and acoustic reception in fishes with some notes on frogs. In Sensory Processing in Aquatic Environments (ed. S. P. Collin and N. J. Marshall), pp. 173-193. New York: Springer.

Leet, W.S., C.M. Dewees, R. Klingbeil, and E.J. Larson, eds. 2001. California's living marine resources: A status report. University of California Sea Grant Publication SG 01-11. Sacramento, California: California Department of Fish and Game.

Love, M.S., P. Morris, M. McCrae, and R. Collins. 1990. Life history aspects of 19 rockfish species (Scorpaenidae: Sebastes) from the Southern California Bight. NOAA Technical Report NMFS 87:1-38.

Love, M.S., M.M. Yoklavich, and L. Thorsteinson. 2002. The rockfishes of the northeast Pacific. Berkeley, California: University of California Press.

Love, M.S., C.W. Mecklenburg, T.A. Mecklenburg, and L.K. Thorsteinson. 2005. Resource inventory of marine and estuarine fishes of the west coast and Alaska: A checklist of North Pacific and Arctic Ocean species from Baja California to the Alaska-Yukon border. OCS Study MMS 2005-030 and USGS/NBII 2005-001. Seattle, Washington: U.S. Department of the Interior, U.S. Geological Survey, Biological Resources Division.

Lovell, J.M., M.M. Findlay, R.M. Moate, and D.A. Pilgrim. 2005. "The polarization of inner ear ciliary bundles from a scorpaeniform fish." Journal of Fish Biology 66:836–846.

MacGregor, J.S. 1983. Growth of the blue rockfish (Sebastes mystinus). CalCOFl Reports XXIV:216-225.

Mann, D.A., A.N. Popper, and B. Wilson. 2005. "Pacific herring hearing does not include ultrasound." Biology Letters 1:158-161.

Mann, D.A., D.M. Higgs, W.N. Tavolga, M.J. Souza, and A.N. Popper. 2001. "Ultrasound detection by clupeiform fishes." Journal of the Acoustical Society of America 109(6):3048-3054.

Mann, D.A., Z. Lu, and A. N. Popper. 1997. "A clupeid fish can detect ultrasound." Nature 389:341.

Mann, D.A., Z. Lu, M.C. Hastings, and A.N. Popper. 1998. "Detection of ultrasonic tones and simulated dolphin echolocation clicks by a teleost fish, the American shad (Alosa sapidissima)." Journal of the Acoustical Society of America 104(1):562-568.

Matthews, K. 1990. A comparative study of habitat use by young-of-the-year, subadult, and adult rockfishes on four habitat types in central Puget Sound. Fishery Bulletin 88:223-239.

MBC. 1987 Ecology of important fisheries species offshore California. OCS Study MMS 86-0093. Camarillo, California: Minerals Management Service.

McCain, B. 2003. Essential fish habitat west coast groundfish. Draft revised appendix. Seattle, Washington: Northwest Fisheries Science Center. 243 pp.

McCauley, R.D., J. Fewtrell, and A.N. Popper. 2003. “High intensity anthropogenic sound damages fish ears.” Journal of the Acoustical Society of America 113(1):638-642.

McFarlane, G.A. and R.J. Beamish. 1985. Biology and fishery of Pacific whiting, Merluccius productus, in the Strait of Georgia. Marine Fisheries Review 47:23-34.

McFarlane, G.A. and R.J. Beamish. 1986. Biology and fishery of Pacific whiting, Merluccius productus, in the Strait of Georgia. International North Pacific Fisheries Community Bulletin 50:365-392.

McLaughlin. 2005. McLaughlin, P.A., D.K. Camp, M.V. Angel, E.L. Bousfield, P. Brunel, R.C. Brusca, D. Cadien, A.C. Cohen, K. Conlan, L.G. Eldredge, D.L. Felder, J.W. Goy, T. Haney, B. Hann, R.W. Heard, E.A. Hendrycks, H.H. Hobbs III, J.R. Holsinger, B. Kensley, D.R. Laubitz, S.E. LeCroy, R. Lemaitre, R.F. Maddocks, J.W. Martin, P. Mikkelsen, E. Nelson, W.A. Newman, R.M. Overstreet, W.J. Poly, W.W. Price, J.W. Reid, A. Robertson, D.C. Rogers, A. Ross, M. Schotte, F.R. Schram, C.-T. Shih, L. Watling, and G.D.F. Wilson. 2005. Common and scientific names of aquatic invertebrates from the United States and Canada: Crustaceans. Bethesda, Maryland: American Fisheries Society, Special Publication 31.

McLennan, M.W. 1997. A simple model for water impact peak pressure and pulse width. Technical Memorandum, Greeneridge Sciences Inc., Santa Barbara, CA. 4 p.

Meyer, R.M. 1997. Forage fishes in marine ecosystems: Introduction to the symposium. Pages 1-9 in Forage fishes in marine ecosystems. Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems. University of Alaska Fairbanks. Alaska Sea Grant College Program Report No. AK-SG-97-01.

Miller, B.S., C.A. Simenstad, and L.L. Moulton. 1976. Puget Sound baseline: nearshore fish survey. Fisheries Research Institute. University of Washington, Seattle, WA.

Miller, B.S. and S.F. Borton. 1980. Geographical distribution of Puget Sound fishes: Maps and data source sheets. Volume 1: Family Petromyzontidae (Lampreys) 1.1 through Family Syngnathidae (Pipefishes) 31.1.

Monaco, M.E., D.M. Nelson, R.L. Emmett, and S.A. Hinton. 1990. Distribution and abundance of fishes and invertebrates in West Coast estuaries, Volume 1: Data summaries. Distribution and abundance. ELMR Report No. 4. Rockville, Maryland: NOAA/NOS Strategic Assessment Branch. 240 pp.

Monaco, M.E., T.A. Lowery, and R.L. Emmett. 1992. Assemblages of U.S. west coast estuaries based on the distribution of fishes. Journal of Biogeography 19:251-267.

Moriarity, R.M., J.A. Shaffer, and D. Penttila. 2002a. Nearshore mapping of the Strait of Juan de Fuca I: Surf smelt. Final Report. Prepared for Clallam County Marine Resources Committee, Northwest Straits Commission, Clallam County, Washington by Washington Department of Fish and Wildlife, Olympia, Washington.

Moriarity, R.M., J.A. Shaffer, and D. Penttila. 2002b. Nearshore mapping of the Strait of Juan de Fuca IV: Sand lance. Final Report. Prepared for Clallam County Marine Resources Committee, Northwest Straits Commission, Clallam County, Washington by Washington Department of Fish and Wildlife, Olympia, Washington.

Moser, H.G., N.C.H. Lo, and P.E. Smith. 1997. Vertical distribution of Pacific hake eggs in relation to stage of development and temperature. CalCOFI Reports 38:120-126.

Moser, H.G., R.L. Charter, W. Watson, D.A. Ambrose, J.L. Butler, S.R. Charter, and E.M. Sandknop. 2000. Abundance and distribution of rockfish (Sebastes) larvae in the Southern California Bight in relation to environmental conditions and fishery exploitation. CalCOFl Reports 41:132-147.

Moulton, L.L. 2000. Distribution of potential surf smelt and Pacific sandlance spawning habitat in San Juan County. Final report. Prepared for Northwest Straits Commission, Mount Vernon, Washington by MJM Research, Lopez Island, Washington.

Moulton, L.L. and D.E. Penttila. 2000. Forage fish spawning distribution in San Juan County and protocols for sampling intertidal and nearshore regions. Final report. Prepared for Northwest Straits Commission, Mount Vernon, Washington.

Myers, K.W., C.K. Harris, C.M. Knudsen, R.V. Walker, N.D. Davis, and D.E. Rogers. 1987. Stock origins of Chinook salmon in the area of the Japanese mothership salmon fishery. North American Journal of Fisheries Management 7:459-474.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-35:1-443.

Myrberg, A.A. Jr. 1980. "Fish bioacoustics: its relevance to the 'not so silent world.'" Environmental Biology of Fish 5:297-304.

Myrberg, A.A. Jr. 2001. "The acoustical biology of elasmobranchs." Environmental Biology of Fishes 60:31-45.

NRC. 2003. Ocean Noise and Marine Mammals. Washington, DC: National Academy Press.

NRC (National Research Council). 1994. Low-Frequency Sound and Marine Mammals: Current Knowledge and Research Needs. Washington, DC: National Academy Press.

NAVFAC (Naval Facilities Engineering Command, Southwest Division). 1993. Report on Continuing Action: Standard Range Sonobuoy Quality Assurance Program. San Clemente Island, California. Program Executive Office, Antisubmarine Warfare Assault and Special Mission Programs. September 1993.

Nelson, J.S. 1994. Fishes of the World, third edition. John Wiley & Sons, Inc., New York. Pages 12 and 125-127.

Nelson, J.S., E.J. Crossman, H. Espinosa-Perez, L.T. Findley, C.R. Gilbert, R.N. Lea, and J.D. Williams. 2004. Common and scientific names of fishes from the United States, Canada, and Mexico. 6th ed. Bethesda, Maryland: American Fisheries Society.

Nestler, J.M. 2002. "Simulating movement patterns of blueback herring in a stratified southern impoundment." Transactions of the American Fisheries Society 131:55-69.

NMFS (National Marine Fisheries Service). 1996. Making Endangered Species Act Determinations of Effect for Individual or Grouped Action at the Watershed Scale. NW Regional Office. Seattle WA.

NMFS. 1997. Endangered and threatened species: Listing of several evolutionary significant units (ESUs) of West Coast steelhead. Federal Register 62(159):43937-43954.

NMFS. 1999. Our Living Oceans. Report on the status of U.S. living marine resources, 1999. NOAA Technical Memorandum NMFS-F/SPO-41 :1-301.

NMFS. 2002a. Fisheries off west coast states and in the western Pacific; Atlantic highly migratory species; fisheries of the northeastern United States; implementation of the shark finning prohibition act--Final rule. Federal Register 67(28):6194-6202.

NMFS. 2002b. Magnuson-Stevens Act provisions; Essential Fish Habitat (EFH)--Final rule. Federal Register 67(12):2343-2383.

NMFS. 2004a. Taking of threatened or endangered species incidental to commercial fishing operations--Final rule. Federal Register 69(48):1 1540-11545.

NMFS. 2004b. Environmental assessment and regulatory impact review of proposed 2005 changes to the catch sharing plan for Pacific halibut in are 2A. Seattle, Washington: National Marine Fisheries Service.

NMFS. 2004c. Annual report to Congress on the status of U.S. fisheries--2003. Silver Spring, Maryland: National Marine Fisheries Service.

NMFS. 2005a. Endangered and threatened species; designation of critical habitat for seven evolutionarily significant units of Pacific salmon and steelhead in California--Final rule. Federal Register 70(1 70):52488-52627.

NMFS. 2005b. Notice of additional public scoping meeting related to the Makah tribe's continuation of treaty right hunting of gray whales. Federal Register 70(191):57860-57862.

NMFS. 2005c. Endangered and threatened species; designation of critical habitat for 12 evolutionarily significant units of west coast salmon and steelhead in Washington, Oregon, and Idaho--Final rule. Federal Register 70(1 70):52630-52858.

NMFS. 2006. Magnuson-Stevens Act provisions; Fisheries off west coast states; Pacific Coast Groundfish Fishery--Final rule. Federal Register 71(91):27408-27426.

NMFS. 2008. Endangered Species Act Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. United States Navy Explosive Ordnance Disposal Operations, Puget Sound; Whidbey Island, Island County, HUC 171100190301, Port Townsend, Jefferson County, HUC 171100190803, and Bangor, Kitsap County, HUC 171100180801 Washington. June.

NMFS-NWR. 2005. Pacific coast groundfish fishery management plan. Essential fish habitat designation and minimization of adverse impacts. Final environmental impact statement. Seattle, Washington: National Marine Fisheries Service-Northwest Region.

NOAA. 1990. West coast of North America coastal and ocean zones strategic assessment. Data atlas Volume 3: Invertebrates and Fish. Ocean Assessments Division, Strategic Assessment Branch.

Orr, J.W., M.A. Brown, and D.C. Baker. 1998. Guide to rockfishes (Scorpaenidae) of the genera Sebastes, Sebastolobus, and Adelosebastes of the northeast Pacific Ocean. NOAA Technical Memorandum NMFS-AFSC-95:1-46.

Orr, J.W., M.A. Brown, and D.C. Baker. 2000. Guide to rockfishes (Scorpaenidae) of the genera Sebastes, Sebastolobus, and Adelosebastes of the northeast Pacific Ocean, Second Edition. NOAA Technical Memorandum NMFS-AFSC-117:1-47.

Palsson, W.A. 2001. The development of criteria for establishing and monitoring no-take refuges for rockfishes and other rocky habitat fishes in Puget Sound. Drosher, T., ed. Proceedings of the Puget Sound Research 2001 conference, Bellevue, Washington, 12-14 February 2001. Olympia, Washington: Puget Sound Water Quality Authority.

Palsson, W.A., J. Beam, S. Hoffmann, and P. Clarke. 2003b. Fish without borders: Trends in the status and distribution of groundfish in the transboundary waters of Washington and British Columbia.

Droscher, T.W. and D.A. Fraser, eds. Proceedings of the 2003 Georgia Basin/Puget Sound Research Conference, Vancouver, British Columbia, 31 March - 3 April 2003.

Palsson, W.A., T.J. Northup, and M.W. Barker. 1998. Puget Sound groundfish management plan (Revised). 43 pp.

Pearson, W.H., J.R. Skalski, and C.I. Malme. 1987. "Effects of sounds from a geophysical survey device on fishing success." Report prepared by Battelle/Marine Research Laboratory for the Marine Minerals Service, United States Department of the Interior under Contract Number 14-12-0001-30273. June.

Pearson, W.H., J.R. Skalski, and C.I. Malme. 1992. "Effects of sounds from a geophysical survey device on behavior of captive rockfish (Sebastes ssp)." Canadian Journal of Fisheries and Aquatic Sciences 49:1343-1356.

Pedersen, M. 1985. Puget Sound whiting Merluccius productus, resource and industry: an overview. Marine Fisheries Review 47:35-38.

Pedersen, M. and G. DiDonato. 1982. Groundfish management plan for Washington's inside waters. Washington Department of Fisheries Progress Report 170.

Penttila, D.E. 1997. Investigations of intertidal spawning habitats of surf smelt and Pacific sand lance in Puget Sound, Washington. Pages 395-407 in Forage fishes in marine ecosystems. Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems. University of Alaska Fairbanks. Alaska Sea Grant College Program Report No. AK-SG-97-01.

PFMC (Pacific Fishery Management Council). 2000. Amendment 14 to the Pacific coast salmon plan (1997). Incorporating the regulatory impact review/initial regulatory flexibility analysis and final supplemental environmental impact statement. Portland, Oregon: Pacific Fishery Management Council.

PFMC. 2003. Proposed acceptable biological catch and optimum yield specifications and management measures for the 2004 Pacific coast groundfish fishery. FEIS. Seattle, Washington: NMFS-PFMC.

PFMC. 2005. Pacific Coast groundfish fishery management plan for the California, Oregon, and Washington groundfish fishery. Appendix B. Part 2. Groundfish life history descriptions. Portland, Oregon: Pacific Fishery Management Council.

PFMC. 2006. Decisions at the March 2006 meeting. Portland, Oregon: Pacific Fishery Management Council.

PFMC. 2006c. EFH for the Pacific Council. life history and EFH summary tables: Groundfish species, pelagic species and salmon species. www.nmfs.noaa.gov/habitat/habitatprotection/profile/pacificcouncil.htm.

Popper, A.N. 1981. "Comparative scanning electron microscopic investigations of the sensory epithelia in the teleost sacculus and lagena." Journal of Comparative Neurology 200:357-374.

Popper, A.N. 2003. "Effects of anthropogenic sounds on fishes." Fisheries 28(10):24-31.

Popper, A.N., D.T.T. Plachta, D.A. Mann, and D. Higgs. 2004. Response of clupeid fish to ultrasound: a review. ICES Journal of Marine Science, 61: 1057-1061.

Popper. A. N. 2008. Effects of Mid- and High-Frequency Sonars on Fish. Contract N66604-07M-6056, Naval Undersea Warfare Center Division, Newport, Rhode Island. February 21.

Popper, A.N. and T.J. Carlson. 1998. Application of sound and other stimuli to control fish behavior. Transactions of the American Fisheries Society 127: 673-707.

Popper, A.N., and W.N. Tavolga. 1981. "Structure and function of the ear in the marine catfish, Arius felis." Journal of Comparative Physiology 144:27-34.

Popper, A.N., D.T.T. Plachta, D.A. Mann, and D. Higgs. 2004. "Response of clupeid fish to ultrasound: a review." ICES Journal of Marine Science 61:1057-1061.

Popper, A.N., M.B. Halvorsen, E. Kane, D.D. Miller, M.E. Smith, P. Stein, and L.E. Wysocki. 2007. "The effects of high-intensity, low-frequency active sonar on rainbow trout." Journal of the Acoustical Society of America 122:623-635.

Popper, A.N., M.E. Smith, P.A. Cott, B.W. Hanna, A.O. MacGillivray, M.E. Austin, and D.A. Mann. 2005. "Effects of exposure to seismic airgun use on hearing of three fish species." Journal of the Acoustical Society of America 117:3958-3971.

PSWQAT (Puget Sound Water Quality Action Team). 2002. Puget Sound Update 2002. Eighth Report of the Puget Sound Monitoring Program. Olympia, WA.

Quirollo, L.F. 1992. Pacific hake. Pages 109-112 in Leet, W.S., C.M. Dewees, and C.W. Haugen, eds. California's living marine resources and their utilization. Davis, California: California Sea Grant Extension Program. UCSGEP-92-12.

QTNR. 1995. Documents submitted to the ESA Administrative Record for west coast Chinook salmon by S. Haynes, October 1995. (Available from Environmental and Technical Services Division, NMFS Portland, OR.

Ramcharitar J., and A.N. Popper. 2004. "Masked auditory thresholds in sciaenid fishes: a comparative study." Journal of the Acoustical Society of America 116(3):1687-1691.

Ramcharitar, J., D. Gannon, and A. Popper. 2006. "Bioacoustics of fishes of the family Sciaenidae (croakers and drums)." Transactions of the American Fisheries Society 135:1409-1431.

Ramcharitar, J., D.M. Higgs, and A.N. Popper. 2001. "Sciaenid inner ears: a study in diversity." Brain, Behavior and Evolution 58:152-162.

Ramcharitar, J.U., X. Deng, D. Ketten, and A.N. Popper. 2004. "Form and function in the unique inner ear of a teleost fish: the silver perch (Bairdiella chrysoura)." Journal of Comparative Neurology 475:531-539.

Remage-Healey, L., D.P. Nowacek, and A.H. Bass. 2006. "Dolphin foraging sounds suppress calling and elevate stress hormone levels in a prey species, the Gulf toadfish." Journal of Experimental Biology 209:4444-4451.

Richardson, W.J., C.R. Greene Jr., C.I. Malme, and D.H. Thomson. 1995. Marine Mammals and Noise. New York: Academic Press.

Ross, Q.E., D.J. Dunning, J.K. Menezes, M.K Kenna Jr., and G.Tiller. 1996. "Reducing impingement of alewives with high-frequency sound at a power plant intake on Lake Ontario." North American Journal of Fisheries Management 16:548-559.

Sakuma, K.M. and S. Ralston. 1995. Distributional patterns of late larval groundfish off central California in relation to hydrographic features during 1992 and 1993. CalCOFl Reports 36:179-192.

Salo, E.O. 1991. Life history of chum salmon (Oncorhynchus keta). Pages 231-309 in Groot, C. and L. Margolis, eds. Pacific salmon life histories. Vancouver, British Columbia: UBC Press.

Sand, O. and A. D. Hawkins. 1973. Acoustic properties of the cod swimbladder. Journal of Experimental Biology, 58: 797–820.

Sand, O., and H.E. Karlsen. 1986. "Detection of infrasound by the Atlantic cod." Journal of Experimental Biology 125:197-204.

Scholik. A.R. and H.Y. Yan. 2002. "Effects of boat engine noise on the auditory sensitivity of the fathead minnow, Pimephales promelas." Environmental Biology of Fishes 63:203-209.

Shaffer, A. 2003. Preferential use of nearshore kelp habitats by juvenile salmon and forage fish. Droscher, T.W. and D.A. Fraser, eds. Proceedings of the 2003 Georgia Basin/Puget Sound Research Conference, Vancouver, British Columbia, 31 March - 3 April 2003.

Shaffer, J.A. 1998. Kelp bed habitats of the inland waters of western Washington. Pages 353-362 in Strickland, R., ed. Proceedings of the Puget Sound Research '98 conference, Seattle, Washington, 12-13 March 1998. Olympia, Washington: Puget Sound Water Quality Action Team.

Shaffer, J.A. 2001. Macroalgae blooms and nearshore habitat and resources of the Strait of Juan de Fuca. Droscher, T.W., ed. Proceedings of the Puget Sound Research 2001 conference, Bellevue, Washington, 12-14 February 2001. Olympia, Washington: Puget Sound Water Quality Action Team.

Shaffer, J.A. 2002. Nearshore habitat mapping of the central and western strait of Juan de Fuca: II. Preferential use of nearshore kelp habitats by juvenile salmon and forage fish. Clallam Co: County Grant No. G0100155. Washington Department of Fish and Wildlife. 20 pp.

Shaw, W., G.A. McFarlane, and R. Kieser. 1990. Distribution and abundance of the Pacific hake)Merluccius productus) spawing stocks in the Strait of Georgia, British Columbia, based on trawl and acoustic surveys in 1981 and 1988. International North Pacific Fisheries Community Bulletin 50:121-134.

Sikes, J., J.A. Shaffer, and D. Penttila. 2002. Nearshore habitat mapping of the central and western Strait of Juan de Fuca III: Pacific herring spawning surveys. Final Report. Prepared for Clallam County Marine Resources Committee, Northwest Straits Commission, Clallam County, Washington by Washington Department of Fish and Wildlife, Olympia, Washington.

Sisneros, J.A., and A.H. Bass. 2003. "Seasonal plasticity of peripheral auditory frequency sensitivity." The Journal of Neuroscience 23:1049-1058.

Slotte, A., K. Kansen, J. Dalen, and E. Ona. 2004. "Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast." Fisheries Research 67:143-150.

Smith, M.E., A.S. Kane, and A.N. Popper. 2004a. "Acoustical stress and hearing sensitivity in fishes: does the linear threshold shift hypothesis hold water?" Journal of Experimental Biology 207:3591-3602.

Smith, M.E., A.S. Kane, and A.N. Popper. 2004b. "Noise-induced stress response and hearing loss in goldfish (Carassius auratus)." Journal of Experimental Biology 207:427-435.

Somerton, D. and C. Murray. 1976. Field guide to the fish of Puget Sound and the northwest coast. Seattle, Washington: Washington Sea Grant Program, University of Washington.

Song, J., A. Mathieu, R.F. Soper, and A.N. Popper. 2006. "Structure of the inner ear of bluefin tuna Thunnus thynnus." Journal of Fish Biology 68:1767-1781.

Sprague, M. W., and J. J. Luczkovich. 2004. Measurement of an individual silver perch, Bairdiella chrysoura, sound pressure level in a field recording. Journal of the Acoustical Society of America, Vol 116, No 5, pp 3186–3191.

Sumida, B.Y. and H.G. Moser. 1984. Food and feeding of bocaccio (Sebastes paucispinis) and comparison with Pacific hake (Merluccius productus) larvae in the California Current. CalCOFl Reports XXV:112-118.

Tavolga, W.N. and J. Wodinsky. 1963. "Auditory capacities in fishes: pure tone thresholds in nine species of marine teleosts." Bulletin of the American Museum of Natural History 126:177-240.

Thomas, D.H. and A.D. MacCall. 2001. Bocaccio. Pages 361-362 in Leet, W.S., C.M. Dewees, R. Klingbeil, and E.J. Larson, eds. California's living marine resources: A status report. California Department of Fish and Game SG01-11.

Triangle Associates Inc. 2004. Technical workshop on nearshore restoration in the central Strait of Juan de Fuca. Seattle, Washington: Triangle Associates, Inc.

Turgeon, D.D., J.F. Quinn, Jr., A.E. Bogan, E.V. Coan, F.G. Hochberg, W.G. Lyons, P.M. Mikkelsen, R.J. Neves, C.F.E. Roper, G. Rosenberg, B. Roth, A. Scheltema, F.G. Thompson, M. Vecchione, and J.D. Williams. 1998. Common and scientific names of aquatic invertebrates from the United States and Canada: Mollusks Second Edition. Bethesda, Maryland: American Fisheries Society Publication 26.

Turnpenny, A.W.H., K.P. Thatcher, and J.R. Nedwell. 1994. "The effects on fish and other marine animals of high-level underwater sound." Report FRR 127/94 prepared by Fawley Aquatic Research Laboratories, Ltd., Southampton, UK.

University of South Florida. 2007. Marine Animal Bioacoustics. College of Marine Science. http://www.marine.usf.edu/bio/fishlab/bioacoustics.htm.URS Greiner Woodward Clyde 2000. Preliminary evaluation of ecological risks related to naval activities at the Atlantic Fleet Weapons Training Facility on Vieques, Puerto Rico. Prepared for U.S. Navy Litigation Office, Washington, D.C.U.S. Coast Guard 1994. Aids to Navigation (AtoN) Battery Release Reporting Requirements. 25 May 1994. http://www.uscg.mil/ccs/cit/cim/directives/CI/CI_1 6478_1 0.pdf.USAF (United States Air Force). 1999. Final Environmental Assessment Search and Rescue Training HH-60 and HC-130 Rescue Squadrons Moody AFB, Georgia. USAF Air Combat Command. December.

USFWS (U.S. Fish and Wildlife Service). 1998. Draft framework to assist in making Endangered Species Act determinations of effect for individual or grouped actions at the bull trout subpopulation watershed scale. February.

Venier, J. and J. Kelson. 1996. The demersal fish "box". Fisheries Centre Research Reports 4(1):67. Ventresca, D.A. 1992. Vermillion rockfish. Pages 123-124 in Leet, W.S., C.M. Dewees, and C.W.

WDF (Washington Department of Fish and Wildlife). 1993. Washington Department of Wildlife, and Western Washington Treaty Indian Tribes (WWTIT) 1992 Washington State salmon and steelhead stock inventory (SASSI) Olympia, WA.

WDFW. 2003. Salmonscape. www.wdfw.wa.gov/mapping/salmonscape.

Webb, J. F., J. Montgomery, and J. Mogdans. 2008. "Bioacoustics and the lateral line of fishes." In Fish Bioacoustics, eds. J.F. Webb, R.R. Fay, and A.N. Popper. New York: Springer Science + Business Media, LLC.

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope, and R.S. Waples. 1995. Status Review of Coho Salmon from Washington, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-24. NMFS, Northwest Fishery Science Center, Seattle, WA.

Wilson, B. and M. Dill. 2002. Pacific herring respond to simulated odontocete echolocation sounds. Can. J. Fish. Aquat. Sci. 59: 542-553.

Wright, K.J., D.M. Higgs, A.J. Belanger, and J.M. Leis. 2005. "Auditory and olfactory abilities of pre-settlement larvae and post-settlement juveniles of a coral reef damselfish (Pisces: Pomacentridae)." Marine Biology 147:1425-1434.

Wright, K.J., D.M. Higgs, A.J. Belanger, and J.M. Leis. 2007. "Auditory and olfactory abilities of pre-settlement larvae and post-settlement juveniles of a coral reef damselfish (Pisces: Pomacentridae). Erratum." Marine Biology 150:1049-1050.

Wysocki, L. E. and F. Ladich. 2004. Hearing in Fish Under Noise Conditions. Association for Research in Otolaryngology. 26p.

Yelverton, J.T., D.R. Richmond, W. Hicks, K. Saunders, and E.R. Fletcher. 1975. "The relationship between fish size and their response to underwater blast." Report DNA 3677T prepared by Lovelace Foundation for Medical Education and Research for Director, Defense Nuclear Agency, Washington, DC.

Yoklavich, M.M., H.G. Greene, G.M. Cailliet, D.E. Sullivan, R.N. Lea, and M.S. Love. 2000. Habitat associations of deep-water rockfishes in a submarine canyon: An example of a natural refuge. Fishery Bulletin 98:625-641.

Young, G.A. 1991. Concise methods for predicting the effects of underwater explosions on marine life. NSWC/WOL MP-91-220. Naval Surface Weapons Center, White Oak Laboratory, Silver Spring, MD. 13 pm DTIC/NTIS AS-A241310.

3.8 SEA TURTLES

Balazs, G.H. 1985. Impact of ocean debris on marine turtles: Entanglement and ingestion. Pp 387-429 in Shomura, R.S., and H.O. Yoshida (Eds.), Proceedings of the Workshop on the Fate and Impact of Marine Debris, November 27-29, 1984, Honolulu, HI. NOAA Tech. Mem. NOAA-TM-NMFS-SWFC-54. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Washington, DC.

Balazs, G.H. 1995. Status of sea turtles in the central Pacific Ocean. Pages 243-252 in Bjorndal, K.A., ed. Biology and conservation of sea turtles, Rev. ed. Washington, D.C.: Smithsonian Institution Press.

Bartol, S.M., J.A. Musick, and M.L. Lenhardt. 1999. Auditory evoked potentials of the loggerhead sea turtle (Caretta caretta). Copeia. 1999:836-840.

Bartol, S.M. and J.A. Musick. 2003. Sensory biology of sea turtles. Pages 79-102 in Lutz, P.L., J.A. Musick, and J. Wyneken, eds. The biology of sea turtles, Volume 2. Boca Raton, Florida: CRC Press.

Beale, C.M. and P. Monaghan. 2004. Human disturbance: People as predation-free predators? Journal of Applied Ecology 41:335-343.

Benson, Scott R. ; Forney, Karin A. ; Harvey, James T. ; Carretta, James V. ; Dutton, Peter H. 2007a. Abundance, distribution, and habitat of leatherback turtles (Dermochelys coriacea) off California, 1990-2003.

Benson, Scott R. ; Dutton, Peter H. ; Hitipeuw, Creusa; Samber, Betuel; Bakarbessy, Jacob; Parker, Denise 2007b. Post-Nesting Migrations of Leatherback Turtles (Dermochelys coriacea) from Jamursba-Medi, Bird's Head Peninsula, Indonesia. Chelonian Conservation and Biology 6(1): 150-154,

Bjorndal, K. 1997. Foraging ecology and nutrition of sea turtles. Pages 199-231 in Lutz, P.L. and J.A. Musick, eds. The biology of sea turtles. Boca Raton, Florida: CRC Press.

Bleakney, J.S. 1965. Reports of marine turtles from New England and eastern Canada. Canadian Field-Naturalist 79:120-128.

Boulon, R.H., Jr., K.L. Eckert, and S.A. Eckert. 1988. Dermochelys coriacea (leatherback sea turtle). Migration. Herpetological Review 19(4):88.

Bowlby, C.E., G.A. Green, and M.L. Bonnell. 1994. Observations of leatherback turtles offshore of Washington and Oregon. Northwestern Naturalist 75:33-35.

Carr, A. 1987. New perspectives on the pelagic stage of sea turtle development. Conservation Biology 1(2):103-121.

Carr, A. 1995. Notes on the behavioral ecology of sea turtles. Pages 19-26 in Bjorndal, K.A., ed. Biology and conservation of sea turtles, Rev. ed. Washington, D.C.: Smithsonian Institution Press. Carr, M.H. 1991. Habitat selection and recruitment of an assemblage of temperate zone reef fishes. Journal of Experimental Marine Biology and Ecology 146:113-137.

CCC (Caribbean Conservation Corporation). 2008. An Introduction to Sea Turtles. http://www.cccturtle.org/overview.htm.

Center for Biological Diversity, Oceana, and Turtle Island Restoration Network. 2007. Petition to Revise the Critical Habitat Designation for the Leatherback Sea Turtle (Dermochelys coriacea) Under the Endangered Species Act. September 26, 2007. San Francisco, California. 40 pp.

Dahlgren 2000 Naval Surface Warfare Center Combat System Safety and Engineering Division. July 2000. Noise Blast Test Results Aboard USS Cole. Dahlgren, Virginia.

Davenport, J. 1988. Do diving leatherbacks pursue glowing jelly? British Herpetological Society Bulletin 24:20-21.

Davenport, J. and G.H. Balazs. 1991. 'Fiery bodies' -- Are pyrosomas an important component of the diet of leatherback turtles? British Herpetological Society Bulletin 37:33-38.

DoN (Department of the Navy). 1998. Final Environmental Impact Statement, Shock Testing the SEAWOLF Submarine. U.S. Department of the Navy, Southern Division, Naval Facilities Engineering Command, North Charleston, SC, 637 pp.

DoN. 2001. Naval Submarine Base Bangor, Silverdale, Washington: Integrated natural resources management plan. Naval Submarine Base Bangor.

Dutton, Peter H. ; Hitipeuw, Creusa; Zein, Mohammed; Benson, Scott R.; Petro, George; Pita, John; Rei, Vagi; Ambio, Levi; Bakarbessy, Jacob, 2007. Status and Genetic Structure of Nesting Populations of Leatherback Turtles (Dermochelys coriacea) in the Western Pacific. Chelonian Conservation and Biology, 6(1): 47-53.

Dutton, P.H., A. Frey, R. Leroux, and G. Balazs. 2000a. Molecular ecology of leatherback turtles in the Pacific. Pages 248-253 in Pilcher, N. and G. Ismail, eds. Sea turtles of the Indo-Pacific: Research, conservation & management. London, England: ASEAN Academic Press.

Dutton, P.H., E. Bixby, R. LeRoux, and G. Balazs. 2000b. Genetic stock origin of sea turtles caught in the Hawaii-based longline fishery. Pages 120-121 in Kalb, H. and T. Wibbels, eds. Proceedings of the Nineteenth Annual Symposium on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFSC-443.

Dutton, P.H., B.W. Bowen, D.W. Owens, A. Barragan, and S.K. Davis. 1999. Global phylogeography of the leatherback turtle (Dermochelys coriacea). Journal of Zoology, London 248:397-409.

Dutton, P.H., G.H. Balazs, and A.E. Dizon. 1998. Genetic stock identification of sea turtles caught in the Hawaii-based pelagic longline fishery. Pages 43-44 in Epperly, S.P. and J. Braun, eds. Proceedings of the Seventeenth Annual Sea Turtle Symposium. NOAA Technical Memorandum NMFS-SEFSC-41 5.

Eckert, K.L. 1993. The biology and population status of marine turtles in the North Pacific Ocean. NOAA Technical Memorandum NMFS-SWFSC-186:1-156.

Eckert, K.L. 1995. Anthropogenic threats to sea turtles. Pages 611-612 in Bjorndal, K.A., ed. Biology and conservation of sea turtles, Rev. ed. Washington, D.C.: Smithsonian Institution Press. Eckert, K.L. and C. Luginbuhl. 1988. Death of a giant. Marine Turtle Newsletter 43:2-3.

Eckert, K.L., S.A. Eckert, T.W. Adams, and A.D. Tucker. 1989. Inter-nesting migrations by leatherback sea turtles (Dermochelys coriacea) in the West Indies. Herpetologica 45(2):190-194.

Eckert, S.A. 2002. Swim speed and movement patterns of gravid leatherback sea turtles (Dermochelys coriacea) at St. Croix, US Virgin Islands. Journal of Experimental Biology 205:3689-3697.

Eckert, S.A., D.W. Nellis, K.L. Eckert, and G.L. Kooyman. 1986. Diving patterns of two leatherback sea turtles (Dermochelys coriacea) during internesting intervals at Sandy Point, St. Croix, U.S. Virgin Islands. Herpetologica 42(3):381 -388.

Eller, A.I. and R.C. Cavanagh. 2000. Subsonic Aircraft Noise at and Beneath the Ocean Surface: Estimation of Risk for Effects on Marine Mammals. AFRL-HE-WP-TR-2000-0156. Prepared for U.S. Air Force Research Laboratory by Science Applications International Corp., McLean, VA.

Ernst, C.H., J.E. Lovich, and R.W. Barbour. 1994. Turtles of the United States and Canada. Washington, D.C.: Smithsonian Institution Press.

Frid, A. 2003. Dall's sheep responses to overflights by helicopter and fixed-wing aircraft. Biological Conservation 110:387-399.

Fritts, T.H., M.L. Stinson, and R. Márquez-M. 1982. Status of sea turtle nesting in southern Baja California, México. Bulletin of the Southern California Academy of Sciences 81 (2):51 -60.

Fuentes, A.L., V.H. Garduño, J. Alvarado, and C. Delgado. 2000. Possible effects of El Niño-southern oscillation on the black turtle nesting population at Michoacan, Mexico. Pages 269-271 in Kalb, H. and T. Wibbels, eds. Proceedings of the Nineteenth Annual Symposium on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFSC-443.

Gill, J.A., K. Norris, and W.J. Sutherland. 2001. Why behavioural responses may not reflect the population consequences of human disturbance. Biological Conservation 97:265-268.

Goertner, J.F. 1982. Prediction of underwater explosion safe ranges for sea mammals. Report NSWC/WOL TR 82-188. Silver Spring, MD: Naval Ordnance Laboratory.

Goff, G.P. and G.B. Stenson. 1988. Brown adipose tissue in leatherback sea turtles: A thermogenic organ in an endothermic reptile? Copeia 1988(4): 1071-1075.

Grant, G.S. 1994. Juvenile leatherback turtle caught by longline fishing in American Samoa. Marine Turtle Newsletter 66:3-5.

Grant, G.S. and D. Ferrell. 1993. Leatherback turtle, Dermochelys coriacea (Reptilia: Dermochelidae): Notes on near-shore feeding behavior and association with cobia. Brimleyana 19:77-81.

Green, G.A., R.A. Grotefendt, M.A. Smultea, C.E. Bowlby, and R.A. Rowlett. 1993. Delphinid aerial surveys in Oregon and Washington offshore waters. Final report. Contract number 50ABNF200058. Prepared for National Marine Fisheries Service National Marine Mammal Laboratory, Seattle, Washington.

Green, G.A., J.J. Brueggeman, R.A. Grotefendt, C.E. Bowlby, M.L. Bonnell, and K.C. Balcomb III. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. Pages 1-1 to 1-100 in Brueggeman, J.J., ed. Oregon and Washington marine mammal and seabird surveys. OCS Study MMS 91-0093. Los Angeles, California: Minerals Management Service.

Greer, A.E., Jr., J.D. Lazell, Jr., and R.M. Wright. 1973. Anatomical evidence for a counter-current heat exchanger in the leatherback turtle (Dermochelys coriacea). Nature 244:181.

Gregory, L.F. and J.R. Schmid. 2001. Stress responses and sexing of wild Kemp's ridley sea turtles (Lepidochelys kempii) in the northeastern Gulf of Mexico. General and Comparative Endocrinology 124:66-74.

Hazel, J., I.R. Lawler, H. Marsh, and S. Robson. 2007. Vessel speed increases collision risk for the green turtle Chelonia mydas. Endangered Species Research 3:105–113.

Hodge, R.P. and B.L. Wing. 2000. Occurrences of marine turtles in Alaska waters: 1960-1998. Herpetological Review 31(3):148-151.

James, M.C. and T.B. Herman. 2001. Feeding of Dermochelys coriacea on medusae in the northwest Atlantic. Chelonian Conservation and Biology 4(1):202-205.

James, M.C., R.A. Myers, and C.A. Ottensmeyer. 2005a. Behaviour of leatherback sea turtles, Dermochelys coriacea, during the migratory cycle. Proceedings of the Royal Society B: Biological Sciences 272:1547-1555.

James, M.C., S.A. Eckert, and R.A. Myers. 2005b. Migratory and reproductive movements of male leatherback turtles (Dermochelys coriacea). Marine Biology 147:845-853.

Keinath, J.A. and J.A. Musick. 1990. Dermochelys coriacea (leatherback sea turtle). Migration. Herpetological Review 21:92.

Ketten, D.R., 1998. Marine mammal auditory systems: A summary of audiometric and anatomical data and its implications for underwater acoustic impacts," NOAA-TM-NMFSSWFSC-256, Department of Commerce.

Ketten, D.R. and S.M. Bartol. 2006. Functional measures of sea turtle hearing. ONR Award Number N00014-02-1-0510 Prepared for the Office of Naval Research, Arlington, Virginia by Woods Hole Oceanographic Institution, Woods Hole, Massachusetts.

Laney, H. and R. Cavanagh. 2000. Supersonic aircraft noise at and beneath the ocean surface: Estimation of risk for effects on marine mammals. Prepared for U.S. Air Force, Air Force Research Laboratory, AFRL/HECB, Wright-Patterson AFB, Ohio.

Lazell, J.D., Jr. 1980. New England waters: Critical habitat for marine turtles. Copeia 1980(2):290-295.

Lenhardt, M.L., S. Bellmund, R.A. Byles, S.W. Harkins, and J.A. Musick. 1983. Marine turtle reception of bone-conducted sound. Journal of Auditory Research. 23:119-123.

Lenhardt, M.L. 1994. Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (Caretta caretta). Pages 238-241 in Bjorndal, K.A., A.B. Bolten, D.A. Johnson, and P.J. Eliazar, eds. Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-351.

Levenson, D.H., S.A. Eckert, M.A. Crognale, J.F. Deegan II, and G.H. Jacobs. 2004. Photopic spectral sensitivity of green and loggerhead sea turtles. Copeia 2004(4):908-914.

Lewison, R.L., S.A. Freeman, and L.B. Crowder. 2004. Quantifying the effects of fisheries on threatened species: The impact of pelagic longlines on loggerhead and leatherback sea turtles. Ecology Letters 7:221-231.

López-Castro, M.C., W.J. Nichols, and M. Orantes. 2000. Olive ridley nesting in Baja California Sur, México: Preliminary observations. Pages 273-274 in Kalb, H. and T. Wibbels, eds. Proceedings of the Nineteenth Annual Symposium on Sea Turtle Conservation and Biology. NOAA Technical Memorandum NMFS-SEFSC-443.

Lordi, B., V. Patin, P. Protais, D. Mellier, and J. Caston. 2000. Chronic stress in pregnant rats: Effects on growth rate, anxiety and memory capabilities of the offspring. International Journal of Psychophysiology 37:195-205.

Lutcavage, M.E. and P.L. Lutz. 1997. Diving physiology. Pages 277-296 in Lutz, P.L. and J.A. Musick, eds. The biology of sea turtles. Boca Raton, Florida: CRC Press.

Lutz, P.L. and J.A. Musick, eds. 1997. The biology of sea turtles. Boca Raton, Florida: CRC Press.

ManTech-SRS. 2007. Final Marine Mammal and Sea Turtle Density Estimates for the Pacific Northwest study area. Solana Beach, California.

McAlpine, D.F., S.A. Orchard, and K.A. Sendall. 2002. Recent occurrences of the green turtle from British Columbia waters. Northwest Science 76(2): 185-188.

McAlpine, D.F., S.A. Orchard, K.A. Sendall, and R. Palm. 2004. Status of marine turtles in British Columbia waters: A reassessment. Canadian Field-Naturalist 118:72-76.

McCauley, S.J. and K.A. Bjorndal. 1999. Conservation implications of dietary dilution from debris ingestion: Sublethal effects in post-hatchling loggerhead sea turtles. Conservation Biology 13(4):925-929.

McCauley, R. D., J. Fewtrell, A. J. Duncan, C. Jenner, M.-N. Jenner, J. D. Penrose, R. I. T. Prince, A. Adhitya, J. Murdoch, and K. McCabe, 2000. Marine seismic surveys: analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid. CMST 163, Report R99-15, prepared for the Australian Petroleum Production Exploration Association from the Centre for Marine Science and Technology, Curtin University, Perth, Western Australia.

McDonald, D.L. and P.H. Dutton. 1996. Use of PIT tags and photoidentification to revise remigration estimates of leatherback turtles (Dermochelys coriacea) nesting in St. Croix, USVI, 1979-1995. Chelonian Conservation and Biology 2(2): 148-152.

Meylan, A. 1995. Sea turtle migration - evidence from tag returns. Pages 91-100 in Bjorndal, K.A., ed. Biology and conservation of sea turtles, Rev. ed. Washington, D.C.: Smithsonian Institution Press.

Moein Bartol, S. and D.R. Ketten. 2006. Turtle and tuna hearing. Pages 98-103 in Swimmer, Y. and R. Brill, eds. Sea turtle and pelagic fish sensory biology: Developing techniques to reduce sea turtle bycatch in longline fisheries. NOAA Technical Memorandum NMFS-PIFSC-7.

Moein, S.E., J.A. Musick, and M.L. Lenhardt. 1994. Auditory behavior of the loggerhead sea turtle (Caretta caretta). Page 89 in Bjorndal, K.A., A.B. Bolten, D.A. Johnson, and P.J. Eliazar, eds. Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC 351.

Mrosovsky, N. and P.C.H. Pritchard. 1971. Body temperatures of Dermochelys coriacea and other sea turtles. Copeia 1971 (4):624-631.

Neill, W.H. and E.D. Stevens. 1974. Thermal inertia versus thermoregulation in "warm" turtles and tunas. Science 184:1008-1010.

NMFS (National Marine Fisheries Service). 2001. Environmental assessment on issuing a quota to the Makah Indian Tribe for a subsistence hunt on gray whales for the years 2001 and 2002. Silver Spring, Maryland: National Marine Fisheries Service.

NMFS. 2003. Taking of threatened or endangered species incidental to commercial fishing operations--Final rule and technical correction. Federal Register 68(241):69962-69967.

National Marine Fisheries Service. 2007c. Listing Endangered and Threatened Wildlife and Designating Critical Habitat; 90-day Finding for a Petition to Revise the Critical Habitat Designation for the Leatherback Turtle. Federal Register 72(248):73745-73747, December 28, 2007.

NMFS and USFWS (U.S. Fish and Wildlife Service). 1992. Recovery plan for leatherback turtles in the U.S. Caribbean, Atlantic and Gulf of Mexico. Washington, D.C.: National Marine Fisheries Service.NMFS and USFWS. 1998a. Recovery plan for U.S. Pacific populations of the hawksbill turtle (Eretmochelys imbricata). Silver Spring, Maryland: National Marine Fisheries Service.

NMFS and USFWS. 1998b. Recovery plan for U.S. Pacific populations of the leatherback turtle (Dermochelys coriacea). Silver Spring, Maryland: National Marine Fisheries Service.

NRC (National Research Council). 1990. Decline of the sea turtles: Causes and prevention. Washington, D.C.: National Academy Press.

Paladino, F.V., M.P. O'Connor, and J.R. Spotila. 1990. Metabolism of leatherback turtles, gigantothermy and thermoregulation of dinosaurs. Nature 344:858-860.

Ridgway, S.H., E.G. Wever, J.G. McCormick, J. Palin, and J.H. Anderson. 1969. Hearing in the giant sea turtle, Chelonia mydas. Proceedings of the National Academy of Sciences 64:884-890.

Ridgway, S.H., D.A. Carder, R.R. Smith, T. Kamolnick, C.E. Schlundt, and W.R. Elsberry. 1997. Behavioral responses and temporary shift in masked hearing threshold of bottlenose dolphins, Tursiops truncatus, to 1-second tones of 141 to 201 dB re 1 µPa. Technical Report 1751, Revision 1. San Diego: Naval Sea Systems Command.

Romero, L.M. 2004. Physiological stress in ecology: Lessons from biomedical research. Trends in Ecology and Evolution 19(5):250-255.

Salmon, M., T.T. Jones, and K.W. Horch. 2004. Ontogeny of diving and feeding behavior in juvenile seaturtles: Leatherback seaturtles (Dermochelys coriacea L) and green seaturtles (Chelonia mydas L) in the Florida Current. Journal of Herpetology 38(1):36-43.

Sarti-M., L., S.A. Eckert, N. Garcia-T., and A.R. Barragan. 1996. Decline of the world's largest nesting assemblage of leatherback turtles. Marine Turtle Newsletter 74:2-5.

Skillman, R.A. and G.H. Balazs. 1992. Leatherback turtle captured by ingestion of squid bait on swordfish longline. Fishery Bulletin 90:807-808.

Smith, S.A. and W.J. Houck. 1984. Three species of sea turtles collected from northern California. California Fish and Game 70:60-62.

Southwood, A.L., R.D. Reina, V.S. Jones, and D.R. Jones. 2003. Seasonal diving patterns and body temperatures of juvenile green turtles at Heron Island, Australia. Canadian Journal of Zoology 81:1014-1024.

Sutherland, W.J., N.J. Crockford. 1993. Factors affecting the feeding distribution of red-breasted geese Branta ruficollis wintering in Romania. Biological Conservation 63, no. 1: 61-65

Spotila, J.R., M.P. O'Connor, and F.V. Paladino. 1997. Thermal biology. Pages 297-314 in Lutz, P.L. and J.A. Musick, eds. The biology of sea turtles. Boca Raton, Florida: CRC Press.

Stinson, M.L. 1984. Biology of sea turtles in San Diego Bay, California, and in the northeastern Pacific Ocean. Master's thesis, San Diego State University.

USFWS and NMFS. 1998. Endangered Species Consultation Handbook, Procedures for Conducting Consultations and Conference Activities under Section 7 of the Endangered Species Act.

Viada, S.T., R.M. Hammer, R. Racca, D. Hannay, M.J. Thompson, B.J. Balcom, and N.W. Phillips. 2007. Review of potential impacts to sea turtles from underwater explosive removal of offshore structures. Environmental Impact Assessment Review 28 (2008): 267-285.

Wever, E.G., 1978. The Reptile Ear: Its Structure and Function. Princeton University Press, Princeton, NJ. 1,024 pp.

Whittow, G.C. and G.H. Balazs. 1982. Basking behavior of the Hawaiian green turtle (Chelonia mydas). Pacific Science 36(2): 129-139.

Wing, B.L. and R.P. Hodge. 2002. Occurrence terminology for marine turtles. Marine Turtle Newsletter 95:15-16.

Work, T.M. and G.H. Balazs. 2002. Necropsy findings in sea turtles taken as bycatch in the North Pacific longline fishery. Fishery Bulletin 100:876-880.

Wyneken, J. 1997. Sea turtle locomotion: Mechanics, behavior, and energetics. Pages 165-198 in Lutz, P.L. and J.A. Musick, eds. The biology of sea turtles. Boca Raton, Florida: CRC Press.

3.9 MARINE MAMMALS

Aburto, A., D.J. Rountry, and J.L. Danzer. 1997. Behavioral response of blue whales to active signals. Technical Report 1746. San Diego, California: Naval Command, Control and Ocean Surveillance Center, RDT&E Division.

Advisory Committee Report on Acoustic Impacts on Marine Mammals 2006. Prepared by the facilitation team of Suzanne Orenstein Lee Langstaff. November 11, 2005

Agler, B.A., R.L. Schooley, S.E. Frohock, S.K. Katona, and I.E. Seipt. 1993. Reproduction of photographically identified fin whales, Balaenoptera physalus, from the Gulf of Maine. Journal of Mammalogy 74(3):577-587.

Andersen, S. 1970. Auditory sensitivity of then harbour porpoise Phocoena phocoena. Invest Cetacea. 2: 255-259.

Angliss, R.P. and R.B. Outlaw. 2005. Alaska marine mammal stock assessments, 2005. NOAA Technical Memorandum NMFS-AFSC-161:1-250.

Angliss, R.P. and R.B. Outlaw. 2008. Alaska marine mammal stock assessments, 2007. NOAA Technical Memorandum NMFS-AFSC-180:1-252.

Antonelis, G.A., B.S. Stewart, and W.F. Perryman. 1990. Foraging characteristics of female northern fur seals (Callorhinus ursinus) and California sea lions (Zalophus californianus). Canadian Journal of Zoology 68:150-158.

Antonelis, G.A., Jr. and C.H. Fiscus. 1980. The pinnipeds of the California Current. CalCOFl Reports XXI:68-78.

Antonelis, G.A., M.S. Lowry, C.H. Fiscus, B.S. Stewart, and R.L. DeLong. 1994. Diet of the northern elephant seal. Pages 211-223 in Le Boeuf, B.J. and R.M. Laws, eds. Elephant seals: Population ecology, behavior, and physiology. Berkeley, California: University of California Press.

Archer II, F. I., and W. F. Perrin. 1999. Stenella coeruleoalba (Meylen, 1833). Mammalian Species 603:1-9

Au, D.W.K. and W.L. Perryman. 1985. Dolphin habitats in the eastern tropical Pacific. Fishery Bulletin 83(4):623-643.

Au, W., J. Darling, and K. Andrews. 2001. High-frequency harmonics and source level of humpback whale songs. Journal of the Acoustical Society of America 110(5):2770.

Au, W.W.L. 1993. The sonar of dolphins. New York, New York: Springer-Verlag.

Au, W.W.L., J.K.B. Ford, J.K. Horne, and K.A. Newman Allman. 2004. Echolocation signals of free-ranging killer whales (Orcinus orca) and modeling of foraging for chinook salmon (Oncorhynchus tshawytscha). Journal of the Acoustical Society of America 115(2):901-909.

Awbrey, F.T., J.C. Norris, A.B. Hubbard, and W.E. Evans. 1979. The bioacoustics of the Dall porpoise-salmon drift net interaction. H/SWRI (Hubbs/Sea World Research Institute) Technical Report 79-120. Contract number 03-78-M02-0289. Prepared for National Marine Fisheries Service, Seattle, Washington by Hubbs/Sea World Research Institute, San Diego, California.

Babushina, E.S. 1999. "Sound Reception in Marine Mammals: Effects of Stimulus Parameters and. Transmission Pathways." Biophysics 44(6):1064-1071.

Babushina, Ye.S., G.L. Zaslavskii, and L.I. Yurkevich. 1991. Air and underwater hearing characteristics of the northern fur seal: audiograms, frequency, and differential thresholds. Biophysics 36(5):909-913.

Bain, D. E., J. C. Smith, R. Williams and D. Lusseau. 2006. Effects of vessels on behavior of southern resident killer whales (Orcinus spp.) NMFS Contract Report N. AB133F03SE0959 and AB133F04CN0040.

Baird, R.W. 2000. The killer whale: Foraging specializations and group hunting. Pages 127-153 in Mann, J., R.C. Connor, P.L. Tyack, and H. Whitehead, eds. Cetacean societies: Field studies of dolphins and whales. Chicago, Illinois: University of Chicago Press.

Baird, R.W. 2001. Status of harbour seals, Phoca vitulina, in Canada. Canadian Field-Naturalist 11 5(4):663-675.

Baird, R.W. and H. Whitehead. 2000. Social organization of mammal-eating killer whales: Group stability and dispersal patterns. Canadian Journal of Zoology 78:2096-2105.

Baird, R.W. and L.M. Dill. 1995. Occurrence and behaviour of transient killer whales: Seasonal and pod-specific variability, foraging behaviour, and prey handling. Canadian Journal of Zoology 73:1300-1311.

Baird, R.W. and L.M. Dill. 1996. Ecological and social determinants of group size in transient killer whales. Behavioral Ecology 7(4):408-416.

Baird, R.W. and M.B. Hanson. 1997. Status of the northern fur seal, Callorhinus ursinus, in Canada. Canadian Field-Naturalist 111 (2):263-269.

Baird, R.W. and M.B. Hanson. 2004. Diet studies of "southern resident" killer whales: Prey sampling and behavioral cues of predation. Order No. AB133F-03-SE-1070. Prepared for the National Oceanic and Atmospheric Administration, Seattle, Washington by Cascadia Research Collective, Olympia, Washington.

Baird, R.W. and P.J. Stacey. 1991. Status of Risso's dolphin, Grampus griseus, in Canada. Canadian Field-Naturalist 105(2):233-242.

Baird, R.W. and P.J. Stacey. 1993. Sightings, strandings and incidental catches of short-finned pilot whales, Globicephala macrorhynchus, off the British Columbia coast. Reports of the International Whaling Commission (Special Issue 14):475-479.

Baird, R.W., D. Nelson, J. Lien, and D.W. Nagorsen. 1996. The status of the pygmy sperm whale, Kogia breviceps, in Canada. Canadian Field-Naturalist 110(3):525-532.

Baird, R.W., D.L. Webster, D.J. McSweeney, A.D. Ligon, and G.S. Schorr. 2005. Diving behavior and ecology of Cuvier's (Ziphius cavirostris) and Blainville's beaked whales (Mesoplodon densirostris) in Hawai'i. Order No. AB133F-04-RQ-0928. Prepared for Southwest Fisheries Science Center, La Jolla, California by Cascadia Research Collective, Olympia, Washington.

Baird, R.W., K.M. Langelier, and P.J. Stacey. 1989. First records of false killer whales, Pseudorca crassidens, in Canada. Canadian Field-Naturalist 103:368-371.

Baird, R.W., P.J. Stacey, and H. Whitehead. 1993. Status of the striped dolphin, Stenella coeruleoalba, in Canada. Canadian Field-Naturalist 107(4):455-465.

Baker, C.S., D. Gilbert, M. Weinrich, R. Lambertsen, J. Calambokidis, B. McArdle, G. Chambers and S.J. 0’Brien. 1993. Population characteristics of DNA fingerprints in humpback whales (Megaptera novaeangliae). J. Hered. 84:28l-290.

Baker, C.S., L. Medrano-Gonzalez, J. Calambokidis, A. Perry, F. Pichler, H. Rosenbaum, J.M. Straley, J. Urban-Ramirez, M. Yamaguchi, and O. von Ziegesar. 1998. Population structure of nuclear and mitochondrial DNA variation among humpback whales in the North Pacific. Molecular Ecology 7:695-707.

Balcomb, K.C. III. 1989. Baird's beaked whale Berardius bairdii Stejneger, 1883: Arnoux's beaked whale Berardius arnuxii Duvernoy, 1851. Pages 261-288 in Ridgway, S.H. and R. Harrison, eds. Handbook of marine mammals. Volume 4: River dolphins and the larger toothed whales. San Diego, California: Academic Press.

Banick, K. and J.L. Borger. 2005. A mass-stranding event of rough-toothed dolphins (Steno bredanensis) in the Florida Keys (Florida, USA): II. Release and tracking. Page 24 in Abstracts, Sixteenth Biennial Conference on the Biology of Marine Mammals. 12-16 December 2005. San Diego, California.

Barlow, J. and R. Gisiner. 2006. Mitigating, monitoring, and assessing the effects of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management. 7(3):239-249.Barlow, J. 1994. Abundance of large whales in California coastal waters: A comparison of ship surveys in 1979/80 and in 1991. Reports of the International Whaling Commission 44:399-406.

Barlow, J. 1995. The abundance of cetaceans in California waters. Part I: Ship surveys in summer and fall of 1991. Fishery Bulletin 93(1):1-14.

Barlow, J. 2003. Preliminary estimates of the abundance of cetaceans along the U.S. west coast: 1991-2001. NMFS-SWFSC Administrative Report LJ-03-03:1-31.

Barlow, J. and B.L. Taylor. 2005. Estimates of sperm whale abundance in the northeastern temperate Pacific from a combined acoustic and visual survey. Marine Mammal Science 21 (3):429-445.

Barlow, J. and D. Hanan. 1995. An assessment of the status of harbor porpoise in central California. Rept. Int. Whal., Special Issue 16:123-140.

Barlow, J., and G.A. Cameron. 2003. Field experiments show that acoustic pingers reduce marine mammal by-catch in the California drift gill net fishery. Marine Mammal Science, 19:265-283.

Barlow, J., and K.A. Forney. 2007. Abundance and population density of cetaceans in the California Current ecosystem. Fisheries Bulletin. 105:509–526.

Barlow, J., K. A. Forney, P. S. Hill, R. L. Brownell, Jr., J. V. Carretta, D. P. DeMaster, F. Julian, M. S. Lowry, T. Ragen, and R. R. Reeves. 1997. U.S. Pacific marine mammal stock assessments: 1996. U.S. Dep. Commer., NOAA Tech.Memo. NMFS-SWFSC-248. 223 pp.

Barlow, J., NMFS-SWFSC; Personal Communication., 15-16 March 2005.

Barrett-Lennard, L.G., T.G. Smith, and G.M. Ellis. 1996. A cetacean biopsy system using lightweight pneumatic darts, and its effect on the behavior of killer whales. Mar. Mamm. Sci. 12:14-27.

Barros, N.B. and A.A. Myrberg, Jr. 1987. Prey detection by means of passive listening in bottlenose dolphins (Tursiops truncatus). Journal of the Acoustical Society of America 82 (Supplement 1):S65.

Barry, L.M., R.W. Baird, J. Hall, R. Gonzales, and P.J. Stacey. 1989. Observations on the behavior of a lone false killer whale (Pseudorca crassidens) in British Columbia. Page 5 in Abstracts, Eighth Biennial Conference on the Biology of Marine Mammals. 7-11 December 1989. Pacific Grove, California.

Bartholomew, G.A. and C.L. Hubbs. 1960. Population growth and seasonal movements of the northern elephant seal, Mirounga angustirostris (1). Mammalia 24(3):313-324.

Bartholomew, G.A. and N.E. Collias. 1962. The role of vocalization in the social behaviour of the northern elephant seal. Animal Behaviour 10(1-2):7-14.

Baumgartner, M.F. 1997. The distribution of Risso's dolphin (Grampus griseus) with respect to the physiography of the northern Gulf of Mexico. Marine Mammal Science 13(4):614-638.

Baumgartner, M.F., D.M. Fratantoni, and C.W. Clark. 2005. Advancing marine mammal ecology research with simultaneous oceanographic and acoustic observations from autonomous underwater vehicles. Pages 27-28 in Abstracts, Sixteenth Biennial Conference on the Biology of Marine Mammals. 12-16 December 2005. San Diego, California.

Beale, C. M. and P. Monaghan. 2004. Behavioral responses to human disturbance: A matter of choice? Animal Behavior, 68:1065-1069.

Bearzi G., R.R. Reeves, G. Notarbartolo di Sciara, E. Politi, A. Canadas, A. Frantzis, and B. Mussi. 2003. Ecology, status and conservation of short-beaked common dolphins (Delphinus delphis) in the Mediterranean Sea. Mammal Review 33(3):224-252.

Bejder, L., A. Samuels, H. Whitehead, N. Gales, J. Mann, R. Connor, M. Heithaus, J. Watson-Capps, C. Flaherty, and M. Kruetzen. 2006. Decline in relative abundance of bottlenose dolphins (Tursiops sp) exposed to long-term disturbance. Conservation Biology 20(6):1791–1798.

Bernard, H.J. and S.B. Reilly. 1999. Pilot whales Globicephala Lesson, 1828. Pages 245-279 in Ridgway, S.H. and R. Harrison, eds. Handbook of marine mammals. Volume 6: The second book of dolphins and the porpoises. San Diego, California: Academic Press.

Berzin, A.A. 1972. The Sperm Whale. Jerusalem: Israel Program for Scientific Translations.

Best, P.B. and C.H. Lockyer. 2002. Reproduction, growth and migrations of sei whales Balaenoptera borealis off the west coast of South Africa in the 1960s. South African Journal of Marine Science 24:111-1 33.

Bibikov, N.G. 1992. Auditory brainstem responses in the harbor porpoise (Phocoena phocoena). In Marine Mammal Sensory Systems (ed. J. A. Thomas, R. A. Kastelein and A. Y. Supin), pp. 197-211. New York: Plenum Press.

Bigg, M. 1981. Harbour seal Phoca vitulina and P. largha. Pages 55-87 in Ridgway, S.H. and R.J. Harrison, eds. Handbook of marine mammals. Volume 2: Seals. San Diego, California: Academic Press.

Bigg, M. 1982. An assessment of killer whale (Orcinus orca) stocks off Vancouver Island, British Columbia. Reports of the International Whaling Commission 32:655-666.

Bigg, M.A. 1990. Migration of northern fur seals (Callorhinus ursinus) off western North America. Canadian Technical Report of Fisheries and Aquatic Sciences 1764:1-64.

Bigg, M.A., P.F. Olesiuk, G.M. Ellis, J.K.B. Ford, and K.C. Balcomb III. 1990. Social organization and genealogy of resident killer whales (Orcinus orca) in the coastal waters of British Columbia and Washington State. Reports of the International Whaling Commission (Special Issue 12):383-405.

Bjørge, A. 2002. How persistent are marine mammal habitats in an ocean of variability? Pages 63-91 in Evans, P.G.H. and J.A. Raga, eds. Marine mammals: Biology and conservation. New York, New York: Kluwer Academic/Plenum Publishers.

Black, N.A. 1994. Behavior and ecology of Pacific white-sided dolphins (Lagenorhynchus obliquidens) in Monterey Bay, California. Master's thesis, San Francisco State University.

Bodkin, J.L. 2003. Sea otter: Enhydra lutris. Pages 735-743 in Feldhamer, G.A., B.C. Thompson, and J.A. Chapman, eds. Wild mammals of North America, 2d ed. Baltimore, Maryland: Johns Hopkins University Press.

Bonnell, M.L. and M.D. Dailey. 1993. Marine mammals. Pages 604-681 in Dailey, M.D., D.J. Reish, and J.W. Anderson, eds. Ecology of the Southern California Bight: A synthesis and interpretation. Berkeley, California: University of California Press.

Bonnell, M.L. and R.G. Ford. 1987. California sea lion distribution: A statistical analysis of aerial transect data. Journal of Wildlife Management 51(1):13-20.

Bonnell, M.L., C.E. Bowlby, and G.A. Green. 1992. Pinniped distribution and abundance off Oregon and Washington, 1989-1990. Pages 2-1 to 2-60 in Brueggeman, J.J., ed. Oregon and Washington marine mammal and seabird surveys. OCS Study MMS 91-0093. Los Angeles, California: Minerals Management Service.

Bonnell, M.L., M.O. Pierson, and G.D. Farrens. 1983. Pinnipeds and sea otters of central and northern California, 1980 - 1983: Status, abundance, and distribution. Volume III, Book 1. OCS Study MMS 84-0044. Los Angeles, California: Minerals Management Service.

Boveng, P. 1988. Status of the Pacific harbor seal population on the U.S. West Coast. NMFS-SWFSC Administrative Report LJ-88-06:1-43.

Bowen, W.D., C.A. Beck, and D.A. Austin. 2002. Pinniped ecology. Pages 911-921 in Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego, California: Academic Press.

Bowen, W.D., D.J. Boness, and S.J. Iverson. 1999. Diving behaviour of lactating harbour seals and their pups during maternal foraging trips. Canadian Journal of Zoology 77:978-988.

Bowen, W.D., J.I. McMillan, and W. Blanchard. 2006. Reduced Population Growth of Gray Seals at Sable Island: Evidence from Pup Production and Age of Primiparity. Marine Mammal Science 23, no. 1: 48-64.

Bowlby, C. E., B. L. Troutman, and S. J. Jeffries. 1988. Sea otters in Washington: distribution, abundance, and activity patterns. Washington State Department of Wildlife, Olympia, WA. Final Report to National Coastal Resources Research and Development Institute, Newport, Oregon.

Boyd, I.L., C. Lockyer, and H.D. Marsh. 1999. Reproduction in Marine Mammals. Pages 218- 287 in Reynolds III, J.E. and S.A. Rommel, eds. Biology of Marine Mammals. Smithsonian Institution Press, Washington, DC.

Bradshaw C.J.A., K. Evans, and M.A. Hindell. 2006. Mass Cetacean Strandings—A Plea for Empiricism. Conservation Biology 20, no. 2: 584-586.

Braham, H.W. 1984. Distribution and migration. In: Jones, M.L., Swartz, S.L., and Leatherwood, S., eds. The gray whale, Eschrichtius robustus. San Diego, California: Academic Press. 249-266.

Brown, R.F. 1997. Pinnipeds in Oregon: Status of populations and conflicts with fisheries, fish resources and human activities. Pages 124-134 in Stone, G., J. Goebel, and S. Webster, eds. Pinniped Populations, Eastern North Pacific: Status, Trends and Issues. 28 August. Monterey, California.

Brown, R.F. and B.R. Mate. 1983. Abundance, movements, and feeding habits of harbor seals, Phoca vitulina, at Netarts and Tillamook Bays, Oregon. Fishery Bulletin 81(2):291-301.

Brownell, R.L., Jr., P.J. Clapham, T. Miyashita, and T. Kasuya. 2001. Conservation status of North Pacific right whales. Journal of Cetacean Research and Management (Special Issue 2):269-286.

Brownell, R.L., Jr., W.A. Walker, and K.A. Forney. 1999. Pacific white-sided dolphin Lagenorhynchus obliquidens Gill, 1865. Pages 57-84 in Ridgway, S.H. and R. Harrison, eds. Handbook of marine mammals. Vol. 6: The second book of dolphins and the porpoises. New York: Academic Press.

Buck, J.R. and P.L. Tyack. 2000. Response of gray whales to low-frequency sounds. The Journal of the Acoustical Society of America 107, no. 5: 2774.

Calambokidis, J. 1995. Contaminants in Puget Sound marine mammals: Temporal, spacial, and species-related patterns. Presentation at Puget Sound Research '95, 12-14 January 1995, Bellevue, WA. Pages 901-908 in Proceedings, Vol. 2. Puget Sound Water Quality Authority, Olympia, WA.

Calambokidis, J. 2005. Personal Communication. Cascadia Research Collective. 1 December 2005.

Calambokidis, J. and G.H. Steiger. 1990. Sightings and movements of humpback whales in Puget Sound, Washington. Northwestern Naturalist 71:45-49.

Calambokidis, J. and S.J. Jeffries. 1991. Censuses and disturbance of harbor seals at Woodard Bay and recommendations for protection. Final report. Prepared for Washington Department of Natural Resources, Olympia, Washington by Cascadia Research Collective, Olympia, Washington and Washington Department of Wildlife.

Calambokidis, J., G.H. Steiger, and J.C. Cubbage. 1987. Marine mammals in the southwestern Strait of Juan de Fuca: Natural history and potential impacts of harbor development in Neah Bay. Contract number DACW67-85-M-0046. Prepared for Seattle District Army Corps of Engineers, Seattle, Washington by Cascadia Research Collective, Olympia, Washington.

Calambokidis, J., T. Chandler, E. Falcone, and A. Douglas. 2004a. Research on large whales off California, Oregon, and Washington in 2003. Annual Report for 2003. Contract number 50ABNF100065. Prepared for Southwest Fisheries Science Center, La Jolla, California by Cascadia Research, Olympia, Washington.

Calambokidis, J., G.H. Steiger, D.K. Ellifrit, B.L. Troutman, and C.E. Bowlby. 2004b. Distribution and abundance of humpback whales (Megaptera novaeangliae) and other marine mammals off the northern Washington coast. Fishery Bulletin 102:563-580.

Calambokidis, J., G.H. Steiger, J.C. Cubbage, K.C. Balcomb, C. Ewald, S. Kruse, R. Wells, and R. Sears. 1990. Sightings and movements of blue whales off central California 1986-88 from photo-identification of individuals. Reports of the International Whaling Commission (Special Issue 12):343-348.Calambokidis, J., G.H. Steiger, J.M. Straley, L.M. Herman, S. Cerchio, D.R. Salden, J. Urbán R, J.K. Jacobsen, O. von Ziegesar, K.C. Balcomb, C.M. Gabriele, M.E. Dahlheim, S. Uchida, G. Ellis, Y. Miyamura, P. Ladrón de Guevara P., M. Yamaguchi, F. Sato, S.A. Mizroch, L. Schlender, K. Rasmussen, J. Barlow, and T.J. Quinn II. 2001. Movements and population structure of humpback whales in the North Pacific. Marine Mammal Science 17(4):769-794.

Calambokidis, J., J.D. Darling, V. Deecke, P. Gearin, M. Gosho, W. Megill, C.M. Tombach, D. Goley, C. Toropova, and B. Gisborne. 2002. Abundance, range and movements of a feeding aggregation of gray whales (Eschrichtius robustus) from California to southeastern Alaska in 1998. Journal of Cetacean Research and Management 4(3):267-276.

Calambokidis, J., J.R. Evenson, G.H. Steiger, and S.J. Jeffries. 1994. Gray whales of Washington State: Natural history and photographic catalog. Olympia, Washington: Cascadia Research Collective.

Calambokidis, J., J.R. Evenson, J.C. Cubbage, P.J. Gearin, and S.D. Osmek. 1992. Harbor porpoise distribution and abundance off Oregon and Washington from aerial surveys in 1991. Final report by Cascadia Research Collective, Olympia, WA, to National Marine Mammal Laboratory. Seattle, Washington: NMFS-AFSC. 44 pp.

Campbell, G.S., R.C. Gisiner, D.A. Helweg, and L.L. Milette. 2002. Acoustic identification of female Steller sea lions (Eumetopias jubatus). Journal of the Acoustical Society of America 111 (6):2920-2928.

Cañadas, A., R. Sagarminaga, and S. García-Tiscar. 2002. Cetacean distribution related with depth and slope in the Mediterranean waters off southern Spain. Deep-Sea Research I 49:2053-2073.

Carretta, J.V., K.A. Forney, M.M. Muto, J. Barlow, J. Baker, B. Hanson and M.S. Lowry. 2007a. U.S. Pacific Marine Mammal Stock Assessments: 2006, National Marine Fisheries Service, Southwest Fisheries Science Center, NOAA-TM-NMFS-SWFSC-398. 321 pp.

Carretta, J.V., K.A. Forney, M.M. Muto, J. Barlow, J. Baker, B. Hanson, and M.S. Lowry. 2005. U.S. Pacific marine mammal stock assessments: 2004. NOAA Technical Memorandum NMFS-SWFSC-375:1-316.

Carretta, J.V., K.A. Forney, M.M. Muto, J. Barlow, J. Baker, B. Hanson, and M.S. Lowry. 2006. U.S. Pacific marine mammal stock assessments: 2005. NOAA Technical Memorandum NMFS-SWFSC-388:1-317.

Carretta, J.V., K.A. Forney, M.S. Lowry, J. Barlow, J. Baker, B. Hanson, and M.M. Muto. 2007b. U.S. Pacific Marine Mammal Stock Assessments: 2007. National Marine Fisheries Service, Southwest Fisheries Science Center, NOAA-TM-NMFS-SWFSC-414. 326 pp.

Carretta, J.V., M.S. Lynn, and C.A. LeDuc. 1994. Right whale (Eubalaena glacialis) sighting off San Clemente Island, California. Marine Mammal Science 10(1):101-105.

CETAP (Cetacean and Turtle Assessment Program). 1982. Characterization of marine mammals and turtles in the Mid- and North Atlantic areas of the U.S. Outer Continental Shelf. Contract AA551-CT8-48. Prepared for U.S. Bureau of Land Management, Washington, D.C. by Cetacean and Turtle Assessment Program, University of Rhode Island, Graduate School of Oceanography, Kingston, Rhode Island.

Charif, R.A., D.K. Mellinger, K.J. Dunsmore, K.M. Fristrup, and C.W. Clark. 2002. Estimated source levels of fin whale (Balaenoptera physalus) vocalizations: Adjustments for surface interference. Marine Mammal Science 18(1):81-98.

Chou, L.S. 2005, National Taiwan University. Personal Communication. 11 January 2005

Clapham, P.J. 1996. The social and reproductive biology of humpback whales: An ecological perspective. Mammal Review 26(1):27-49.

Clapham, P.J. and J.G. Mead. 1999. Megaptera novaeangliae. Mammalian Species 604:1-9.

Clapham, P.J., C. Good, S.E. Quinn, R.R. Reeves, J.E. Scarff, and R.L. Brownell, Jr. 2004. Distribution of North Pacific right whales (Eubalaena japonica) as shown by 19th and 20th century whaling catch and sighting records. Journal of Cetacean Research and Management 6(1):1-6.

Clark, C.W. and P.J. Clapham. 2004. Acoustic monitoring on a humpback whale (Megaptera novaeangliae) feeding ground shows continual singing into late spring. Proceedings of the Royal Society of London Part B 271:1051-1057.

Clarke R. 1956. Sperm whales off the Azores. 'Discovery' Rep 28:239-298

Clarke, M.R. 1996. Cephalopods as prey. III. Cetaceans. Philosophical Transactions of the Royal Society of London, Part B 351:1053-1065.

Condit, R. and B.J. Le Boeuf. 1984. Feeding habits and feeding grounds of the northern elephant seal. Journal of Mammalogy 65(2):281-290.

Cook, M.L.H., R.A. Varela, J.D. Goldstein, S.D. McCulloch, G.D. Bossart, J.J. Finneran, D. Houser, and D.A. Mann. 2006. Beaked whale auditory evoked potential hearing measurements. Journal of Comparative Physiology A 192:489-495.

Corkeron, P.J. and R.C. Connor. 1999. Why do baleen whales migrate? Marine Mammal Science 15(4):1228-1245.

Corkeron, P.J. and S.M. Van Parijs. 2001. Vocalizations of eastern Australian Risso's dolphins, Grampus griseus. Canadian Journal of Zoology 79(1):160-164.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2002. COSEWIC assessment and update status report on the blue whale Balaenoptera musculus in Canada. Ottawa, Ontario: Committee on the Status of Endangered Wildlife in Canada. vi + 32 pp.

Costa, D.P. 1993. The secret life of marine mammals: Novel tools for studying their behavior and biology at sea. Oceanography 6(3):120-128.

Cowan, I.M. and C.J. Guiguet. 1952. Three cetacean records from British Columbia. Murrelet 33(1):10-11.

Cox, T. M., T. J. Ragen, A. J. Read, E. Vos, R. W. Baird, K. C. Balcomb, J. Barlow, J. Caldwell, T. W. Cranford, L. Crum, A. D'Amico, G. D'Spain, A. Fernández, J. J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. A. Hildebrand, D. Houser, T. Hullar, P. D. Jepson, D. R. Ketten, C. D. MacLeod, P. Miller, S. E. Moore, D. C. Mountain, D. L. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. L. Tyack, D. Wartzok, R. Gisiner, J. G. Mead and L. Benner. 2006. Understanding the impacts of anthropogenic sound on beaked whales. Journal of Cetacean Management and Research. 7:177–187.

Crane, N.L. and K. Lashkari. 1996. Sound production of gray whales, Eschrichtius robustus, along their migration route: A new approach to signal analysis. Journal of the Acoustical Society of America 100(3):1878-1886.

Croll, D.A., B.R. Tershy, A. Acevedo, and P. Levin. 1999. Marine vertebrates and low frequency sound. Technical Report for LFA EIS. Marine Mammal and Seabird Ecology\ Group, Institute of Marine Sciences, University of California, Santa Cruz.

Croll, D.A., C.W. Clark, A. Acevedo, B. Tershy, S. Flores, J. Gedamke, and J. Urban. 2002. Only male fin whales sing loud songs. Nature 417:809.

Culik, B.M., 2002. "Review on Small Cetaceans: Distribution, Behaviour, Migration and Threats," in United Nations Environment Programme, Convention on Migratory Species (Marine Mammal Action Plan/Regional Seas Reports and Studies No. 177), p. 343. [Online]. Available: http://www.unep.org/regionalseas/News/Review_of_Small_Cetaceans/default.asp

Cummings, W.C. and P.O. Thompson. 1971. Gray whales, Eschrichtius robustus, avoid the underwater sounds of killer whales, Orcinus orca. Fishery Bulletin 69(3):525-530.

Cummings, W.C., P.O. Thompson, and R. Cook. 1968. Underwater sounds of migrating gray whales, Eschrichtius glaucus (Cope). Journal of the Acoustical Society of America 44(5):1278-1281.

Dahlheim, M.E. and D.K. Ljungblad. 1990. Preliminary hearing study on gray whales (Eschrichtius robustus) in the field. Pages 335-346 in Thomas, J. and R. Kastelein, eds. Sensory abilities of cetaceans: Laboratory and field evidence. New York, New York and London, England: Plenum Press.

Dahlheim, M.E. and J.E. Heyning. 1999. Killer whale Orcinus orca (Linnaeus, 1758). Pages 281-322 in Ridgway, S.H. and R. Harrison, eds. Handbook of marine mammals. Volume 6: The second book of dolphins and the porpoises. San Diego, California: Academic Press.

Dahlheim, M.E., H.D. Fisher, and J.D. Schempp. 1984. Sound production by the gray whale and ambient noise levels in Laguna San Ignacio, Baja California Sur, Mexico. Pages 511-541 in Jones, M.L., S.L. Swartz, and S. Leatherwood, eds. The gray whale Eschrichtius robustus. San Diego, California: Academic Press, Inc.

D'Amico, A., and W.Verboom. 1998. Report of the Bioacoustics Panel, NATO/SACLANT. Pp. 2-1-2-60.

David L. 2002. Disturbance to Mediterranean cetaceans caused by vessel traffic. In: G. Notarbartolo di Sciara (Ed.), Cetaceans of the Mediterranean and Black Seas: state of knowledge and conservation strategies. A report to the ACCOBAMS Secretariat, Monaco, February 2002. Section 11, 21 pp.

Davis, R.W., G.S. Fargion, N. May, T.D. Leming, M. Baumgartner, W.E. Evans, L.J. Hansen, and K. Mullin. 1998. Physical habitat of cetaceans along the continental slope in the north-central and western Gulf of Mexico. Marine Mammal Science. 14:490-507.

Davis, R.W., J.G. Ortega-Ortiz, C.A. Ribic, W.E. Evans, D.C. Biggs, P.H. Ressler, R.B. Cady, R.R. Leben, K.D. Mullin, and B. Würsig. 2002. Cetacean habitat in the northern oceanic Gulf of Mexico. Deep-Sea Research I 49:121-142.

Dawson, S., J. Barlow, and D. Ljungblad. 1998. Sounds recorded from Baird's beaked whale, Berardius bairdii. Marine Mammal Science 14(2):335-344.

Deecke, V.B., J.K.B. Ford, and P.J.B. Slater. 2005. The vocal behaviour of mammal-eating killer whales: Communicating with costly calls. Animal Behaviour 69:395-405.

DeLong, R. 2006. Personal Communication. NMML. 3 May 2006.

DeLong, R.L. 1982. Population biology of northern fur seals at San Miguel Island, California. Ph.D. diss., University of California, Berkeley.

DeLong, R.L. and B.S. Stewart. 1991. Diving patterns of northern elephant seal bulls. Marine Mammal Science 7(4):369-384.

DeLong, R.L. and G.A. Antonelis. 1991. Impact of the 1982-1983 El Niño on the northern fur seal population at San Miguel Island, California. Pages 75-83 in Trillmich, F. and K.A. Ono, eds. Pinnipeds and El Niño: Responses to environmental stress. New York, New York: Springer-Verlag.

DoN (Department of Navy)/DoC (Department of Commerce). 2001. Joint Interim Report Bahamas Marine Mammal Stranding Event of 15-16 March 2000.

DoN. 1997. Environmental Impact Statement for Shock Testing the Seawolf Submarine.

DoN. 1998. Final Environmental Impact Statement, Shock Testing the SEAWOLF Submarine. U.S. Department of the Navy, Southern Division, Naval Facilities ngineering Command, North Charleston, SC, 637 pp.

Dahlgren. 2000. Noise blast test results aboard USS Cole. Report from Dahlgren Division, Naval Surface Warfare Center, to Commander-in Chief, U.S. Atlantic Fleet (N3).

DoN. 2001a. Biological assessment: Installation of force protection barrier, Naval Submarine Base, Bangor (SUBASE).

DoN. 2001b. Final Environmental Impact Statement for the Shock Trial of the Winston S. Churchill, (DDG-81), Department of the Navy.

DoN. 2001c. Final Environmental Impact Statement for the North Pacific Acoustic Laboratory. Volumes I and II, Department of the Navy.

DoN. 2001d. Final Overseas Environmental Impact Statement and Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar. Department of the Navy, Chief of Naval Operations. January 2001.

DoN. 2002a. Marine resource assessment for the Cherry Point Operating Area. Contract Number N62470-95-D-1160. Prepared for the Commander, U.S. Atlantic Fleet, Norfolk, Virginia by Geo-Marine, Inc., Plano, Texas.

DoN. 2002c. Record of Decision for Proposed Future Operations and Facility Modernization at the Naval Air Warfare Center Weapons Division Point Mugu Sea Range, Point Mugu, CA. Federal Register 67(150):50658-50660. August 5, 2002.

DoN. 2004. Report on the results of the inquiry into allegations of marine mammal impacts surrounding the use of active sonar by USS SHOUP (DDG 86) in the Haro Strait on or about 5 May 2003. 64 pp. Accessed at http://www.cpf.navy.mil/news_images/special_projects/shoup/SHOUP%20Final%20REPORT%209%20Feb%2004(1530).pdf.

DoN. 2005a. Marine Resources Assessment for the Hawaiian Islands Operating Area, Draft Report, Department of the Navy, Commander. U.S. Pacific Fleet . July.

DoN. 2005b. Draft Overseas Environmental Impact Statement/Environmental Impact Statement (OEIS/EIS), Undersea Warfare Training Range. Department of the Navy, Commander, U.S. Atlantic Fleet.

DoN. 2006. Marine Resources Assessment for the Pacific Northwest Operating Area. Pacific Division. Naval Facilities Engineering Command, Pearl Harbor, Hawaii. Prepared by Geo-Marine, Inc. Plano, Texas.

DoN. 2007. Department of the Navy, Chief of Naval Operations, "Final Supplemental Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar," April 2007.

DoN. 2008. Final Overseas Environmental Impact Statement/Environmental Impact Statement (OEIS/EIS), Hawaii Range Complex. Department of the Navy, Commander, U.S. Pacific Fleet.

Di Iorio, L., M. Castellote, A.M. Warde, and C.W. Clark. 2005. Broadband sound production by feeding blue whales (Balaenoptera musculus). Page 74 in Abstracts, Sixteenth Biennial Conference on the Biology of Marine Mammals. 12-16 December 2005. San Diego, California.

Dierauf, L.A., F.M.D. Gulland, eds. 2001. CRC Handbook of Marine Mammal Science. Boca Raton, FL: CRC Press LLC.

Dohl, T.P., R.C. Guess, M.L. Duman, and R.C. Helm. 1983. Cetaceans of central and northern California, 1980 - 1983: Status, abundance, and distribution. Volume III, Book 2. OCS Study MMS 84-0045. Los Angeles, California: Minerals Management Service.

Domjan, M. 1998. The Principles of Learning and Behavior, 4th edition. Brooks-Cole Publishing, Pacific Grove.

Dorsey, E.M. 1983. Exclusive adjoining ranges in individually identified minke whales (Balaenoptera acutorostrata) in Washington State. Canadian Journal of Zoology 61:174-181.

Dorsey, E.M., S.J. Stern, A.R. Hoelzel, and J. Jacobsen. 1990. Minke whales (Balaenoptera acutorostrata) from the west coast of North America: Individual recognition and small-scale site fidelity. Reports of the International Whaling Commission (Special Issue 12):357-368.

Doughton, S. 2004. Sea otters' revival in state waters brings new concerns. Seattle Times (Tuesday, August 3).

Douglas, A. and J. Calambokidis. 2002. Marine Mammal observations associated with seismic surveys off Washington and British Columbia in May 2002. Report to U.S. Geological Survey, Menlo Park, CA. Cascadia Research, Olympia, WA.. 30 pp

D'Spain, G.L., A.D'Amico, and D.M. Fromm. 2006. Properties of the underwater sound fields during some well documented beaked whale mass stranding events. Journal of Cetacean Research and Management. 7:223-238.

D'Vincent, C.G., R.M. Nilson, and R.E. Hanna. 1985. Vocalization and coordinated feeding behavior of the humpback whale in southeastern Alaska. Scientific Reports of the Whales Research Institute 36:41-47.

Eller, A. and R. Cavanaugh, 2000. Subsonic Aircraft Noise at and Beneath the Ocean Surface: Estimation of Risk for Effects on Marine Mammals.Science Applications International Corporation, McLean, VA, June 2000.

Estes, J.A. and J.L. Bodkin. 2002. Otters. Pages 842-858 in Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego, California: Academic Press.

Evans, D.L., and G.R. England, 2001. "Joint Interim Report Bahamas Marine Mammal Stranding Event of 15-16 March 2000," (Department of Commerce), pp. 1-66.

Evans, W.E. 1994. Common dolphin, white-bellied porpoise Delphinus delphis Linnaeus, 1758. Pages 191 -224 in Ridgway, S.H. and R. Harrison, eds. Handbook of marine mammals. Volume 5: The first book of dolphins. San Diego, California: Academic Press.

Evans, D.L. U.S. Dept. of Commerce, Secretary; G.R. England, Secretary of the Navy. December, 2001.

Everitt, R.D., C.H. Fiscus, and R.L. DeLong. 1979. Marine mammals of northern Puget Sound and the Strait of Juan de Fuca: A report on investigations November 1, 1977 - October 31, 1978. NOAA Technical Memorandum ERL-MESA-41:1-191.

Everitt, R.D., P.J. Gearin, J.S. Skidmore, and R.L. DeLong. 1981. Prey items of harbor seals and California sea lions in Puget Sound, Washington. Murrelet 62(3):83-86.

Fahner, M., J. Thomas, K. Ramirez, and J. Boehm. 2004. Acoustic properties of echolocation signals by captive Pacific white-sided dolphins (Lagenorhynchus obliquidens). Pages 53-59 in Thomas, J.A., C.F. Moss, and M. Vater, eds. Echolocation in bats and dolphins. Chicago, Illinois: University of Chicago Press.

Felleman, F.L., J.R. Heimlich-Boran, and R.W. Osborne. 1991. The feeding ecology of killer whales (Orcinus orca) in the Pacific Northwest. Pages 113-147 in Pryor, K. and K.S. Norris, eds. Dolphin societies: Discoveries and puzzles. Berkeley: University of California Press.

Feller, W. An Introduction to Probability Theory and Its Applications, Vol. 1, 3rd ed. New York: Wiley, 1968.

Ferguson, M.C., and J. Barlow. 2001. Spatial distribution and density of cetaceans in the eastern tropical Pacific Ocean based on summer/fall research vessel surveys in 1986-1996. Southwest Fisheries Science Center Administrative Report LJ-01-04. La Jolla, California: National Marine Fisheries Service.

Ferguson, M. C. and J. Barlow. 2003. Addendum: Spatial distribution and density of cetaceans in the eastern tropical Pacific Ocean based on summer/fall research vessel surveys in 1986-96. Administrative Report LJ-01-04 (addendum), Southwest Fisheries Science Center, National Marine Fisheries Service, 8604 La Jolla Shores Drive, La Jolla, CA 92037.

Ferguson, M.C., J. Barlow, S.B. Reilly, and T. Gerrodette. 2006. Predicting Cuvier's (Ziphius cavirostris) and Mesoplodon beaked whale population density from habitat characteristics in the eastern tropical Pacific Ocean. Journal of Cetacean Research and Management 7(3):287-299.

Fernández, A., J.F. Edwards, F. Rodreguez, A. Espinosa de los Monteros, P. Herreez, P. Castro, J. R. Jaber, V. Marten and M. Arbelo. 2005. Gas and Fat Embolic Syndrome Involving a Mass Stranding of Beaked Whales. Family Ziphiidae) Exposed to Anthropogenic Sonar Signals. Veterinary Pathology. 42:446-457.

Ferrero, R.C. and L.M. Tsunoda. 1989. First record of a bottlenose dolphin (Tursiops truncatus) in Washington State. Marine Mammal Science 5(3):302-305.

Ferrero, R.C. and W.A. Walker. 1993. Growth and reproduction of the northern right whale dolphin, Lissodelphis borealis, in the offshore waters of the North Pacific Ocean. Canadian Journal of Zoology 71:2335-2344.

Ferrero, R.C., J. Hodder, and J. Cesarone. 1994. Recent strandings of rough-toothed dolphins (Steno bredanensis) on the Oregon and Washington coasts. Marine Mammal Science 10(1):114-116.

Fiedler, P.C. 2002. Ocean environment. Pages 824-830 in Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego, California: Academic Press.

Finneran, J.J., and C.E. Schlundt. 2004. Effects of intense pure tones on the behavior of trained odontocetes. Space and Naval Warfare Systems Center, San Diego, Technical Document. September.

Finneran, J.J., C.E. Schlundt, D.A. Carder, J.A. Clark, J.A. Young, J.B. Gaspin, and S.H. Ridgway. 2000. Auditory and behavioral responses of bottlenose dolphins (Tursiops truncatus) and a beluga whale (Delphinapterus leucas) to impulsive sounds resembling distant signatures of underwater explosions. Journal of the Acoustical Society of America. 108:417-431.

Finneran, J.J., D.A. Carder, and S.H. Ridgway. 2001. Temporary threshold shift (TTS) in bottlenose dolphins Tursiops truncatus exposed to tonal signals. Journal of the Acoustical Society of America. 1105:2749(A), 142nd Meeting of the Acoustical Society of America, Fort Lauderdale, FL. December.

Finneran, J.J., C.E Schlundt, R. Dear, D.A. Carder, and S.H. Ridgway. 2002. Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. Journal of the Acoustical Society of America. 111:2929-2940.

Finneran, J.J., D.A. Carder, and S.H. Ridgway. 2003. Temporary threshold shift measurements in bottlenose dolphins Tursiops truncatus, belugas Delphinapterus leucas, and California sea lions Zalophus californianus. Environmental Consequences of Underwater Sound (ECOUS) Symposium, San Antonio, TX, 12-16 May 2003.

Finneran, J.J., D.A. Carder, C.E. Schlundt and S.H. Ridgway. 2005. Temporary threshold shift in bottlenose dolphins (Tursiops truncatus) exposed to mid-frequency tones. Journal of Acoustical Society of America. 118:2696-2705.

Finneran, J.J., R. Dear, D.A. Carder, and S.H. Ridgway. 2002. Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. Journal of the Acoustical Society of America. 111:2929-2940.

Fiscus, C.H. and D.W. Rice. 1974. Giant squids, Architeuthis sp., from stomachs of sperm whales captured off California. California Fish and Game 60(2):91-101.

Fiscus, C.H. and K. Niggol. 1965. Observations of cetaceans off California, Oregon, and Washington. U.S. Fish and Wildlife Service Special Scientific Report--Fisheries No. 498:1-27.

Fish, J.F. and C.W. Turl. 1976. Acoustic source levels of four species of small whales. NUC TP 547. San Diego, California: Naval Undersea Center. 14 pp.

Flaherty, C. and S. Stark. 1982. Harbor porpoise, Phocoena phocoena, assessment in Washington Sound. Contract report available through the NMFS, AFSC, National Marine Mammal Lab, Seattle, WA, 83 pp.

Flores, P.A.C. and A. Ximenez. 1997. Observations on the rough-toothed dolphin Steno bredanensis off Santa Catarina Island, southern Brazilian coast. Biotemas 10(1):71-79.

Forcada, J. 2002. Distribution. Pages 327-333 in Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego, California: Academic Press.

Ford, J., 2006. DFO, Personal Communication., 9 January 2006.

Ford, J.K.B. 1991. Vocal traditions among resident killer whales (Orcinus orca) in coastal waters of British Columbia. Canadian Journal of Zoology 69:1454-1483.

Ford, J.K.B. 2002a. Dialects. Pages 322-323 in Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego, California: Academic Press.

Ford, J.K.B. 2002b. Killer whale Orcinus orca. Pages 669-676 in Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego, California: Academic Press.

Ford, J.K.B. and G.M. Ellis. 1999. Transients: Mammal-hunting killer whales of British Columbia, Washington, and southeastern Alaska. Vancouver, B.C. and Seattle, Washington: UBC Press and University of Washington Press.

Ford, J.K.B. and G.M. Ellis. 2005. Prey selection and food sharing by fish-eating 'resident' killer whales (Orcinus orca) in British Columbia. Canadian Science Advisory Secretariat Research Document 2005/041. Ottawa, Ontario: Department of Fisheries and Oceans. 30 pp.

Ford, J.K.B., G.M. Ellis, and K.C. Balcomb. 1994. Killer whales: The natural history and genealogy of Orcinus orca in British Columbia and Washington State. Vancouver, British Columbia: UBC Press; and Seattle, Washington: University of Washington Press.

Ford, J.K.B., G.M. Ellis, and P.F. Olesiuk. 2005. Linking prey and population dynamics: Did food limitation cause recent declines of 'resident' killer whales (Orcinus orca) in British Columbia? Canadian Science Advisory Secretariat Research document 2005/042. Department of Fisheries and Oceans.

Ford, J.K.B., G.M. Ellis, L.G. Barrett-Lennard, A.B. Morton, R.S. Palm, and K.C. Balcomb III. 1998. Dietary specialization in two sympatric populations of killer whales (Orcinus orca) in coastal British Columbia and adjacent waters. Canadian Journal of Zoology 76:1456-1471.

Forney, K.A. 1994. Recent information on the status of odontocetes in Californian waters. NOAA Technical Memorandum NM FS-S WFSC-202:1-87.

Forney, K.A. and J. Barlow. 1998. Seasonal patterns in the abundance and distribution of California cetaceans, 1991-1992. Marine Mammal Science 14(3):460-489.

Forney, K.A., J. Barlow, and J.V. Carretta. 1995. The abundance of cetaceans in California waters. Part II: Aerial surveys in winter and spring of 1991 and 1992. Fishery Bulletin 93(1):15-26.

Frantzis, A. 1998. Does acoustic testing strand whales? Nature. 392:29.

Frantzis, A., J.C. Goold, E.K. Skarsoulis, M.I. Taroudakis, and V. Kandia. 2002. Clicks from Cuvier's beaked whales, Ziphius cavirostris (L). Journal of the Acoustical Society of America 112(1):34-37.

Freitas, L. 2004. The stranding of three Cuvier's beaked whales Ziphius caviostris in Madeira archipelago- May 2000. European Cetacean Society Newsletter 42(Special Issue):28-32.

Frid, A. 2003. Dall's sheep responses to overflights by helicopter and fixed-wing aircraft. Biological Conservation 110:387-399.

Fromm, D. 2004a. Acoustic Modeling Results of the Haro Strait For 5 May 2003. Naval Research Laboratory Report, Office of Naval Research, 30 January 2004.

Fromm, D. 2004b. EEEL Analysis of U.S.S. SHOUP Transmissions in the Haro Strait on 5 May 2003. Naval Research Laboratory briefing of 2 September 2004.

Frost, K. F. and L.F. Lowry. 1993. Assessment of injury to harbor seals in Prince William Sound, Alaska, and adjacent areas following the Exxon Valdez oil spill. State-Federal Natural Resource Damage Assessment, Marine Mammals Study No.5. 95 pp.

Gabriele, C. and A. Frankel. 2002. The occurrence and significance of humpback whale songs in Glacier Bay, southeastern Alaska. Arctic Research of the United States 16:42-47.

Gabriele, C., A. Frankel, and T. Lewis. 2001. Frequent humpback whale songs recorded in Glacier Bay, Alaska in Fall 2000. Pages 77-78 in Abstracts, Fourteenth Biennial Conference on the Biology of Marine Mammals. 28 November - 3 December. Vancouver, British Columbia.

Gambell, R. 1985. Sei whale Balaenoptera borealis Lesson, 1828. Pages 155-170 in Ridgway, S.H. and R. Harrison, eds. Handbook of marine mammals. Volume 3: The sirenians and baleen whales. San Diego, California: Academic Press.

Gannier A. and K.L. West. 2005. Distribution of the rough-toothed dolphin (Steno bredanensis) around the Windwards Islands (French Polynesia). Pacific Science 59(1):17-24.

Gannier, A. 2000. Distribution of cetaceans off the Society Islands (French Polynesia) as obtained from dedicated surveys. Aquatic Mammals 26(2):111-126.

Gannon, D.P., N.B. Barros, D.P. Nowacek, A.J. Read, D.M. Waples, and R.S. Wells. 2005. Prey detection by bottlenose dolphins, Tursiops truncatus: An experimental test of the passive listening hypothesis. Animal Behaviour 69:709-720.

Gaskin, D.E. 1982. The ecology of whales and dolphins. Portsmouth, New Hampshire: Heinemann.

Gass, S.E. 2003. Conservation of deep-sea corals in Atlantic Canada. World Wildlife Fund-Canada.

Gearin, P., S.R. Melin, R.L. DeLong, H. Kajimura, and M.A. Johnson. 1994. Harbor porpoise interactions with a chinook salmon set-net fishery in Washington state. In W.F. Perrin, G.P. Donavan, and J. Barlow (editors). Rep. Int. Whal. Commn. Special Issue 15:427–438.

Gearin, P.J., R.L. DeLong, S.R. Melin, and M.E. Gosho. 2001. The southbound migration of adult male California sea lions. Page 80 in Abstracts, Fourteenth Biennial Conference on the Biology of Marine Mammals. 28 November - 3 December 2001. Vancouver, British Columbia.

Gedamke, J., D.P. Costa, and A. Dunstan. 2001. Localization and visual verification of a complex minke whale vocalization. Journal of the Acoustical Society of America 109(6):3038-3047.

Gendron, D. and J. Urbán R. 1993. Evidence of feeding by humpback whales (Megaptera novaeangliae) in the Baja California breeding ground, Mexico. Marine Mammal Science 9(1):76-81.

Gentry, R.L. 1981. Northern fur seal Callorhinus ursinus (Linnaeus, 1758). Pages 143-160 in Ridgway, S.H. and R.J. Harrison, eds. Handbook of marine mammals. Volume 1: The walrus, sea lions, fur seals and sea otter. London, England: Academic Press.

Gentry, R.l. 1998. Behavior and ecology of the northern fur seal. Princeton, New Jersey: Princeton University Press.

Gentry, R.L. 2002. Northern fur seal, Callorhinus ursinus. Pages 813-817 in Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego, California: Academic Press.

Geraci, J.R., and V.J. Lounsbury. 2005. Marine Mammals Ashore: A Field Guide for Strandings. Second Edition. National Aquarium in Baltimore, Baltimore, MD. 371 pp.

Geraci et al.; in V. L. Trainer and D. G. Baden. 1999. High affinity binding of red tide neurotoxins to marine mammal brain. Aquatic Toxicology, Vol 46, pp 139–148.

Gilbert, J.R. and N. Guldager. 1998. Status of harbor and gray seal populations in northern New England. Woods Hole, Massachusetts: National Marine Fisheries Service.

Gill, J. A., K. Norris, and W. J. Sutherland. 2001. Why behavioural responses may not reflect the population consequences of human disturbance. Biological Conservation 97:265-268.

Gjertz, I. and A. Børset. 1992. Pupping in the most northerly harbor seal (Phoca vitulina). Marine Mammal. Science 8:103-109.

Goertner, J.F. 1982. Prediction of underwater explosion safe ranges for sea mammals. NSWC/WOL TR-82-188. Naval Surface Weapons Center, White Oak Laboratory, Silver Spring, MD. 25 pp.

Gorzelany, J.F. 1998. Unusual deaths of two free-ranging Atlantic bottlenose dolphins (Tursiops truncatus) related to ingestion of recreational fishing gear. Marine Mammal Science. 14:614-617.

Green, G., R. A. Grotefendt, M. A. Smultea, C. E. Bowlby, and R. A. Rowlett. 1993. Delphinid aerial surveys in Oregon and Washington waters. Final Report prepared for NMFS, National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, Washington, 98115, Contract #50ABNF200058.

Green, G.A., J.J. Brueggeman, R.A. Grotefendt, C.E. Bowlby, M.L. Bonnell, and K.C. Balcomb III. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. Pages 1-1 to 1-100 in Brueggeman, J.J., ed. Oregon and Washington marine mammal and seabird surveys. OCS Study MMS 91-0093. Los Angeles, California: Minerals Management Service.

Gregr, E.J. and A.W. Trites. 2001. Predictions of critical habitat for five whale species in the waters of coastal British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 58:1265-1285.

Gregr, E.J., L. Nichol, J.K.B. Ford, G. Ellis, and A.W. Trites. 2000. Migration and population structure of northeastern Pacific whales off coastal British Columbia: An analysis of commercial whaling records from 1908-1967. Marine Mammal Science 16(4):699-727.

Gulland, F.M.D., M.H. Pérez-Cortés, R.J. Urbán, L. Rojas-Bracho, G. Ylitalo, J. Weir, S.A. Norman, M.M. Muto, D.J. Rugh, C. Kreuder, and T. Rowles. 2005. Eastern North Pacific gray whale (Eschrichtius robustus) unusual mortality event, 1999-2000. NOAA Technical Memorandum NMFS-AFSC-1 50:1-33.

Hain, J.H.W., M.A.M. Hyman, R.D. Kenney, and H.E. Winn. 1985. The role of cetaceans in the shelf-edge region of the northeastern United States. Marine Fisheries Review 47(1):13-17.

Hain, J.H.W., M.J. Ratnaswamy, R.D. Kenney, and H.E. Winn. 1992. The fin whale, Balaenoptera physalus, in waters of the northeastern United States continental shelf. Reports of the International Whaling Commission 42:653-669.

Hain, J.H.W., S.L. Ellis, R.D. Kenney, P.J. Clapham, B.K. M.T, Gray, I.G. Weinrich, and ?? Babb. 1995. Apparent bottom feeding by humpback whales on Stellwagen Bank. Marine Mammal Science 11:464-479.

Hamazaki, T. 2002. Spatiotemporal prediction models of cetacean habitats in the mid-western North Atlantic Ocean (from Cape Hatteras, North Carolina, U.S.A. to Nova Scotia, Canada). Marine Mammal Science 18(4):920-937.

Hanggi, E.B. and R.J. Schusterman. 1994. Underwater acoustic displays and individual variation in male harbour seals, Phoca vitulina. Animal Behaviour 48:1275-1283.

Hanson, B. 2005. NMFS-NWFSC, Personal Communication, 29 November 2005.

Hanson, M.B., R.W. Baird, and G.S. Schorr. 2005. Focal behavioral observations and fish-eating killer whales: Improving our understanding of foraging behavior and prey selection. Page 120 in Abstracts, Sixteenth Biennial Conference on the Biology of Marine Mammals. 12-16 December 2005. San Diego, California.

Hanson, M.B., R.W. Baird, and R.L. DeLong. 1998. Movements of tagged Dall's porpoises in Haro Strait, Washington. Pages 111-119 in Marine Mammal Protection Act and Endangered Species Act Implementation Program. AFSC Processed Report 98-10.

Harris, D.E., B. Lelli, and S. Gupta. 2003. Long-term observations of a harbor seal haul-out site in a protected cove in Casco Bay, Gulf of Maine. Northeastern Naturalist 10(2):141-148.

Harwood, J. 2001. Marine mammals and their environment in the Twenty-First Century. Journal of Mammalogy 82(3):630-640.

Hatfield, B. 2005. USGS, Personal Communication, 7 September 2005.

Heath, C.B. 2002. California, Galapagos, and Japanese sea lions, Zalophus californianus, Z. wollebaeki, and Z. japonicus. Pages 180-186 in Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego, California: Academic Press.

Heimlich-Boran, J.R. 1986. Fishery correlations with the occurrence of killer whales in Greater Puget Sound. Pages 113-131 in Kirkevold, B.C. and J.S. Lockard, eds. Behavioral biology of killer whales. New York: Alan R. Liss, Inc.

Heimlich-Boran, J.R. 1988. Behavioral ecology of killer whales (Orcinus orca) in the Pacific Northwest. Canadian Journal of Zoology 66:565-578.

Heise, K. 1997a. Diet and feeding behaviour of Pacific white-sided dolphins (Lagenorhynchus obliquidens) as revealed through the collection of prey fragments and stomach content analyses. Reports of the International Whaling Commission 47:807-815.

Heise, K. 1997b. Life history and population parameters of Pacific white-sided dolphins (Lagenorhynchus obliquidens). Reports of the International Whaling Commission 47:817-825.

Heise, K., L.G. Barrett-Lennard, E. Saulitis, C. Matkin, and D. Bain. 2003. Examining the evidence for killer whale predation on Steller sea lions in British Columbia and Alaska. Aquatic Mammals 29(3):325-334.

Helweg, D.A., A.S. Frankel, J.R. Mobley, Jr., and L.M. Herman. 1992. Humpback whale song: Our current understanding. Pages 459-483 in Thomas, J.A., R.A. Kastelein, and A.Y. Supin, eds. Marine mammal sensory systems. New York, New York: Plenum Press.

Herman, D.P., D.G. Burrows, P.R. Wade, J.W. Durban, C.O. Matkin, R.G. LeDuc, L.G. Barrett-Lennard, and M.M. Krahn. 2005. Feeding ecology of eastern North Pacific killer whales Orcinus orca from fatty acid, stable isotope, and organochlorine analyses of blubber biopsies. Marine Ecology Progress Series 302:275-291.

Herzing, D.L. and B.R. Mate. 1984. Gray whale migrations along the Oregon coast, 1978-1981. Pages 289-307 in Jones, M.L., S.L. Swartz, and S. Leatherwood, eds. The gray whale Eschrichtius robustus. San Diego, California: Academic Press, Inc.

Hewitt, R.P. 1985. Reaction of dolphins to a survey vessel: effects on census data. Fishery Bulletin 83(2):187-193.

Heyning, J.E. 1989. Cuvier's beaked whale - Ziphius cavirostris (G. Cuvier, 1823). Pages 289-308 in Ridgway, S.H. and R. Harrison, eds. Handbook of marine mammals. Volume 4: River dolphins and the larger toothed whales. San Diego, California: Academic Press.

Hodder, J., R.F. Brown, and C. Cziesla. 1998. The northern elephant seal in Oregon: A pupping range extension and onshore occurrence. Marine Mammal Science 14(4):873-881.

Hoelzel, A.R., E.M. Dorsey, and S.J. Stern. 1989. The foraging specializations of individual minke whales. Animal Behaviour 38:786-794.

Hohn, A.A., D.S. Rotstein, C.A. Harms and B.L. Southall. 2006. Report on marine mammal unusual mortality event UMESE0501Sp: Multispecies mass stranding of pilot whales (Globicephala macrorhynchus), minke whale. (Balaenoptera acutorostrata), and dwarf sperm whales (Kogia sima) in North Carolina on 15-16 January 2005: 222 pp.

Hoover, A.A. 1988. Harbor seal Phoca vitulina. In: Selected Marine Mammals of Alaska: Species Accounts with Research and Management Recommendations (J.W. Lentfer, ed), pp. 125-157. Marine Mammal Commission, Washington, DC.

Horwood, J. 1987. The sei whale: Population biology, ecology, and management. New York, New York: Croom Helm in association with Methuen, Inc.

Horwood, J. 1990. Biology and exploitation of the minke whale. Boca Raton, Florida: CRC Press.

Houck W.J. and T.A. Jefferson. 1999. Dall's porpoise - Phocoenoides dalli (True, 1885). In: Handbook of Marine Mammals (Ridgway SH, Harrison SR Eds.) Vol. 6: The second book of dolphins and porpoises. pp. 443-472

Houser, D.S., D.A. Helweg, and P.W.B. Moore. 2001. A bandpass filter-bank model of auditory sensitivity in the humpback whale. Aquatic Mammals 27(2):82-91.

Houston, J. 1990. Status of Hubbs' beaked whale, Mesoplodon carlhubbsi, in Canada. Canadian Field-Naturalist 104(1):121-124.

Hubbs, C. 1960. The marine invertebrates of the outer coast. In: The biogeography of Baja California and adjacent seas, part 2. Systematic Zoology 9:134-147.

Hubbs, C.L. 1946. First records of two beaked whales, Mesoplodon bowdoini and Ziphius cavirostris, from the Pacific Coast of the United States. Journal of Mammalogy 27(3):242-255.

Hubbs, C.L. 1951. Eastern Pacific records and general distribution of the pygmy sperm whale. Journal of Mammalogy 32(4):403-410.

Hui C.A. 1979. Undersea topography and distribution of dolphins of the genus Delphinus in the southern California Bight. J Mamm 60(3):521-527

Hui, C.A. 1985. Undersea Topography and the Comparative Distributions of Two Pelagic Cetaceans. Fish. Bull. 83:472-475.

ICES, 2005a. Report of the Ad-hoc Group on the Impacts of Sonar on Cetaceans and Fish- 2nd edition. International Council for the Exploration of the Sea. ICES AGISC CM 2005/ACE:06. 25 pp.

ICES. 2005b. Answer to DG Environment request on scientific information concerning impact of sonar activities on cetacean populations. International Council for the Exploration of the Sea. 5 pp.

IWC (International Whaling Commission). 2001. Report of the Workshop on the Comprehensive Assessment of Right Whales: A worldwide comparison. Journal of Cetacean Research and Management Special Issue 2:1-60.

Jahoda, M., C.L. Lafortuna, N. Biassoni, C. Almirante, A. Azzellino, S. Panigada, M. Zanardelli, and G. Notarbartolo di Sciara. 2003. Mediterranean fin whale's (Balaenoptera physalus) response to small vessels and biopsy sampling assessed through passive tracking and timing of respiration. Marine Mammal Science 19(1):96-110.

Jameson, R. J. 1989. Movements, home range, and territories of male sea otters off central California. Marine Mammal Science, 5(2):159-172.

Jameson, R.J. and A.M. Johnson. 1993. Reproductive characteristics of female sea otters. Marine Mammal Science 9(2):156-167.

Jameson, R.J. and S. Jeffries. 2004. Results of the 2004 survey of the reintroduced sea otter population in Washington state. Unpublished Report. 6 pp.

Jameson, R.J., K.W. Kenyon, A.M. Johnson and H.M. Wight. 1982. History and status of translocated sea otter populations in North America. Wildlife Society Bulletin 10:100-107.

Jefferson, T.A. 1988. Phocoenoides dalli. Mammalian Species 319:1-7.

Jefferson, T.A. 1989. Status of Dall's porpoise, Phocoenoides dalli, in Canada. Canadian Field-Naturalist 104:112-116.

Jefferson, T.A. 1990. Sexual dimorphism and development of external features in Dall's porpoise Phocoenoides dalli. Fishery Bulletin 88:119-132.

Jefferson, T.A. 1991. Observations on the distribution and behaviour of Dall's porpoise (Phocoenoides dalli) in Monterey Bay, California. Aquatic Mammals 17(1):12-19.

Jefferson, T.A. 2005. NMFS-SWFSC, Personal Communication., 14-18 March 2005.

Jefferson, T.A., M.W. Newcomer, S. Leatherwood, and K. Van Waerebeek. 1994. Right whale dolphins Lissodelphis borealis (Peale, 1848) and Lissodelphis peronii (Lacépède, 1804). Pages 335-362 in Ridgway, S.H. and S.R. Harrison, eds. Handbook of marine mammals. Volume 5: The first book of dolphins. San Diego, California: Academic Press.

Jefferson, T.A., S. Leatherwood, and M.A. Webber. 1993. FAO species identification guide. Marine mammals of the world. Rome, Italy: Food and Agriculture Organization of the United Nations.

Jeffries, S. and H. Allen. 2001. Wayfaring sea otter captured in McAllister Creek. Press Release. Olympia, Washington: Washington Department of Fish and Wildlife News Release - June 5, 2001.

Jeffries, S., H. Huber, J. Calambokidis, and J. Laake. 2003. Trends and status of harbor seals in Washington State: 1978-1999. Journal of Wildlife Management 67(1):208-219.

Jeffries, S.J., K.L. Laidre, R.J. Jameson, and H. Allen. 2005. Movements and foraging ecology of sea otters in coastal Washington. Page 141 in Abstracts, Sixteenth Biennial Conference on the Biology of Marine Mammals. 12-16 December 2005. San Diego, California.

Jeffries, S.J., P.J. Gearin, H.R. Huber, D.L. Saul, and D.A. Pruett. 2000. Atlas of seal and sea lion haulout sites in Washington. Olympia, Washington: Washington Department of Fish and Wildlife, Wildlife Science Division.

Jehl, J.R., and C.F. Cooper, eds. 1980. Potential effects of space shuttle booms on the biota and geology of the California Channel Islands: research reports. Center for Marine Studies, San Diego State University, San Diego, CA, Tech. Rep. 80-1. 246 pp.

Jensen, A.S. and G.K. Silber. 2003. Large Whale Ship Strike Database. U.S. Department of Commerce, NOAA National Marine Fisheries Service Technical Memorandum. NMFS-OPR-25. 37 pp.

Jepson, P.D., M. Arbelo, R. Deaville, I.A.P. Patterson, P. Castro, J. R. Bakers, E. Degollada, H. M. Ross, P. Herraez, A. M. Pocknell, F. Rodriguez, F. E. Howie, A. Espinsoa, R. J. Reid, J. R. Jaber, V.Martin, A. A. Cunningham and A. Fernandez. 2003. Gas-bubble lesions in stranded cetaceans. Nature. 425:575-576.

Jepson, P.D., R. Deaville, I.A.P. Patterson, A.M. Pocknell, H.M. Ross, J.R. Baker, F.E. Howie, R.J. Reid, A. Colloff, and A.A. Cunningham. 2005. “Acute and Chronic Gas Bubble Lesions in Cetaceans Stranded in the United Kingdom.” Vet Pathol 42:291-305.

Jérémie, S., A. Gannier, S. Bourreau, and J.-C. Nicolas. 2006. Acoustic monitoring of cetaceans in territorial waters off La Martinique (FWI), Lesser Antilles: Global abundance and first description of Kogia simus vocalisations (November-December 2004). Page 91 in ECS (European Cetacean Society), ed. Abstracts, Twentieth Annual Conference of the European Cetacean Society and associated workshops, April 2-7, 2006. Gdynia, Poland.

Johnson, C.S. 1967. Sound detection thresholds in marine mammals. In: W.N. Tavolga (ed.), Marine bioacoustics, Vol. 2, p. 247-260. Pergamon Press, NY.

Johnson, M., P.T. Madsen, W.M.X. Zimmer, N. Aguilar de Soto, and P.L. Tyack. 2004. Beaked whales echolocate on prey. Proceedings of the Royal Society of London, Part B 271 :S383-S386.

Johnston, D.W. 2002. The effect of acoustic harassment devices on harbour porpoises (Phocoena phocoena) in the Bay of Fundy, Canada. Biological Conservation 108, no. 1: 113-118.

Jones, M.L. and S.L. Swartz. 2002. Gray whale Eschrichtius robustus. Pages 524-536 in Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego, California: Academic Press.

Kajimura H. 1984. Opportunistic feeding of the northern fur seal, Callorhinus ursinus, in the eastern North Pacific Ocean and eastern Bering Sea. NOAA Tech Rep NMFS SSRF-779, Seattle, WA

Kastak D., B.L. Southall, R.J. Schusterman, and C.R. Kastak. 2005. Underwater temporary threshold shift in pinnipeds: Effects of noise level and duration. Journal of the Acoustical Society of America. 118:3154–3163.

Kastak, D. and R.J. Schusterman. 1998. Low-frequency amphibious hearing in pinnipeds: Methods, measurements, noise, and ecology. Journal of the Acoustical Society of America 103(4):2216-2228.

Kastak, D. and R.J. Schusterman. 1999. In-air and underwater hearing sensitivity of a northern elephant seal (Mirounga angustirostris). Canadian Journal of Zoology 77:1751-1758.

Kastelein, R.A., H.T. Rippe, N. Vaughan, N.M. Schooneman. W.C. Verboom, D. De Haan. 2000. The Effects Of Acoustic Alarms On The Behavior Of Harbor Porpoises (Phocoena Phocoena) In A Floating Pen. Marine Mammal Science 16, no. 1: 46-64.

Kastelein, R., P. Bunskoek, M. Hagedoorn, W.W.L. Au, and D. de Haan. 2002. Audiogram of a harbor porpoise (Phocoena phocoena) measured with narrrow-band frequency-modulated signals. Journal of the Acoustical Society of America 112(1):334-344.

Kastelein, R.A., M. Hagedoorn, W.W.L. Au, and D. de Haan. 2003. Audiogram of a striped dolphin (Stenella coeruleoalba). Journal of the Acoustical Society of America 113(2):1130-1137.

Kastelein, R.A. R. van Schie, W.C. Verboom, and D. de Haan. 2005. Underwater hearing sensitivity of a male and a female Steller sea lion (Eumetopias jubatus). J. Acoust. Soc. Am. 118 (3):1820-1829.

Kastelein, R.A., N. Jennings, W.C. Verboom, D. de Haan, and N.M. Schooneman. 2006. Differences in the response of a striped dolphin (Stenella coeruleoalba) and a harbour porpoise (Phocoena phocoena) to an acoustic alarm. Marine Environmental Research 61, no. 3: 363-378.

Kasuya, T. 1975. Past occurrence of Globicephala melaena in the western North Pacific. Scientific Reports of the Whales Research Institute 27:95-110.

Kasuya, T. 2002. Giant beaked whales, Berardius bairdii and B. arnuxii. Pages 519-522 in Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego, California: Academic Press.

Kellogg R. and V.B. Scheffer. 1947. Occurrence of Stenetla euphrosyne off the Oregon coast. Murrelet, 28:9-10

Kenney, R.D. and H.E. Winn. 1987. Cetacean biomass densities near submarine canyons compared to adjacent shelf/slope areas. Continental Shelf Research. 7:107-114.

Kenney, R.D., P.M. Payne, D.W. Heinemann, and H.E. Winn. 1996. Shifts in northeast shelf cetacean distributions relative to trends in Gulf of Maine/Georges Bank finfish abundance. Pages 169-196 in Sherman, K., N.A. Jaworski, and T.J. Smayda, eds. The northeast shelf ecosystem: Assessment, sustainability, and management. Boston, Massachusetts: Blackwell Science.

Kenyon, K.W. 1975. The sea otter in the eastern Pacific Ocean. New York, New York: Dover Publications, Inc.

Kenyon, K.W. and V.B. Scheffer. 1949. A long-snouted dolphin from the Washington coast. Journal of Mammalogy 30(3):267-268.

Keple, A.R. 2002. Seasonal abundance and distribution of marine mammals in the southern Strait of Georgia, British Columbia. Master's thesis, University of British Columbia.

Ketten, D.R. 1992. The marine mammal ear: Specializations for aquatic audition and echolocation. Pages 71 7-750 in Webster, D.B., R.R. Fay, and A.N. Popper, eds. The evolutionary biology of hearing. Berlin, Germany: Springer-Verlag.

Ketten, D.R. 1997. Structure and function in whale ears. Bioacoustics 8:103-135.

Ketten, D.R. 1998. Marine mammal auditory systems: A summary of audiometric and anatomical data and its implications for underwater acoustic impacts. NOAA Technical Memorandum NMFS-SWFSC-256:1-74.

Koski, K. 2007. 2006 Final Program Report: Soundwatch Public Outreach/Boater Education Project. The Whale Museum, Friday Harbor, Washington.

Koski, W.R., J.W. Lawson, D.H. Thomson, and W.J. Richardson. 1998. Point Mugu Sea Range marine mammal technical report. Point Mugu and San Diego, California: Naval Air Warfare Center, Weapons Division and Southwest Division, Naval Facilities Engineering Command. 364 pp.

Krahn, M.M., M.J. Ford, W.F. Perrin, P.R. Wade, R.P. Angliss, M.B. Hanson, B.L. Taylor, G.M. Ylitalo, M.E. Dahlheim, J.E. Stein, and R.S. Waples. 2004. 2004 status review of southern resident killer whales (Orcinus orca) under the Endangered Species Act. NOAA Technical Memorandum NMFS-NWFSC-62:1-73.

Kraus, S.D., J.H. Prescott, A.R. Knowlton, and G.S. Stone. 1986. Migration and calving of right whales (Eubalaena glacialis) in the western North Atlantic. Reports of the International Whaling Commission (Special Issue 10):139-144.

Kraus, S.D., P.K. Hamilton, R.D. Kenney, A.R. Knowlton, and C.K. Slay. 2001. Reproductive parameters of the North Atlantic right whale. Journal of Cetacean Research and Management (Special Issue 2):231-236.

Kriete, B. 2002. Bioenergetic changes from 1986 to 2001 in the southern resident killer whale population, (Orcinus orca). Orca Relief Citizens' Alliance, Friday Harbor, Washington.

Kruse, S., D.K. Caldwell, and M.C. Caldwell. 1999. Risso's dolphin Grampus griseus (G. Cuvier, 1812). Pages 183-212 in Ridgway, S.H. and R. Harrison, eds. Handbook of marine mammals. Volume 6: The second book of dolphins and the porpoises. San Diego, California: Academic Press.

Kruse, S. 1991. The interactions between killer whales and boats in Johnstone Strait, B.C. Pages 149-159 in K. Pryor and K. S. Norris, editors. Dolphin societies: discoveries and puzzles. University of California Press, Berkeley, California.

Kryter, K.D. W.D. Ward, J.D. Miller, and D.H. Eldredge. 1966. Hazardous exposure to intermittent and steady-state noise. Journal of the Acoustical Society of America. 48:513-523.

Kvitek, R.G., D. Shull, D. Canestro, E.C. Bowlby, and B.L. Troutman. 1989. Sea otters and benthic prey communities in Washington State. Marine Mammal Science 5(3):266-280.

Kvitek, R.G., P.J. Iampietro, and C.E. Bowlby. 1998. Sea otters and benthic prey communities: A direct test of the sea otter as keystone predator in Washington State. Marine Mammal Science 14(4):895-902.

Kvitek, R.G., P.J. Iampietro, and K. Thomas. 2001. Quantitative assessment of sea otter benthic prey communities within the Olympic Coast National Marine Sanctuary: 1999 re-survey of 1995 and 1985 monitoring stations. Drosher, T., ed. Proceedings of the Puget Sound Research 2001 conference, Bellevue, Washington, 12-14 February 2001.

Laake, J. 2005. NMFS-NMML, Personal Communication., 3-6 October 2005.

Laake, J. 2007. Harbor Porpoise Abundance in Northwest Waters. Unpublished manuscript. National Marine Mammal Laboratory. 10 pp.

Lagomarsino, I. and T. Price. 2001. Whales, dolphins, porpoises. Pages 529-535 in Leet, W.S., C.M. Dewees, R. Klingbeil, and E.J. Larson, eds. California's living marine resources: A status report. California Department of Fish and Game SG01-11.

Laidre, K.L., M.P. Heide-Jørgensen, O.A. Jørgensen, and M.A. Treble. 2004. Deep-ocean predation by a high Arctic cetacean. ICES Journal of Marine Science 61:430-440.

Laist, D.W. 1997. Impacts of marine debris: entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. Marine Debris: Sources, Impacts, and Solutions: 99-139.

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet and M. Podesta. 2001. Collisions between ships and whales. Marine Mammal Science. 17:35–75.

Lance, M.M., S.A. Richardson and H.L. Allen. 2004. Washington state recovery plan for the sea otter. Washington Department of Fish and Wildlife, Olympia. 91 pp.

Laney, H. and R. Cavanaugh, 2000. Supersonic Aircraft Noise at and Beneath the Ocean Surface: Estimation of Risk for Effects on Marine Mammals.Science Applications International Corporation, McLean, VA, June 2000.

Laurinolli, M.H., A.E. Hay, F. Desharnais, and C.T. Taggart. 2003. Localization of North Atlantic right whale sounds in the Bay of Fundy using a sonobuoy array. Marine Mammal Science 19(4):708-723.

Le Boeuf, B. J., and M. L. Bonnell. 1980. Pinnipeds of the California islands: abundance and distribution. Pages 475-493 in D. Power, ed. The California islands. Santa Barbara Mus. Nat. Hist. 787 pp.

Le Boeuf, B.J. 2002. Status of pinnipeds on Santa Catalina Island. Proceedings of the California Academy of Sciences 53(2):11-21.

Le Boeuf, B.J. and L.F. Petrinovich. 1974. Dialects of northern elephant seals, Mirounga angustirostris: Origin and reliability. Animal Behaviour 22:656-663.

Le Boeuf, B.J., D.E. Crocker, D.P. Costa, S.B. Blackwell, P.M. Webb, and D.S. Houser. 2000. Foraging ecology of northern elephant seals. Ecological Monographs 70(3):353-382.

Leatherwood, S. and W.A. Walker. 1979. The northern right whale dolphin Lissodelphis borealis Peale in the eastern North Pacific. Pages 85-141 in Winn, H.E. and B.L. Olla, eds. Behavior of marine animals: Current perspectives in research. Volume 3: Cetaceans. New York, New York: Plenum Press.

Leatherwood, S., R.R. Reeves, A.E. Bowles, B.S. Stewart, and K.R. Goodrich. 1984. Distribution, seasonal movements, and abundance of Pacific white-sided dolphins in the eastern North Pacific. Scientific Reports of the Whales Research Institute 35:129-157.

Leatherwood, S., R.R. Reeves, W.F. Perrin, and W.E. Evans. 1988. Whales, dolphins, and porpoises of the eastern North Pacific and adjacent Arctic waters: A guide to their identification. New York, New York: Dover Publications, Inc.

Leatherwood, S., W.F. Perrin, V.L. Kirby, C.L. Hubbs, and M. Dahlheim. 1980. Distribution and movements of Risso's dolphin, Grampus griseus, in the eastern North Pacific. Fishery Bulletin 77(4):951-963.

Lodi, L. and B. Hetzel, 1999. Rough-toothed dolphin, Steno bredanensis, feeding behaviors in Ilha Grande Bay, Brazil.- Biociências 7:29-42.

London, J.M., S.J. Jeffries, J.W. Durban, P.R. Wade, J. Calambokidis, M.M. Lance, and G.R. VanBlaricom. 2005. Transient killer whales in Hood Canal -- The sequel: Ramifications of a second extended foraging event by mammal-eating killer whales on a population of harbor seals in Washington State, USA. Page 171 in Abstracts, Sixteenth Biennial Conference on the Biology of Marine Mammals. 12-16 December 2005. San Diego, California.

Lordi et al. 2000

Loughlin, T.R. 1997. Using the phylogeographic method to identify Steller sea lion stocks. Pages 159-171 in Dizon, A.E., S.J. Chivers, and W.F. Perrin, eds. Molecular genetics of marine mammals. Lawrence, Kansas: Society for Marine Mammalogy.

Loughlin, T.R. 2002. Steller's sea lion, Eumetopias jubatus. Pages 1181-1185 in Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego, California: Academic Press.

Loughlin, T.R. and M.A. Perez. 1985. Mesoplodon stejnegeri. Mammalian Species 250:1-6.

Loughlin, T.R., A.S. Perlov, and V.A. Vladimirov. 1992. Range-wide survey and estimation of total number of Steller sea lions in 1989. Marine Mammal Science 8(3):220-239.

Loughlin, T.R., M.A. Perez, and R.L. Merrick. 1987. Eumetopias jubatus. Mammalian Species 283:1-7.

Lowry, M.S., B.S. Stewart, C.B. Heath, P.K. Yochem, and J.M. Francis. 1991. Seasonal and annual variability in the diet of California sea lions Zalophus californianus at San Nicolas Island, California, 1981-86. Fishery Bulletin 89:331-336.

Lynch, D. 2005. USFWS, Personal Communication., 29 November 2005.

Lynn, S.K. and D.L. Reiss. 1992. Pulse sequence and whistle production by two captive beaked whales, Mesoplodon species. Marine Mammal Science 8(3):299-305.

MacLeod, C., W.F. Perrin, R. Pitman, J. Barlow, L. Ballance, A. D'Amico, T. Gerrodette, G. Joyce, K.D. Mullin, D.L. Palka, and G.T. Waring. 2006. Known and inferred distributions of beaked whale species (Cetacea: Ziphiidae). Journal of Cetacean Research and Management 7(3):271-286.

MacLeod, C.D. 1999. A review of beaked whale acoustics, with inferences on potential interactions with military activities. European Research on Cetaceans 13:35-38.

MacLeod, C.D. and A. D'Amico. 2006. A review of beaked whale behaviour and ecology in relation to assessing and mitigating impacts of anthropogenic noise. Journal of Cetacean Research and Management 7(3):21 1-221.

MacLeod, C.D. and G. Mitchell. 2006. Key areas for beaked whales worldwide. Journal of Cetacean Research and Management 7(3):309-322.

MacLeod, C.D., M.B. Santos, and G.J. Pierce. 2003. Review of data on diets of beaked whales: Evidence of niche separation and geographic segregation. Journal of the Marine Biological Association of the United Kingdom 83:651-665.

MacLeod, C.D., N. Hauser, and H. Peckham. 2004. Diversity, relative density and structure of the cetacean community in summer months east of Great Abaco, Bahamas. Journal of the Marine Biological Association of the United Kingdom 84:469-474.

Madsen, P.T., I. Kerr, and R. Payne. 2004. Echolocation clicks of two free-ranging, oceanic delphinids with different food preferences: False killer whales Pseudorca crassidens and Risso's dolphins Grampus griseus. Journal of Experimental Biology 207:1811-1823.

Madsen, P.T., M. Johnson, N. Aguilar de Soto, W.M.X. Zimmer, and P. Tyack. 2005. Biosonar performance of foraging beaked whales (Mesoplodon densirostris). Journal of Experimental Biology 208(2):181-194.

Magalhães, S., R. Prieto, M.A. Silva, J. Gonçalves, M. Afonso-Dias, and R.S. Santos. 2002. Short-term reactions of sperm whales (Physeter macrocepahlus) to whale-watching vessels in the Azores. Aquatic Mammals 28(3):267-274.

Maldini-Feinholz, D. 1996. Pacific coastal bottlenose dolphins (Tursiops truncatus gilli) in Monterey Bay, California. Master's thesis, San Jose State University.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. 1983. “Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior.” BBN Rep. 5366. Rep. from Bolt Beranek & Newman Inc., Cambridge, MA, for U.S. Minerals Manage. Serv., Anchorage, AK. NTIS PB86-174174. Var. p. Malme, C.I., Miles, Wursig, B., Bird, J.E. and Tyack, P. 1986. Behavioral responses of gray whales to industrial noise: Feeding observations and predictive modeling. BBN Report 6265, Report from BBN Laboratories Inc.. Cambridge, MA for US National Oceanic and Atmospheric Administration and US Minerals Management Service, Anchorage, AK.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack and J.E. Bird. 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior/Phase II: January 1984 migration. BBN Rep. 5586. Report from Bolt Beranek & Newman Inc., Cambridge, MA, for U.S. Minerals Management Service, Anchorage, AK. NTIS PB86-218377.

ManTech-SRS Technologies. 2007. Final Marine Mammal and Sea Turtle Density Estimates for the Pacific Northwest Study Area. Solana Beach, California. 43 pp.

Marten, K. 2000. Ultrasonic analysis of pygmy sperm whale (Kogia breviceps) and Hubbs' beaked whale (Mesoplodon carlhubbsi) clicks. Aquatic Mammals 26(1):45-48.

Mate, B.R. 1975. Annual migrations of the sea lions Eumetopias jubatus and Zalophus californianus along the Oregon coast. Rapports et Proces-Verbaux des Reunions Commission Internationale pour l'Exploration Scientifique de la Mer Mediterranee Monaco 169:455-461.

Mate, B.R., B.A. Lagerquist, and J. Calambokidis. 1999. Movements of North Pacific blue whales during the feeding season off southern California and their southern fall migration. Marine Mammal Science 15(4):1246-1257.

Matkin, C. and E. Saulitis. 1997. Killer whale Orcinus orca. Restoration Notebook (Publication of the Exxon Valdez Oil Spill Trustee Council) November:1-12.

Matthews, J.N., S. Brown, D. Gillespie, M. Johnson, R. McLanaghan, A. Moscrop, D. Nowacek, R. Leaper, T. Lewis, and P. Tyack. 2001. Vocalisation rates of the North Atlantic right whale (Eubalaena glacialis). Journal of Cetacean Research and Management 3(3):271-281.

Mattila, D.K., L.N. Guinee, and C.A. Mayo. 1987. Humpback whale songs on a North Atlantic feeding ground. Journal of Mammalogy 68(4):880-883.

McAlpine, D.F. 2002. Pygmy and dwarf sperm whales Kogia breviceps and K. sima. Pages 1007-1009 in Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of Marine Mammals. San Diego, California: Academic Press.

McDonald, M.A. and S.E. Moore. 2002. Calls recorded from North Pacific right whales (Eubalaena japonica) in the eastern Bering Sea. Journal of Cetacean Research and Management 4(3):261-266.

McDonald, M.A., J. Calambokidis, A.M. Teranishi, and J.A. Hildebrand. 2001. The acoustic calls of blue whales off California with gender data. Journal of the Acoustical Society of America 109:1728-1735.

McDonald, M.A., J.A. Hildebrand, S.M. Wiggins, D. Thiele, D. Glasgow, and S.E. Moore. 2005. Sei whale sounds recorded in the Antarctic. Journal of the Acoustical Society of America 11 8(6):3941-3945.

McShane, L.J., J.A. Estes, M.L. Riedman, and M.M. Staedler. 1995. Repertoire, structure, and individual variation of vocalizations in the sea otter. Journal of Mammalogy 76(2):414-427.

Mead, J.G. 1989. Beaked whales of the genus-Mesoplodon. Pages 349-430 in Ridgway, S.H. and R. Harrison, eds. Handbook of marine mammals. Volume 4: River dolphins and the larger toothed whales. London, United Kingdom: Academic Press.

Mead J.G., W.A. Walker, and.W.J. Houck. 1982. Biological observations on Mesoplodon carlhubbsi (Cetacea: Ziphiidae). Smithsonian Contr Zool 344

Mead, J.G. and C.W. Potter. 1990. Natural history of bottlenose dolphins along the central Atlantic coast of the United States. Pages 165-195 in Leatherwood, S. and R.R. Reeves, eds. The bottlenose dolphin. San Diego, California: Academic Press.

Melin, S.R. and R.L. DeLong. 2000. At-sea distribution and diving behavior of California sea lion females from San Miguel Island, California. Pages 407-412 in Browne, D.R., K.L. Mitchell, and H.W. Chaney, eds. Proceedings of the Fifth California Islands Symposium. OCS Study MMS 99-0038. Camarillo, California: Minerals Management Service.

Mellinger, D.K. and C.W. Clark. 2003. Blue whale (Balaenoptera musculus) sounds from the North Atlantic. Journal of the Acoustical Society of America 114(2):1108-1119.

Mendes, S., W. Turrell, T. Lütkebohle, and P. Thompson. 2002. Influence of the tidal cycle and a tidal intrusion front on the spatio-temporal distribution of coastal bottlenose dolphins. Marine Ecology Progress Series 239:221-229.

Merrick, R.L., M.K. Chumbley, and G.V. Byrd. 1997. Diet diversity of Steller sea lions (Eumetopias jubatus) and their population decline in Alaska: A potential relationship. Canadian Journal of Fisheries and Aquatic Sciences 54:1342-1348.

Mignucci-Giannoni, A.A. 1998. Zoogeography of cetaceans off Puerto Rico and the Virgin Islands. Caribbean

Miller, J.D. 1974. Effects of noise on people. Journal of the Acoustical Society of America. 56:729–764.

Miller, P.J.O., M.P. Johnson, and P.L. Tyack. 2004. Sperm whale behaviour indicates the use of echolocation click buzzes 'creaks' in prey capture. Proceedings of the Royal Society of London, Part B 271:2239-2247.

MMS (Minerals Management Service). 2008. Possible Effects of OCS Gas and Oil Activities on the California Sea Otter. Accessed at http://www.mms.gov/omm/pacific/enviro/calseaotter.htm.

Miyashita, T. 1993. Abundance of dolphin stocks in the western North Pacific taken by the Japanese drive fishery. Reports of the International Whaling Commission 43:417-437.

Miyazaki, N. and W.F. Perrin. 1994. Rough-toothed dolphin-Steno bredanensis (Lesson, 1828). Pages 1-21 in Ridgway, S.H. and R. Harrison, eds. Handbook of marine mammals. Volume 5: The first book of dolphins. San Diego, California: Academic Press.

Mizroch, S.A., D.W. Rice, D. Zwiefelhofer, J. Waite, and W.L. Perryman. 1999. Distribution and movements of fin whales (Balaenoptera physalus) in the Pacific Ocean. Page 127 in Abstracts, Thirteenth Biennial Conference on the Biology of Marine Mammals. 28 November - 3 December, 1999. Wailea, Hawaii.

Møhl, B., M. Wahlberg, P.T. Madsen, A. Heerfordt, and A. Lund. 2003. The monopulsed nature of sperm whale clicks. Journal of the Acoustical Society of America 114(2):1143-1154.

Moore, P.W.B. and R.J. Schusterman. 1987. Audiometric assessment of northern fur seals, Callorhinus ursinus. Marine Mammal Science 3(1):31-53.

Moore, S.E. and J.T. Clarke. 2002. Potential impact of offshore human activities on gray whales (Eschrichtius robustus). Journal of Cetacean Research and Management 4(1):19-25.

Moore, S.E., J.M. Waite, L.L. Mazzuca, and R.C. Hobbs. 2000. Mysticete whale abundance and observations of prey associations on the central Bering Sea shelf. Journal of Cetacean Research and Management 2(3):227-234.

Morejohn, G.V. 1979. The natural history of Dall's porpoise in the North Pacific Ocean. Pages 45–83 in Behavior of Marine Animals, Vol. 3, Cetaceans. H.E. Winn and B.L. Olla (Eds). Plenum Press, New York.

Moreno, M.P.T. 2006. Environmental predictors of bottlenose dolphins distribution and core feeding densities in Galveston Bay, Texas. College Station: Texas A&M University.

Morton, A. 2000. Occurrence, photo-identification and prey of Pacific white-sided dolphins (Lagenorhyncus obliquidens) in the Broughton Archipelago, Canada 1984-1998. Marine Mammal Science 16(1):80-93.

Morton, A.B. 1990. A quantitative comparison of the behaviour of resident and transient forms of the killer whale off the central British Columbia coast. Reports of the International Whaling Commission (Special Issue 12):245-248.

Mullin, K., W. Hoggard, C. Roden, R. Lohoefener, C. Rogers, and B. Taggart. 1991. Cetaceans on the upper continental slope in the north-central Gulf of Mexico. OCS Study MMS 91-0027. New Orleans, Louisiana: Minerals Management Service.

Murphy, M.A. 1995. Occurrence and group characteristics of minke whales, Balaenoptera acutorostrata, in Massachusetts Bay and Cape Cod Bay. Fishery Bulletin 93:577-585.

Nachtigall, P.E., A. Supin, J.L. Pawloski, and W.W.L. Au. 2004. Temporary threshold shift after noise exposure in bottlenosed dolphin (Tursiops truncatus) measured using evoked auditory potential. Marine Mammal Science. 20:673-687.

Nachtigall, P.E., J.L. Pawloski, and W.W.L. Au. 2003. Temporary threshold shift and recovery following noise exposure in the Atlantic bottlenosed dolphin (Tursiops truncatus). Journal of the Acoustical Society of America. 113:3425-3429.

Nachtigall, P.E., D.W. Lemonds, and H.L. Roitblat. 2000. Psychoacoustic studies of dolphin and whale hearing. Pages 330-363 in Au, W.W.L., A.N. Popper, and R.R. Fay, eds. Hearing by whales and dolphins. New York, New York: Springer-Verlag.

Nachtigall, P.E., W.W.L. Au, J.L. Pawloski, and P.W.B. Moore. 1995. Risso's dolphin (Grampus griseus) hearing thresholds in Kaneohe Bay, Hawaii. Pages 49-53 in Kastelein, R.A., J.A. Thomas, and P.E. Nachtigall, eds. Sensory Systems of Aquatic Mammals. Woerden, The Netherlands: De Spil Publishers.

Nagorsen, D.W. and G.E. Stewart. 1983. A dwarf sperm whale (Kogia simus) from the Pacific coast of Canada. Journal of Mammalogy 64(3):505-506.

Nekoba-Dutertre, N., M. Poole, and B. Bilgre. 1999. Rough-tooth dolphins (Steno bredanensis) in French Polynesia. Page 133 in Abstracts, Thirteenth Biennial Conference on the Biology of Marine Mammals. 28 November - 3 December, 1999. Wailea, Hawaii.

Nemoto, T. and A. Kawamura. 1977. Characteristics of food habits and distribution of baleen whales with special reference to the abundance of North Pacific sei and Bryde's whales. Reports of the International Whaling Commission (Special Issue 1):80-87.

Nichol, L.M. and D.M. Shackleton. 1996. Seasonal movements and foraging behaviour of northern resident killer whales (Orcinus orca) in relation to the inshore distribution of salmon (Oncorhynchus spp.) in British Columbia. Canadian Journal of Zoology 74:983-991.

NMFS. 2005. Notice of Issuance of an Incidental Harassment Authorization, Incidental to Conducting the Precisions Strike Weapon (PSW) Testing and training by Elgin Air Force base in the Gulf of Mexico. Federal register 70:48675-48591.

NMFS. 2006. Incidental Takes of Marine Mammals Incidental to Specified Activities: Naval Explosive Ordnance Disposal School Training Operations at Eglin Air Force Base, Florida. NMFS Federal Register 71(199):60693-60697.

NMFS. 1991. Recovery Plan for the Humpback Whale (Megaptera novaeangliae). Prepared by the Humpback Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, MD. 105 pp.

NMFS. 1992a. FEIS and Management Plan for the Proposed Monterey Bay National Marine Sanctuary, Volume 1, June 1992. Accessed at http://montereybay.noaa.gov/intro/mbnms_eis/partIV_sII.html.

NMFS. 1992b. Recovery plan for Steller sea lions (Eumetopias jubatus). Silver Spring, Maryland: National Marine Fisheries Service.

NMFS. 1993a. Final conservation plan for the northern fur seal (Callorhinus ursinus). The National Marine Mammal Laboratory/Alaska Fisheries Science Center, Seattle, Washington, and the Office of Protected Resources/National Marine Fisheries Service, Silver Spring, Maryland. 80 pp.

NMFS. 1993b. Designated critical habitat; Steller sea lion. National Marine Fisheries Service. Federal Register 58(165):45269-45285.

NMFS. 1997a. Investigation of scientific information on the impacts of California sea lions and Pacific harbor seals on salmonids and on the coastal ecosystems of Washington, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-28:1-172.

NMFS. 1997b. Threatened fish and wildlife; change in listing status of Steller sea lions under the Endangered Species Act. National Marine Fisheries Service. Federal Register 62(86):24345-24355.

NMFS. 1998a. Draft recovery plan for the fin whale Balaenoptera physalus and sei whale Balaenoptera borealis. Prepared by R.R. Reeves, G.K. Silber, and P.M. Payne for National Marine Fisheries Service, Silver Spring, Maryland.

NMFS. 1998b. Final Rule for the incidental taking of marine mammals, Naval activities; USS Seawolf submarine shock testing. Federal Register, Vol 63, No 230, 66069-77. December 1, 1998.

NMFS. 1998c. Recovery plan for the blue whale (Balaenoptera musculus). Prepared by R.R. Reeves, P.J. Clapham, R.L. Brownell, Jr., and G.K. Silber for the National Marine Fisheries Service, Silver Spring, Maryland. 42 pp.

NMFS. 2001. Environmental assessment on issuing a quota to the Makah Indian Tribe for a subsistence hunt on gray whales for the years 2001 and 2002. Silver Spring, Maryland: National Marine Fisheries Service.

NMFS. 2002. Final Rule SURTASS LFA Sonar. Federal Register, Department of Commerce; NMFS, FR 67, 136, 46712-89, 16 July.

NMFS. 2005. Guidelines for Preparing Stock Assessment Reports Pursuant to Section 117 of the Marine Mammal Protection Act. National Marine Fisheries Service, NOAA, Silver Spring, MD.

NMFS. 2005a. Assessment of acoustic exposures on marine mammals in conjunction with USS Shoup active sonar transmissions in the eastern Strait of Juan de Fuca and Haro Strait, Washington, 5 May 2003. Seattle, Washington: National Marine Fisheries Service.

NMFS. 2005b. Endangered and threatened species; revision of critical habitat for the northern right whale in the Pacific Ocean. National Marine Fisheries Service. Federal Register 70(211):66332-66346.

NMFS. 2005c. Notice of additional public scoping meeting related to the Makah tribe's continuation of treaty right hunting of gray whales. National Marine Fisheries Service Federal Register 70(191):57860-57862.

NMFS. 2005d. Proposed conservation plan for southern resident killer whales (Orcinus orca). Seattle, Washington: National Marine Fisheries Service.

NMFS. 2005e. Recovery plan for the North Atlantic right whale (Eubalaena glacialis). Silver Spring, Maryland: National Marine Fisheries Service. ///former 2005a///

NMFS. 2006. Biological Opinion on the proposed letter of authorization to authorize Navy to take marine mammals incidental to its employment of Surveillance Towed Array Sensor System Low

Frequency Active Sonar for the period August 16, 2006, through August 15, 2007. NMFS. Silver Spring, MD. 14 August 2006.

NMFS. 2006a. Draft Recovery Plan for the Fin Whale (Balaenoptera physalus). National Marine Fisheries Service, Silver Spring, MD. 78 pp.

NMFS. 2006b. Draft Recovery Plan for the Sperm Whale (Physeter macrocephalus). National Marine Fisheries Service, Silver Spring, MD. 92 pp.

NMFS. 2006c. Incidental Harassment Authorization for RIMPAC 2006 issued by NOAA-NMFS.

NMFS. 2006d. Endangered and threatened species; revision of critical habitat for the northern right whale in the Pacific Ocean--Proposed rule. National Marine Fisheries Service Federal Register 71(28):6999-7001.

NMFS. 2006e. Endangered and threatened species; Designation of critical habitat for the southern resident killer whale--Final rule. November 29, 2006. National Marine Fisheries Service Federal Register 71(229):69054-69070.

NMFS. 2007a. Update 6/03/2007. http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/rightwhale_northern.htm.

NMFS. 2007b. STRANDINGS Newsletter of the Southeast United States Marine Mammal Health and Stranding Network. Winter 2006/Spring 2007. NOAA Tech Memo NMFS-SEFSC-545. Accessed 2/16/07. http://www.sefsc.noaa.gov/PDFdocs/SNewsletter112806.pdf.

NMFS 2008 http://www.fakr.noaa.gov/protectedresources/stellers/recovery/sslrpfinalrev030408.pdf

NMFS. 2008a. Office of Protected Resources. Accessed on May 27, 2008 at http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/rightwhale_northpacific.htm#mor.

NMFS. 2008b. Recovery Plan for Southern Resident Killer Whales (Orcinus orca). National Marine Fisheries Service, Northwest Region, Seattle, Washington. 251 pp.

NMFS. 2008c. Recovery Plan for the Steller Sea Lion (Eumetopias jubatus). Revision. National Marine Fisheries Service, Silver Spring, MD. 325 pages.

NMFS 2008d http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/rightwhale_northpacific.htm, accessed May 30, 2008

NOAA. 2001. Final Rule for the Shock Trial of the WINSTON S. CHURCHILL (DDG-81), Federal Register, Department of Commerce; NMFS, FR 66, No. 87:22450-67.

NOAA 1992 FEIS and Management Plan for the Proposed Monterey Bay National Marine Sanctuary Volume 1 June at http://montereybay.noaa.gov/intro/mbnms_eis/partIV_sII.html.

Norman, S.A., C.E. Bowlby, M.S. Brancato, J. Calambokidis, D. Duffield, P.J. Gearin, T.A. Gornall, M.E. Gosho, B. Hanson, J. Hodder, S.J. Jeffries, B. Lagerquist, D.M. Lambourn, B. Mate, B. Norberg, R.W. Osborne, J.A. Rash, S. Riemer, and J. Scordino. 2004. Cetacean strandings in Oregon and Washington between 1930 and 2002. Journal of Cetacean Research and Management 6(1):87-99.

Norris, K.S. and J.H. Prescott. 1961. Observations on Pacific cetaceans of Californian and Mexican waters. University of California Publications in Zoology. 63:291-402.

Nowacek, D.P., M.P. Johnson, and P.L. Tyack. 2004. North Atlantic right whales (Eubalaena glacialis) ignore ships but respond to alerting stimuli. Proceedings of the Royal Society of London, Part B 271:227-231.

Nowacek, D.P., L.H. Thorne, M.P. Johnson, and P.L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. Mammal Review 37, no. 2: 81-115.

NRC (National Research Council). 2003. Decline of the Steller sea lion in Alaskan waters. Washington, D.C.: National Academies Press.

Odell, D.K. and K.M. McClune. 1999. False killer whale Pseudorca crassidens (Owen, 1846). Pages 213-243 in Ridgway, S.H. and R. Harrison, eds. Handbook of marine mammals. Volume 6: The second book of dolphins and the porpoises. San Diego, California: Academic Press.

Ogden Environmental and Energy Services, Inc. 1997 Airborne Noise Modeling for the Point Mugu Sea Range EIS. Modeling conducted by Ogden Environmental and Energy Services, Inc., Colorado Springs, CO.

Ohizumi, H., T. Isoda, T. Kishiro, and H. Kato. 2003. Feeding habits of Baird's beaked whale Berardius bairdii, in the western North Pacific and Sea of Okhotsk off Japan. Fisheries Science 69:11-20.

O'Keeffe, D.J., and G.A. Young. 1984. Handbook on the environmental effects of underwater explosions. Naval Surface Weapons Center. NSWC TR 83-240.

Olesiuk, P.F., M.A. Bigg, and G.M. Ellis. 1990. Life history and population dynamics of resident killer whales (Orcinus orca) in the coastal waters of British Columbia and Washington State. Reports of the International Whaling Commission (Special Issue 12):209-243.

Olson, J.M. 1998. Temporal and spatial distribution patterns of sightings of southern community and transient orcas in the inland waters of Washington and British Columbia. Master's thesis, Western Washington University.

Olson, P.A. and S.B. Reilly. 2002. Pilot whales Globicephala melas and G. macrorhynchus. Pages 898-903 in Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego, California: Academic Press.

Omura, H., S. Ohsumi, T. Nemoto, K. Nasu, and T. Kasuya. 1969. Black right whales in the North Pacific. Scientific Reports of the Whales Research Institute 21:1-78.

Orr, A.J., A.S. Banks, S. Mellman, H.R. Huber, R.L. DeLong, and R.F. Brown. 2004. Examination of the foraging habits of Pacific harbor seal (Phoca vitulina richardsi) to describe their use of the Umpqua River, Oregon, and their predation on salmonids. Fishery Bulletin 102:108-117.

Orr, R.T. 1963. A northern record for the Pacific bottlenose dolphin. Journal of Mammalogy 44(3):424.

Osborne, R. 2003. Statement provided to NOAA Fisheries. 28 May 2003.

Osborne, R., J. Calambokidis, and E.M. Dorsey. 1988. A guide to marine mammals of Greater Puget Sound. Anacortes, Wa: Island Publishers. 191pp.

Osborne, R.W. and T.W. Ransom. 1988. Two rare strandings in Washington State. Cetus 8(1):24-25. Osorio, D.A. and R. Klingbell. 2001. Quillback rockfish. Pages 177-178 in Leet, W.S., C.M. Dewees, R. Klingbeil, and E.J. Larson, eds. California's living marine resources: A status report. California Department of Fish and Game SG01-1 1.

Oswald, J.N., J. Barlow, and T.F. Norris. 2003. Acoustic identification of nine delphinid species in the Eastern Tropical Pacific Ocean. Mar. Mam. Sci. 19(1):20-37.

Palacios, D.M. and B.R. Mate. 1996. Attack by false killer whales (Pseudorca crassidens) on sperm whales (Physeter macrocephalus) in the Galápagos Islands. Marine Mammal Science 12(4):582-587.

Parks, S.E. 2006. Personal Communication. Woods Hole Oceanographic Inistitution. 11 January 2006).

Parks, S.E. and P.L. Tyack. 2005. Sound production by North Atlantic right whales (Eubalaena glacialis) in surface active groups. Journal of the Acoustical Society of America 117(5):3297-3306.

Parks, S.E., P.K. Hamilton, S.D. Kraus, and P.L. Tyack. 2005. The gunshot sound produced by male North Atlantic right whales (Eubalaena glacialis) and its potential function in reproductive advertisement. Marine Mammal Science 21(3):458-475.

Patenaude, N. J., W.J. Richardson, M.A. Smultea, W.R. Koski, G.W. Miller, B. Wursig, and C.R. Greene. 2002. Aircraft sound and disturbance to bowhead and beluga whales during spring migration I the Alaskan Beaufort Sea. Marine Mammal Science 18(2):309-335.

Payne, K., P. Tyack, and R. Payne. 1983. Progressive changes in the songs of humpback whales (Megaptera novaeangliae): A detailed analysis of two seasons in Hawaii. Pages 9-57 in Payne, R., ed. Communication and behavior of whales. Volume AAAS Selected Symposia Series 76. Boulder, Colorado: Westview Press.

Payne, P.M. and L.A. Selzer. 1989. The distribution, abundance and selected prey of the harbor seal, Phoca vitulina concolor, in southern New England. Marine Mammal Science 5(2):173-192.

Payne, P.M., D.N. Wiley, S.B. Young, S. Pittman, P.J. Clapham, and J.W. Jossi. 1990. Recent fluctuations in the abundance of baleen whales in the southern Gulf of Maine in relation to changes in selected prey. Fishery Bulletin 88:687-696.

Payne, P.M., J.R. Nicolas, L. O'Brien, and K.D. Powers. 1986. The distribution of the humpback whale, Megaptera novaeangliae, on Georges Bank and in the Gulf of Maine in relation to densities of the sand eel, Ammodytes americanus. Fishery Bulletin 84:271-277.

Perrin, W.F. and R.L. Brownell, Jr. 2002. Minke whales Balaenoptera acutorostrata and B. bonaerensis. Pages 750-754 in Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego, California: Academic Press.

Perrin, W.F., C.E. Wilson, and F.I. Archer II. 1994. Striped dolphin--Stenella coeruleoalba (Meyen, 1833). Pages 129-159 in Ridgway, S.H. and R. Harrison, eds. Handbook of marine mammals. Volume 5: The first book of dolphins. San Diego, California: Academic Press.

Perrin, W. F. and J. R. Geraci. 2002. Stranding. Pages 1192-1197 in W. F. Perrin, B. Würsig, and J. G. M. Thewissen, editors. Encyclopedia of marine mammals. Academic Press, San Diego, California.

Perry, S.L., D.P. DeMaster, and G.K. Silber. 1999. The great whales: History and status of six species listed as endangered under the U.S. Endangered Species Act of 1973. Marine Fisheries Review 61(1):1-74.

Perryman, W.L. and T.C. Foster. 1980. Preliminary report on predation by small whales, mainly the false killer whale, Pseudorca crassidens, on dolphins (Stenella spp. and Delphinus delphis) in the eastern tropical Pacific. NMFS-SWFSC Administrative Report LJ-80-05:1-9.

Philips, J.D., P.E. Nachtigall, W.W.L. Au, J.L. Pawloski, and H.L. Roitblat. 2003. Echolocation in the Risso's dolphin, Grampus griseus. Journal of the Acoustical Society of America 113(1):605-61 6.

Pike, G.C. and I.B. MacAskie. 1969. Marine mammals of British Columbia. Bulletin of the Fisheries Research Board of Canada 171:1-54.

Pinnell, N. and D. Sandilands. 2004. Humpbacks pay a rare visit to the Strait of Georgia. Sightings. The Newsletter of the B.C. Cetacean Sightings Network July/August(17):5.

Pitcher, K.W., Olesiuk, P.F., Brown, R.F., Lowry, M.S., Jeffries, S.J., Sease, J.L., Perryman, W.L., Stinchcomb, C.E., and Lowry, L.F. 2007. Status and trends in abundance and distribution of the eastern population of Steller sea lions (Eumetopias jubatus). Fish. Bull. (Washington, D.C.).

Pitcher, K.W. and D.G. Calkins. 1981. Reproductive biology of Steller sea lions in the Gulf of Alaska. Journal of Mammalogy 62(3):599-605.

Pitman, R.L. 2002. Mesoplodont whales Mesoplodon spp. Pages 738-742 in Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of marine mammals. San Diego, California: Academic Press.

Pitman, R.L. and C. Stinchcomb. 2002. Rough-toothed dolphins (Steno bredanensis) as predators of mahimahi (Coryphaena hippurus). Pacific Science 56(4):447-450.

Podesta, M., A. D'Amico, G. Pavan, A. Drougas, A. Komnevou, and N. Portunato. 2006. A Review of Cuvier's beaked whale strandings in the Mediterranean Sea. Journal of Cetacean Research and Management 7, no. 3: 251-261.

Popov, V.V. and V.O. Klishin. 1998. EEG study of hearing in the common dolphin, Delphinus delphis. Aquatic Mammals 24(1):13-20.

Prescott, R. 1982. Harbor seals: Mysterious lords of the winter beach. Cape Cod Life 3(4):24-29.

Preston, D. 2003. Sei whale carcass provides opportunity for research. NWIFC News 29(3):4-5.

Pyle, P., D.J. Long, J. Schonewald, R.E. Jones, and J. Roletto. 2001. Historical and recent colonization of the South Farallon Islands, California, by northern fur seals (Callorhinus ursinus). Marine Mammal Science 17(2):397-402.

Quaranta, A., P. Portalatini, and D. Henderson. 1998. Temporary and permanent threshold shift: An overview. Scandinavian Audiology. 27:75–86.

Ralls, K., B.B. Hatfield, and D.B. Siniff. 1995. Foraging patterns of California sea otters as indicated by telemetry. Canadian Journal of Zoology 73:523-531.

Ralls, K., T.C. Eagle, and D.B. Siniff. 1996. Movement and spatial use patterns of California sea otters. Canadian Journal of Zoology 74:1841-1849.

Rankin, S. and J. Barlow. 2005. Source of the North Pacific "boing" sound attributed to minke whales. Journal of the Acoustical Society of America 118(5):3346-3351.

Rankin, S., D. Ljungblad, C. Clark, and H. Kato. 2005. Vocalisations of Antarctic blue whales, Balaenoptera musculus intermedia, recorded during the 2001/2002 and 2002/2003 IWC/SOWER circumpolar cruises, Area V, Antarctica. Journal of Cetacean Research and Management 7(1):13-20.

Raum-Suryan, K.L. and J.T. Harvey. 1998. Distribution and abundance of and habitat use by harbor porpoise, Phocoena phocoena, off the northern San Juan Islands, Washington. Fish. Bull. 96:808-822.

Read, A.J. 1990. Reproductive seasonality in harbour porpoises, Phocoena phocoena, from the Bay of Fundy. Canadian Journal of Zoology 68:284-288.

Read, A.J. 1990b. Reproductive seasonality in harbour porpoises, Phocoena phocoena, from the Bay of Fundy. Canadian Journal of Zoology 68:284-288.

Read, A.J., 1999. Harbour porpoise Phocoena phocoena (Linnaeus, 1758). Pages 323-355 in Ridgway, S.H. and R. Harrison, eds. Handbook of marine mammals. Volume 6: The second book of dolphins and the porpoises. San Diego, California: Academic Press.

Read, A.J. and A.A. Hohn. 1995. Life in the fast lane: The life history of harbor porpoises from the Gulf of Maine. Marine Mammal Science 11(4):423-440.

Read, A.J., P.Drinker, and S. Northridge. 2006. Bycatch of Marine Mammals in U.S. and Global Fisheries. Conservation Biology 20, no.1: 163-169.

Ream, R.R., J.T. Sterling, and T.R. Loughlin. 2005. Oceanographic features related to northern fur seal migratory movements. Deep-Sea Research II 52:823-843.

Reeder D.M. and K.M. Kramer. 2005. Stress in free-ranging mammals: integrating physiology, ecology, and natural history. Journal of Mammalogy 86:225-235.

Reeves, R.R. and E. Mitchell. 1993. Status of Baird's beaked whale, Berardius bairdii. Canadian Field-Naturalist 107(4):509-523.

Reeves, R.R. and R.D. Kenney. 2003. Baleen whales: Right whales and allies. Pages 425-463 in Feldhamer, G.A., B.C. Thompson, and J.A. Chapman, eds. Wild mammals of North America: Biology, management, and conservation, 2d ed. Baltimore, Maryland: Johns Hopkins University Press.

Reeves, R.R., B.D. Smith, E.A. Crespo, and G. Notarbartolo di Sciara, compilers. 2003. 2002-2010 conservation action plan for the world's cetaceans: Dolphins, whales and porpoises. Gland, Switzerland: IUCN. ix + 139 pp.

Reeves, R.R., B.S. Stewart, and S. Leatherwood. 1992. The Sierra Club handbook of seals and sirenians. San Francisco, California: Sierra Club Books.

Reeves, R.R., B.S. Stewart, P.J. Clapham, and J.A. Powell. 2002. National Audubon Society guide to marine mammals of the world. New York, New York: Alfred A. Knopf, Inc.

Reeves R.R., and E. Mitchell. 1988. History of whaling in and near North Carolina. NOAA Tech Rep NMFS 65:1–28.

Reeves, R.R., S. Leatherwood, G.S. Stone, and L.G. Eldredge. 1999. Marine mammals in the area served by the South Pacific Regional Environment Programme (SPREP). Apia, Samoa: South Pacific Regional Environment Programme.

Reilly, S.B. 1990. Seasonal changes in distribution and habitat differences among dolphins in the eastern tropical Pacific. Marine Ecology Progress Series 66:1-11.

Reilly, S., and V.G. Thayer. 1990. Blue whale (Balaenoptera musculus) distribution in the eastern tropical Pacific. Marine Mammal Science. 6:265-277.

Reimchen, T. 1980. Sightings of Risso's dolphins (Grampus griseus) off Queen Charlotte Islands, British Columbia. Murrelet 61:44-45.

Rice, D.W. 1977. Synopsis of biological data on the sei whale and Bryde's whale in the eastern North Pacific. Reports of the International Whaling Commission (Special Issue 1):92-97.

Rice, D.W. 1989. Sperm Whale -- Physeter macrocephalus Linnaeus, 1758, Pages 177-234 in S. H. Ridgway, and R. Harrison, eds. Handbook of Marine Mammals: Volume 4: River Dolphins and the Larger Toothed Whales. New York, Academic Press.

Rice, D.W. 1998. Marine mammals of the world: Systematics and distribution. Society for Marine Mammalogy (Special Publication Number 4):1-231.

Rice, D.W. and A.A. Wolman. 1971. The life history and ecology of the gray whale (Eschrichtius robustus). American Society of Mammalogists, Special Publication 3.

Rice, D.W., A.A. Wolman, B.R. Mate, and J.T. Harvey. 1986. A mass stranding of sperm whales in Oregon: Sex and age composition of the school. Marine Mammal Science 2(1):64-69.

Richardson, S. 1997. Washington State status report for the gray whale. Olympia, Washington: Washington Department of Fish and Wildlife.

Richardson, W.J. 1995. Marine mammal hearing. Pages 205-240 in Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson, eds. Marine mammals and noise. San Diego, California: Academic Press.

Richardson, W. J., C.R.J. Green, C.I. Malme and D.H. Thomson. 1995. Marine Mammals and Noise. San Diego, CA, Academic Press.

Richter, C.F., S.M. Dawson, and E. Slooten. 2003. Sperm Whale Watching off Kaikoura, New Zealand: Effects of Current Activities on Surfacing and Vocalisation Patterns. Science for Conservation 219, New Zealand Department of Conservation, Wellington, New Zealand.

Richter, C., S.M. Dawson, and E. Slooten. 2006. Impacts of commercial whale watching on male sperm whales at Kaikoura, New Zealand. Marine Mammal Science 22, no. 1: 46-63.

Ridgway, S.H., and D.A. Carder. 2001. Assessing hearing and sound production in cetaceans not available for behavioral audiograms: Experiences with sperm, pygmy sperm, and gray whales. Aquatic Mammals. 27:267-276.

Ridgway, S.H., D.A. Carder, R.R. Smith, T. Kamolnick, C.E. Schlundt, and W.R. Elsberry. 1997. Behavioral responses and temporary shift in masked hearing threshold of bottlenose dolphins, Tursiops truncatus, to 1-second tones of 141 to 201 dB re 1 µPa. Technical Report 1751, Revision 1. San Diego: Naval Sea Systems Command.

Riedman, M. 1990. The pinnipeds: Seals, sea lions, and walruses. Berkeley, California: University of California Press.Riedman, M.L. and J.A. Estes. 1990. The sea otter (Enhydra lutris): Behavior, ecology, and natural history. U.S. Fish and Wildlife Service Biological Report 90(14). Washington, D.C.: U.S. Fish and Wildlife Service.

Ritter, F. 2002. Behavioural observations of rough-toothed dolphins (Steno bredanensis) off La Gomera, Canary Islands (1995-2000), with special reference to their interactions with humans. Aquatic Mammals 28(1):46-59.

Robson, B.W., ed. 2002. Fur seal investigations, 2000-2001. NOAA Technical Memorandum NMFS-AFSC-1 34:1-80.

Roest, A. I. 1970. Kogia simus and other cetaceans from San Luis Obispo County, California. J. Mamm. 51:410-417.

Roffe T.J. and B.R. Mate. 1984. Abundances and feeding-habits of pinnipeds in the Rogue River, Oregon. J. Wildl. Manage. 48:1262–1274.

Romero, L.M. 2004. Physiological stress in ecology: Lessons from biomedical research. Trends in Ecology and Evolution 19(5):250-255.

Ronald, K. and B.L. Gots. 2003. Seals: Phocidae, Otariidae, and Odobenidae. Pages 789-854 in Feldhamer, G.A., B.C. Thompson, and J.A. Chapman, eds. Wild mammals of North America: Biology, management, and conservation, 2d ed. Baltimore, Maryland: Johns Hopkins University Press.

Rowlett, R.A., G.A. Green, C.E. Bowlby, and M. Smultea. 1994. The first photographic documentation of a northern right whale off Washington State. Northwestern Naturalist 75:102-104.

Rugh, D.J. 1984. Census of gray whales at Unimak Pass, Alaska, November - December 1977 - 1979. Pages 225-248 in Jones, M.L., S.L. Swartz, and S. Leatherwood, eds. The gray whale Eschrichtius robustus. San Diego, California: Academic Press, Inc.

Rugh, D.J., K.E.W. Shelden, and A. Schulman-Janiger. 2001. Timing of the gray whale southbound migration. Journal of Cetacean Research and Management 3(1):31-39.

Salden, D.R. 1989. An observation of apparent feeding by a sub-adult humpback whale off Maui, Hawaii. Page 58 in Abstracts, Eighth Biennial Conference on the Biology of Marine Mammals. 7-11 December 1989. Pacific Grove, California.

Sandegren, F.E., E.W. Chu, and J.E. Vandevere. 1973. Maternal behavior in the California sea otter. Journal of Mammalogy 54(3):668-679.

Sandilands, D. 2003. Is Willy on a walkabout? Sightings. The Newsletter of the B.C. Cetacean Sightings Network June(8):1.

Saulitis, E.L., C.O. Matkin, and F.H. Fay. 2005. Vocal repertoire and acoustic behavior of the isolated AT1 killer whale subpopulation in southern Alaska. Canadian Journal of Zoology 83:1015-1029.

Scarff, J.E. 1991. Historic distribution and abundance of the right whale (Eubalaena glacialis) in the North Pacific, Bering Sea, Sea of Okhotsk and Sea of Japan from the Maury whale charts. Reports of the International Whaling Commission 41:467-489.

Scarff, J.E. 1986. Historic and present distribution of the right whale (Eubalaena glacialis) in the eastern North Pacific south of 50°N and east of 180°W. Reports of the International Whaling Commission (Special Issue 10):43-63.

Scheffer, V.B. 1960. A dolphin Stenella from Washington State. Murrelet 41(2):23.

Scheffer, V.B. and J.W. Slipp. 1948. The whales and dolphins of Washington State with a key to the cetaceans of the west coast of North America. American Midland Naturalist 39(2):257-337.

Schilling, M.R., I. Seipt, M.T. Weinrich, S.E. Frohock, A.E. Kuhlberg, and P.J. Clapham. 1992. Behavior of individually-identified sei whales Balaenoptera borealis during an episodic influx into the southern Gulf of Maine in 1986. Fishery Bulletin. 90:749-755.

Schlundt, C.E., J.J. Finneran, D.A. Carder, and S.H. Ridgway. 2000. Temporary shift in masked hearing thresholds of bottlenose dolphins, Tursiops truncatus, and white whales, Delphinapterous leucas, after exposure to intense tones. Journal of the Acoustical Society of America. 107:3496-3508.

Schneider, D.C. and P.M. Payne, 1983. Factors affecting haul-out of harbor seals at a site in southeastern Massachusetts. Journal of Mammalogy 64(3):518-520.

Schoenherr, J.R. 1991. Blue whales feeding on high concentrations of euphausiids around Monterey Submarine Canyon. Canadian Journal of Zoology 69:583-594.

Schusterman, R.J. 1974. Auditory sensitivity of a California sea lion to airborne sound. Journal of the Acoustical Society of America 56(4):1248-1251.

Schusterman, R.J. 1978. Vocal communication in pinnipeds. Pages 247-308 in Markowitz, H. and V.J. Stevens, eds. Behavior of captive wild animals. Chicago, Illinois: Nelson-Hall.

Schusterman, R.J. and R.F. Balliet. 1969. Underwater barking by male sea lions (Zalophus californianus). Nature 222(5199):1179-1181.

Schusterman, R.J., R. Gentry, and J. Schmook. 1966. Underwater vocalization by sea lions: Social and mirror stimuli. Science 154(3748):540-542.

Schusterman, R.J., R. Gentry, and J. Schmook. 1967. Underwater sound production by captive California sea lions, Zalophus californianus. Zoologica 52(3):21-24.

Schusterman, R.J., R.F. Balliet, and J. Nixon. 1972. Underwater audiogram of the California sea lion by the conditioned vocalization technique. Journal of the Experimental Analysis of Behavior 17(3):339-350.

Schusterman, R.J., R.F. Balliet, and S. St. John. 1970. Vocal displays under water by the gray seal, the harbor seal, and the stellar [sic] sea lion. Psychonomic Science 18(5):303-305.

Schwartz, M., A. Hohn, A. Bernard, S. Chivers, and K. Peltier. 1992. Stomach contents of beach cast cetaceans collected along the San Diego County coast of California, 1972-1991. Southwest Fisheries Science Center Administrative Report LJ-92-18. La Jolla, California: National Marine Fisheries Service.

Shane, S.H. 1994. Occurrence and habitat use of marine mammals at Santa Catalina Island, California from 1983-91. Bulletin of the Southern California Academy of Sciences 93:13-29.

Shane, S.H. 1995. Behavior patterns of pilot whales and Risso's dolphins off Santa Catalina Island, California. Aquatic Mammals 21(3):195-197.

Shane, S.H., R.S. Wells, and B. Würsig. 1986. Ecology, behavior and social organization of the bottlenose dolphin: A review. Marine Mammal Science 2(1):34-63.

Shelden, K.E.W. and P.J. Clapham, eds. 2006. Habitat requirements and extinction risks of eastern North Pacific right whales. AFSC Processed Report 2006-06. Seattle, Washington: National Marine Fisheries Service.

Shelden, K.E.W., S.E. Moore, J.M. Waite, P.R. Wade, and D.J. Rugh. 2005. Historic and current habitat use by North Pacific right whales Eubalaena japonica in the Bering Sea and Gulf of Alaska. Mammal Review 35(2):129-155.

Shepherd, G.S. 1932. Killer whale in slough at Portland, Oregon. Journal of Mammalogy 13(1):171-172.

Shore, V. 1999. Whales dolphins and porpoises of British Columbia, Canada. Vancouver, British Columbia: Fisheries and Oceans Canada (DFO).

Silber, G.K. 1986. The relationship of social vocalizations to surface behavior and aggression in the Hawaiian humpback whale (Megaptera novaeangliae). Canadian Journal of Zoology 64:2075-2080.

Simmonds, M.P. & Lopez-Jurado, L.F. 1991. Whales and the military. Nature 351, 448.

Smith, R.C., P. Dustan, D. Au, K.S. Baker, and E.A. Dunlap. 1986. Distribution of cetaceans and sea-surface chlorophyll concentrations in the California Current. Marine Biology 91:385-402.

Smith, T.D., R.B. Griffin, G.T. Waring, and J.G. Casey. 1996. Multispecies approaches to management of large marine predators. Pages 467-490 in K. Sherman, N.A. Jaworski, and T.J. Smayda, eds. The northeast shelf ecosystem: Assessment, sustainability, and management. Cambridge: Blackwell Science.

Smultea, M.A., J.R. Mobley, Jr., and D. Fertl. 2001. Sperm whale (Physeter macrocephalus) reactions to small fixed-wing aircrafts. Page 200 in Abstracts, Fourteenth Biennial Conference on the Biology of Marine Mammals. 28 November-3 December 2001. Vancouver, British Columbia.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Kettern, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and R. L Tyack. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals, 33(4).

Southall, B.L., R. Braun, F.M. D. Gulland, A.D. Heard, R. Baird, S. Wilkin and T.K. Rowles. 2006. Hawaiian melon-headed whale (Peponocephala electra) mass stranding event of July 3-4, 2004. NOAA Technical Memorandum NMFS-OPR-31. 73 pp. (This is cited in the text as Southhall - with two “h”s).

Southall, B.L., R.J. Schusterman, and D. Kastak. 2000. Masking in three pinnipeds: Underwater, low-frequency critical ratios. Journal of the Acoustical Society of America 108(3):1322-1326.

Sutherland, W.J. and N.J. Crockford. 1993. Factors affecting the feeding distribution of red!breasted geese Branta ruficolis. Biological Conservation, 63, 61-65. Stacey, P.J. and R.W. Baird. 1991. Status of the false killer whale, Pseudorca crassidens, in Canada. Canadian Field-Naturalist 105(2):189-197.

Stacey, P.J. and R.W. Baird. 1993. Status of the short-finned pilot whale, Globicephala macrorhynchus, in Canada. Canadian Field-Naturalist 107(4):481-489.

Stacey, P.J. and R.W. Baird. 1997. Birth of a "resident" killer whale off Victoria, British Columbia, Canada. Marine Mammal Science 13(3):504-508.

Stacey, P.J., S. Leatherwood, and R.W. Baird. 1994. Pseudorca crassidens. Mammalian Species 456:1-5.

Stacey, P.J. and R.W. Baird. 1991a. Status of the false killer whale, Pseudorca crassidens, in Canada. Canadian Field-Naturalist 105(2):189-197.

Stafford, K.M., S.E. Moore, and C.G. Fox. 2005. Diel variation in blue whale calls recorded in the eastern tropical Pacific. Animal Behaviour 69:951-958.

Stafford, K.M., S.L. Nieukirk, and C.G. Fox. 2001. Geographic and seasonal variation of blue whale calls in the North Pacific. Journal of Cetacean Research and Management 3(1):65-76.

Stamper, A.M., B. Whitaker, and T.D. Schofield. 2006. Case Study: Morbidity in a Pygmy Sperm Whale Kogia breviceps due to ocean-bourne plastic. Marine Mammal Science 22, no.3: 719-722.

Stern, J. 2005. Personal communication. Northeast Pacific Minke Whale Project. November 11, 2005.

Stern, J. 2006. Personal communication. Northeast Pacific Minke Whale Project. July 31, 2006.

Stevick, P.T., B.J. McConnell, and P.S. Hammond. 2002. Patterns of movement. Pages 185-216 in Hoelzel, A.R., ed. Marine mammal biology: An evolutionary approach. Oxford, United Kingdom: Blackwell Science.

Stewart, B.S. and P.K. Yochem. 1984. Seasonal abundance of pinnipeds at San Nicolas Island, California, 1980-1982. Bulletin of the Southern California Academy of Sciences 83, no. 3: 121-132.

Stewart, B.S. 1997. Ontogeny of differential migration and sexual segregation in northern elephant seals. Journal of Mammalogy 78(4):1101-1116.

Stewart, B.S. 2005. Personal communication. Hubbs-Sea World Research Institute. 14-26 January and 20 April 2005

Stewart, B.S. and H.R. Huber. 1993. Mirounga angustirostris. Mammalian Species 449:1-10.

Stewart, B.S. and R.L. Delong. 1993. Seasonal dispersion and habitat use of foraging northern elephant seals. Symposium of the Zoological Society of London 66:179-194.

Stewart, B.S. and R.L. DeLong. 1994. Postbreeding foraging migrations of northern elephant seals. Pages 290-309 in Le Boeuf, B.J. and R.M. Laws, eds. Elephant seals: Population ecology, behavior, and physiology. Berkeley, California: University of California Press.

Stewart, B.S. and R.L. DeLong. 1995. Double migrations of the northern elephant seal, Mirounga angustirostris. Journal of Mammalogy 76(1):196-205.

Stewart, B.S. and S. Leatherwood. 1985. Minke whale Balaenoptera acutorostrata Lacepede, 1804. Pages 91-136 in Ridgway, S.H. and R. Harrison, eds. Handbook of marine mammals. Volume 3: The sirenians and baleen whales. San Diego: Academic Press.

Stewart, B.S., P.K. Yochem, H.R. Huber, R.L. DeLong, R.J. Jameson, W.J. Sydeman, S.G. Allen, and B.J. Le Boeuf. 1994. History and present status of the northern elephant seal population. Pages 29-

48 in Le Boeuf, B.J. and R.M. Laws, eds. Elephant seals: Population ecology, behavior, and physiology. Berkeley, California: University of California Press.

Straley, J.M. 1990. Fall and winter occurrence of humpback whales (Megaptera novaeangliae) in southeastern Alaska. Reports of the International Whaling Commission (Special Issue 12):319-323.

Stroud, R.K., C.H. Fiscus, and H. Kajimura. 1981. Food of the Pacific white-sided dolphin, Lagenorhynchus obliquidens, Dall's porpoise, Phocoenoides dalli, and northern fur seal, Callorhinus ursinus, off California and Washington. Fishery Bulletin 78(4):951-959.

Sumich, J.L. 1984. Gray whales along the Oregon coast in summer, 1977-1 980. Murrelet 65:33-40. Sumida, B.Y. and H.G. Moser. 1980. Food and feeding of Pacific hake larvae, Merluccius productus, off southern California and northern Baja California. CalCOFl Reports XXI:161-166.

Szymanski, M.D., D.E. Bain, K. Kiehl, S. Pennington, S. Wong, and K.R. Henry. 1999. Killer whale (Orcinus orca) hearing: Auditory brainstem response and behavioral audiograms. Journal of the Acoustical Society of America 106(2):1134-1141.

Terhune, J. and S. Turnbull. 1995. Variation in the psychometric functions and hearing thresholds of a harbour seal. Pages 81-93 in Kastelein, R.A., J.A. Thomas, and P.E. Nachtigall, eds. Sensory Systems of Aquatic Mammals. Woerden, The Netherlands: De Spil Publishers.

Terhune, J.M. and W.C. Verboom. 1999 Right whales and ship noise. Marine Mammal Science 15: 256–258.

Testa, J.W., ed. 2005. Fur seal investigations, 2002-2003. NOAA Technical Memorandum NMFS-AFSC-151:1-72.

The Ordnance Shop. 2007. Mk 58 MOD 1 Marine Location, Marker. http://www.ordnance.org/mk58.htm. Accessed July 2007. Thode, A., D.K. Mellinger, S. Stienessen, A. Martinez, and K. Mullin. 2002. Depth-dependent acoustic features of diving sperm whales (Physeter macrocephalus) in the Gulf of Mexico. Journal of the Acoustical Society of America 112(1):308-321.

Thode et al. 2002

Thomas, J., N. Chun, W. Au, and K. Pugh. 1988. Underwater audiogram of a false killer whale (Pseudorca crassidens). Journal of the Acoustical Society of America 84(3):936-940.

Thompson, P.O., W.C. Cummings, and S.J. Ha. 1986. Sounds, source levels, and associated behavior of humpback whales, southeast Alaska. Journal of the Acoustical Society of America 80(3):735-740.

Thomson, D.H. and W.J. Richardson. 1995. Marine mammal sounds. Pages 159-204 in Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson, eds. Marine mammals and noise. San Diego: Academic Press.

Tremel, D.P., J.A. Thomas, K.T. Ramirez, G.S. Dye, W.A. Bachman, A.N. Orban, and K.K. Grimm. 1998. Underwater hearing sensitivity of a Pacific white-sided dolphin, Lagenorhynchus obliquidens. Aquatic Mammals 24(2):63-69.

Turl, C.W. 1993. Low-frequency sound detection by a bottlenose dolphin. Journal of the Acoustical Society of America 94(5):3006-3008.

Tynan, C.T., D.G. Ainley, J.A. Barth, T.J. Cowles, S.D. Pierce, and L.B. Spear. 2005. Cetacean distributions relative to ocean processes in the northern California Current System. Deep-Sea Research II 52:145-167.

Tynan, C.T., D.P. DeMaster, and W.T. Peterson. 2001. Endangered right whales on the southeastern Bering Sea shelf. Science 294:1894.

Urbán R., J., L. Rojas-Bracho, H. Pérez-Cortés, A. Gómez-Gallardo, S.L. Swartz, S. Ludwig, and R.L. Brownell, Jr. 2003. A review of gray whales (Eschrichtius robustus) on their wintering grounds in Mexican waters. Journal of Cetacean Research and Management 5(3):281-295.

Urian, K.W., D.A. Duffield, A.J. Read, R.S. Wells, and E.D. Shell. 1996. Seasonality of reproduction in bottlenose dolphins, Tursiops truncatus. Journal of Mammalogy 77(2):394-403.

Urick R.J., 1972, Noise signature of an aircraft in level flight over a hydrophone in the sea. Journal of the Acoustical Society of America 52:993-999.

Urick, R.J. 1983. Principles of Underwater Sound for Engineers, McGraw-Hill, NY, 1975.

USFWS and NMFS. 1998. Final Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act. U.S. Fish and Wildlife Service and National Marine Fisheries Service. 315 pp.

USFWS. 2003. Final revised recovery plan for the southern sea otter (Enhydra lutris nereis). Portland, Oregon: U.S. Fish and Wildlife Service. 165 pp.

USFWS 2003b

USFWS. 2005. Endangered and threatened wildlife and plants; determination of threatened status for the southwest Alaska distinct population segment of the northern sea otter (Enhydra lutris kenyoni)--Final rule. Federal Register 70(152):46366-46386.

USFWS 2005c

Van Parijs, S.M., P.J. Corkeron, J. Harvey, S.A. Hayes, D.K. Mellinger, P.A. Rouget, P.M. Thompson, M. Wahlberg, and K.M. Kovacs. 2003. Patterns in the vocalizations of male harbor seals. Journal of the Acoustical Society of America 113(6):3403-3410.

Van Waerebeek, K., F. Félix, B. Haase, D.M. Palacios, D.M. Mora-Pinto, and M. Muñoz-Hincapié. 1998. Inshore records of the striped dolphin, Stenella coeruleoalba, from the Pacific coast of South America. Reports of the International Whaling Commission 48:525-532.

VanBlaricom, G.R. and M.D. Chambers. 2003. Testing a charismatic paradigm: Consequences of a growing sea otter population for nearshore benthic communities along the south shore of the Strait of Juan de Fuca. Final project report: Marine Ecosystem Health Program. Seattle: School of Aquatic and Fishery Sciences, University of Washington. 24 pp.

Vanderlaan, A.S.M., A.E. Hay, and C.T. Taggart. 2003. Characterization of North Atlantic right-whale (Eubalaena glacialis) sounds in the Bay of Fundy. IEEE Journal of Oceanic Engineering 28(2):164-173.

Veirs, V. 2004. Source levels of free-ranging killer whale (Orcinus orca) social vocalizations. Journal of the Acoustical Society of America 116(No. 4, Pt. 2):2615.

Verboom, W. C. and R.A. Kastelein. 1995. Acoustic signals by harbour porpoises (Phocoena phocoena). In Harbour Porpoises – Laboratory Studies to Reduce Bycatch (ed. P. E. Nachtigall, J. Lien, W. W. L. Au and A. J. Read), pp. 1-39. Woerden, The Netherlands: De Spil Publishers.

Vidal, O. and J-P Gallo-Reynoso. 2006. Die-offs of Marine Mammals and Sea Birds in the Gulf of California, Mexico. Marine Mammal Science 12, no. 4: 627-635.

Von Saunder, A., and J. Barlow. 1999. A report of the Oregon, California and Washington line-transect experiment (ORCAWALE) conducted in West Coast waters during Summer/Fall 1996. NOAA Technical Memorandum NMFS-SWFSC-264:1-49.

Wade, L.S. and G.L. Friedrichsen. 1979. Recent sightings of the blue whale, Balenoptera musculus, in the northeastern tropical Pacific. Fishery Bulletin 76(4):915-919.

Wade, P., M.P. Heide-Jørgensen, K. Shelden, J. Barlow, J. Caretta, J. Durban, R. LeDuc, L. Munger, S. Rankin, and C. Stinchcomb. 2006. Acoustic detection and satellite-tracking leads to discovery of rare concentration of endangered North Pacific right whales. Biology Letters:doi:10.1 098/rsbl. 2006.0460.

Wade. 2005. Personal communication. NMFS-NMML. 3-6 October 2005.

Wahl, T.R. 1977. Sight records of some marine mammals offshore from Westport, Washington. Murrelet 58:21-23.

Walker, W.A. and J.M. Coe. 1990. Survey of marine debris ingestion by odontocete cetaceans. Proceedings of the Second International Conference on marine Debris, Honolulu, USA, p.747-774.

Walker, W.A., J.G. Mead, and R.L. Brownell, Jr. 2002. Diets of Baird's beaked whales, Berardius bairdii, in the southern Sea of Okhotsk and off the Pacific coast of Honshu, Japan. Marine Mammal Science 18(4):902-919.

Walsh, M.T., R.Y. Ewing, D.K. Odell and G.D. Bossart. 2001. Mass Stranding of Cetaceans. CRC Handbook of Marine Mammals. L.A. Dierauf and F.M.D. Gulland, CRC Press: pp. 83-93.

Ward, W.D. 1997. Effects of high-intensity sound. In Encyclopedia of Acoustics, ed. M.J. Crocker, 1497-1507. New York: Wiley.

Waring, G.T. and J.T. Finn. 1995. Cetacean trophic interactions off the northeast USA inferred from spatial and temporal co-distribution patterns. Unpublished meeting document. ICES C.M. 1995/N:7:1-44. Copenhagen, Denmark: International Council for the Exploration of the Sea.

Waring, G.T., P. Gerrior, P.M. Payne, B.L. Parry, and J.R. Nicolas. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States, 1977-88. Fishery Bulletin 88(2):347-360.

Waring, G.T., T. Hamazaki, D. Sheehan, G. Wood, and S. Baker. 2001. Characterization of beaked whale (Ziphiidae) and sperm whale (Physeter macrocephalus) summer habitat in shelf-edge and deeper waters off the northeast U.S. Marine Mammal Science 17(4):703-71 7.

Wartzok, D., A.N. Popper, J. Gordon, and J. Merrill. 2003. Factors affecting the responses of marine mammals to acoustic disturbance. Marine Technology Society Journal. 37:6–15.

Watkins, W. A. 1986. Whale reactions to human activities in Cape Cod waters. Mar. Mammal Sci. 2(4):251-262.

Watkins, W.A., K.E. Moore, D. Wartzok, and J.H. Johnson. 1981. Radio tracking of finback (Balaenoptera physalus) and humpback (Megaptera novaeangliae) whales in Prince William Sound, Alaska. Deep-Sea Res. 28A(6):577-588.

Watkins, W.A., P. Tyack, K.E. Moore, and J.E. Bird. 1987. The 20-Hz signals of finback whales (Balaenoptera physalus). Journal of the Acoustical Society of America 82(6):1901-1912.

Wedekin, L.L., A. Freitas, M.H. Engel, and I. Sazima. 2004. Rough-toothed dolphins (Steno bredanensis) catch diskfishes while interacting with humpback whales (Megaptera novaeangliae) off Abrolhos Bank breeding ground, southwest Atlantic. Aquatic Mammals 30(2):327-329.

Weinrich, M.T., C.R. Belt, M.R. Schilling, and M. Marcy. 1986. Behavior of sei whales in the southern Gulf of Maine, summer 1986. Whalewatcher (Journal of the American Cetacean Society) 20(4):4-7. Weitkamp, L.A., R.C. Wissmar, C.A. Simenstad, K.L. Fresh, and J.G. Odell. 1992. Gray whale foraging on ghost shrimp (Callianassa californiensis) in littoral sand flats of Puget Sound, U.S.A. Canadian Journal of Zoology 70:2275-2280.

Weller, D. NMFS-SWFSC. Personal Communication. 15 April 2005.

Weller, D.W., A.M. Burdin, B. Würsig, B.L. Taylor, and R.L. Brownell, Jr. 2002. The western gray whale: A review of past exploitation, current status and potential threats. Journal of Cetacean Research and Management 4(1):7-12.

Wells, R.S. and M.D. Scott. 1999. Bottlenose dolphin--Tursiops truncatus (Montagu, 1821). Pages 137-182 in Ridgway, S.H. and R. Harrison, eds. Handbook of marine mammals. Volume 6: The second book of dolphins and the porpoises. San Diego, California: Academic Press.

Whitehead, H. 2003. Sperm whales: Social evolution in the ocean. Chicago, Illinois: University of Chicago Press.

Whitehead, H. and L. Weilgart. 1991. Patterns of visually observable behaviour and vocalizations in groups of female sperm whales. Behaviour 118:276-296.

Whitehead, H., S. Brennan, and D. Grover. 1992. Distribution and behaviour of male sperm whales on the Scotian Shelf, Canada. Canadian Journal of Zoology 70:912-918.

Wiggins, S.M., M.A. McDonald, L.M. Munger, S.E. Moore, and J.A. Hildebrand. 2004. Waveguide propagation allows range estimates for North Pacific right whales in the Bering Sea. Canadian Acoustics 32(2):146-154.

Wiles, G.J. 2004. Washington State status report for the killer whale. Olympia, Washington: Washington Department of Fish and Wildlife.

Wilkinson, D. M. 1991. Program Review of the Marine Mammal Stranding Networks. Report to the Assistant Administrator for Fisheries, NOAA, National Marine Fisheries Service, Silver Spring, MD. (Available from NMFS Office of Protected Resources, Silver Spring, MD).

Williams, R., A. W. Trites, and D. E. Bain. 2002. Behavioural responses of killer whales (Orcinus orca) to whale-watching boats: opportunistic observations and experimental approaches. Journal of Zoology 256:255-270.

Willis, P.M. and R.W. Baird. 1998a. Status of the dwarf sperm whale, Kogia simus, with special reference to Canada. Canadian Field-Naturalist 112(1):114-125.

Willis, P.M. and R.W. Baird. 1998b. Sightings and strandings of beaked whales on the west coast of Canada. Aquatic Mammals 24(1):21-25.

Willis, P.M., B.J. Crespi, L.M. Dill, R.W. Baird, and M.B. Hanson. 2004. Natural hybridization between Dall's porpoises (Phocoenoides dalli) and harbour porpoises (Phocoena phocoena). Canadian Journal of Zoology 82:828-834.

Wilson, S.C. 1978. Social organization and behavior of harbor seals, Phoca vitulina concolor, in Maine. Final report to the U.S. Marine Mammal Commission. Washington, D.C.: Smithsonian Institution Press.

Wolski, L.F., R.C. Anderson, A.E. Bowles, and P.K. Yochem. 2003. Measuring hearing in the harbor seal (Phoca vitulina): Comparison of behavioral and auditory brainstem response techniques. Journal of the Acoustical Society of America 113(1):629-637.

Worthy, G., D. Casper, H. Rhinehart, and M. Moser. 1993. First record of a live-stranded pan-tropical spotted dolphin (Stenella attenuata graffmani) in central California, USA. Marine Mammal Science 9(3):316-319.

Würsig, B., S.K. Lynn, T.A. Jefferson, and K.D. Mullin. 1998. Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. Aquatic Mammals.24:41-50.

Yelverton, J.T., D.R. Richmond, E.R. Fletcher, and R.K. Jones. 1973. Safe distance from underwater explosions for mammals and birds. Defense Nuclear Agency, Dept. of Defense, Wash. D.C., Tech. Rept. DNA 3114 T. 67 pp.

Yochem, P.K. and S. Leatherwood. 1985. Blue whale Balaenoptera musculus (Linnaeus, 1758). Pages 193-240 in Ridgway, S.H. and R. Harrison, eds. Handbook of marine mammals. Volume 3: The sirenians and baleen whales. San Diego, California: Academic Press.

York, A.E. 1987. Northern fur seal, Callorhinus ursinus, eastern Pacific population (Pribilof Islands, Alaska, and San Miguel Island, California). Pages 9-21 in Status, biology, and ecology of fur seals--Proceedings of an international symposium and workshop, Cambridge, England, 23-27 April 1984. NOAA Technical Report NMFS 51.

Yost, W.A. 1994. Fundamentals of Hearing: An Introduction. San Diego: Academic Press.

Young, R.W. 1973. Sound Pressure in Water from a Source in Air and Vice Versa. Journal of the Acoustic Society of America 53:1708-1716.

Yu, H.Y., H.K. Mok, R.C. Wei, and L.S. Chou. 2003. Vocalizations of a rehabilitated rough-toothed dolphin, Steno bredanensis. Page 183 in Abstracts, Fifteenth Biennial Conference on the Biology of Marine Mammals. 14-19 December 2003. Greensboro, North Carolina.

Yuen, M.M.L., P.E. Nachtigall, M. Breese, and A.Y. Supin. 2005. Behavioral and auditory evoked potential audiograms of a false killer whale (Pseudorca crassidens). Journal of the Acoustical Society of America 11 8(4):2688-2695.

Yurk, H., L. Barrett-Lennard, J.K.B. Ford, and C.O. Matkin. 2002. Cultural transmission within maternal lineages: Vocal clans in resident killer whales in southern Alaska. Animal Behaviour 63:1103-1119.

Zamon, J.E. 2001. Seal predation on salmon and forage fish schools as a function of tidal currents in the San Juan Islands, Washington, USA. Fisheries Oceanography 10(4):353-366.

Zimmer, W.M.X., M.P. Johnson, P.T. Madsen, and P.L. Tyack. 2005a. Echolocation clicks of free-ranging Cuvier's beaked whales (Ziphius cavirostris). Journal of the Acoustical Society of America 11 7(6):3919-3927.

Zimmer, W.M.X., P.T. Madsen, V. Teloni, M.P. Johnson, and P.L. Tyack. 2005b. Off-axis effects on the multipulse structure of sperm whale usual clicks with implications for sound production. Journal of the Acoustical Society of America 118(5):3337-3345.

Zimmer, W.M.X. and P.L. Tyack. 2007. Repetitive Shallow Dives pose decompression risk in deep-diving beaked whales. Marine Mammal Science 23, no. 4: 888-925.

3.10 BIRDS

Ainley, D.G., L.B. Spear, C.T. Tynan, J.A. Barth, S.D. Pierce, R.G. Ford, and T.J. Cowles. 2005. Physical and biological variables affecting seabird distributions during the upwelling season of the northern California Current. Deep-Sea Research II 52:123-143.

Allen, S.E., R.E. Vindeirinho, R.E. Thomson, M.G.G. Foreman, and D.L. Mackas. 2001. Physical and biological processes over a submarine canyon during an upwelling event. Canadian Journal of Fisheries and Aquatic Sciences 58:671-684.

Anderson, D.W. and F. Gress. 1983. Status of a northern population of California Brown Pelicans. Condor 85:79-88.

Bakun, A. 1973. Coastal upwelling indices, west coast of North America, 1946-71. NOAA Technical Report NMFS SSRF-671:1-103.

Barnes, C.A., A.C. Duxbury, and B.A. Morse. 1972. Circulation and selected properties of the Columbia River effluent at sea. Pages 41-80 in Alverson, D.L. and A.L. Pruter, eds. Bioenvironmental Studies of the Columbia River Estuary and Adjacent Ocean Regions. Seattle, Washington: University of Washington Press.

Barreiros, J.P. 2001. Plastic Ingestion by a Leatherback Turtle Dermochelys coriacea from the Azores (NE Atlantic). November 2001.

Beason, R.C. 2003. Through a Bird's Eye—Exploring Avian Sensory Perception. USDA/Wildlife Services/ National Wildlife Research Center/Ohio Field Station, Sandusky OH. http://www.aphis.usda.gov/ws/nwrc/is/03pubs/beason031.pdf.

Bjorndal K.A., Bolton A.B., Johnson D.A., Eliazar P.J. (eds). 1994. Proc 14th Annual Symposium Sea Turtle Biol Conserv. NOAA Tech Memo NMFCSEFSC 351:119

Black, A. 2005. Light Induced Seabird Mortality on Vessels Operating in the Southern Ocean: Incidents and Mitigation Measures. Antarctic Science 17:67-68.

Borberg, J.M., L.T. Balance, R.L. Pitman, and D.G. Ainley. 2005. A Test for Bias Attributable to Seabird Avoidance of Ships During Surveys Conducted in the Tropical Pacific. Marine Ornithology 33:173-179.

Briggs, K.T., W.B. Tyler, D.B. Lewis, P.R. Kelly, and D.A. Croll. 1983. Brown Pelicans in central and northern California. Journal of Field Ornithology 54(4):353-466.

Briggs, K.T., E.W. Chu, D.B. Lewis, W.B. Tyler, R.L. Pitman, and G.L. Hunt, Jr. 1981. Distribution, numbers, and seasonal status of seabirds of the Southern California Bight. Summary of marine mammal and seabird surveys of the Southern California Bight area, 1975 - 1978. Volume III - Investigators' Reports, Part III - Seabirds - Book I. Chapter I(II). Final Report to the Bureau of Land Management, Washington, D.C. from the Center for Coastal Marine Studies, University of California, Santa Cruz. pp. 1-276.

Briggs, K.T., D.H. Varoujean, W.W. Williams, R.G. Ford, M.L. Bonnell, and J.L. Casey. 1992. Seabirds of the Oregon and Washington OCS, 1989-1990. Pages 3-1 to 3-162 in Brueggeman, J.J., ed. Oregon and Washington marine mammal and seabird surveys. OCS Study MMS 91-0093. Los Angeles, California: Minerals Management Service.

Burger, A.E., J.K. Etzkorn, B. Gisborne, and R.Palm. 1998. Influx of Brown Pelicans off southwestern Vancouver Island during the 1997 El Niño. Pacific Seabirds 25(2):61-64.

Carl, R.A. 1987. Age-class variation in foraging techniques by Brown Pelicans. Condor 89:525-533.

Carter, H.R. and J.L. Stein. 1995. Molts and plumages in the annual cycle of the Marbled Murrelet. Pages 99-109 in Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt, eds. Ecology and conservation of the Marbled Murrelet. USDA Forest Service General Technical Report PSW-152.

Contreras, A. 1998. Birds of Coos County, Oregon: Status and distribution. Eugene, Oregon: Oregon Field Ornithologists, Cape Arago Audubon Society.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2002. COSEWIC assessment and update status report on the blue whale Balaenoptera musculus in Canada. Ottawa, Ontario: Committee on the Status of Endangered Wildlife in Canada. vi + 32 pp.

Dailey, M.D., D.J. Reish, and J.W. Anderson. 1993. Ecology of the Southern California Bight, a Synthesis and Interpretation. University of California Press, Berkeley and Los Angeles, CA.

Department of Commerce 1993 Olympic Coast National Marine Sanctuary

DoN (Department of Navy). 1996a. Integrated Natural Resources Management Plan: Naval Air Station Whidbey Island. Poulsbo, WA, Engineering Field Activity, Northwest. Prepared by EA Engineering, Science, and Technology .

DoN. 1996b Naval Air Station Whidbey Island Bald Eagle Management Plan. Prepared for Naval Facilities Engineering Command, Engineering Field Activity Northwest. Poulsbo, WA.

DoN. 1997. Integrated Natural Resources Management Plan, Land Management, Naval Ordnance Center Pacific Division, Detachment Port Hadlock. 1997.

DoN. 1999. Environmental Assessment/Overseas Environmental Assessment of the SH-60R Helicopter/ALFS Test Program, October.

DoN. 2000a. Biological Assessment for the U.S. Navy Explosive Ordnance Disposal (EOD) Operations. Puget Sound, Washington.

DoN. 2001. Integrated Natural Resource Management Plan Naval Submarine Base Bangor, Silverdale, Washington.

DoN. 2005. Joint Logistics Over-the-shore Exercise 2005 Environmental Assessment. Naval Magazine, Indian Island.

DoN. 2006. Marine Resources Assessment for the Pacific Northwest Pacific Northwest Marine Resources Assessment. Prepared for Naval Facilities Engineering Command, Pacific by Geo-Marine, Inc. Final Report, September 2006.

DoN. 2007 . Naval Auxiliary Landing Field, San Clemente Island Area of Special Biological Significance Biological Survey Report . Naval Facilities Engineering Command, Southwest Division Contract #N68711-03-D-7001, Delivery Order No. 18 and 25 . February 2007.

Grubb, T.G., and W.W. Bowerman. 1997. “Variations in breeding bald eagle response to jets, light planes, and helicopters.” J. Raptor Res. 31:213-222.Hamilton, W.J. 1958. Pelagic Birds Observed on a North Pacific Crossing. The Condor 60(3):159-164.

Harrison, P. 1983. Seabirds, An Identification Guide. Boston: Houghton Mifflin.

Harrison, C.S. 1984. Skimmers: Family Laridae. Pages 162-167 in Haley, D., ed. Seabirds of eastern North Pacific and Arctic waters. Seattle, Washington: Pacific Search Press.

Harrison, C.S. 1990. Seabirds of Hawaii: Natural history and conservation. Ithaca, New York: Comstock Publishing Associates.

Hickey, B.M. 1995. Coastal submarine canyons. Pages 95-110 in Muller, P. and D. Henderson, eds. Proceedings of the University of Hawaii 'Aha Huliko'a Workshop on Flow Topography Interactions. University of Hawaii, Honolulu, Hawaii. SOEST Special Publication.

Hunter, W.C., W. Golder, S. Melvin, and J. Wheeler. 2006. Southeast United States Regional Waterbird Conservation Plan. North American Bird Conservation Initiative.

Hyrenbach, K.D. 2001. Albatross Response to Survey Vessels: Implications for Studies of the Distribution, Abundance, and Prey Consumption of Seabird Populations. Marine Ecology Progress Series. 212:283-295.

Hyrenbach, K.D. 2006. Training and Problem-Solving to Address Population Information Needs for Priority Species, Pelagic Species (Procellariiformes) and Other Birds at Sea. Waterbird Monitoring Techniques Workshop, IV North American Ornithological Conference, Veracruz, Mexico, 2 and 3 October, 2006.

Jaques, D.L. and C.S. Strong. 2003. Brown pelican night roost sites on the southern California coast. Prepared for the American Trader Trustee Council, California Department of Fish and Game, USFWS, NOAA 26 pp.

Knight, R.L., and S.A. Temple. 1986. “Why does intensity of avian nest defense increase during the nesting cycle?” Auk 103:318-327.Kuletz, K.J., and marks. 1997. Post Fledgling behavior of a radio-tagged juvenile marbled murrelet, Journal of Field Ornithology 68(3):421-425

Larkin, R.P. 1996. Effects of Military Noise on Wildlife: A Literature Review. Center for Wildlife Ecology, Illinois natural History Survey prepared for U.S. Army Construction Engineering Research Laboratory, Champaign, Illinois.

LeBlond, P.H. 1989. Physical oceanography of the Strait of Georgia as related to marine birds. Pages 10-18 in Vermeer, K. and R.W. Butler, eds. Proceedings of a symposium sponsored by the Pacific Northwest Bird and Mammal Society and the Canadian Wildlife Service, held in Sidney, BC, 11 December 1987.

Lutcavage, M.E., P.L. Lutz, and J.A. Musick . 1997 . Diving physiology . In The biology of sea turtles, pages 277-296 . Boca Raton, Florida: CRC Press.

Lutz, P.L. 1990. Studies on the ingestion of plastic and late by sea turtles. Pp. 719-735 in Proc. Of the Second International Conference on Marine Debris, 2-7 April 1989, Honolulu, Hawaii (Vol. I), R.S. Shomura and M.L. Godfrey, eds. NOAA-TM-NMFS-SWFSC-154.

Mackas, D.L. and J.D. Fulton. 1989. Distribution and aggregation of zooplankton in the Strait of Georgia and their potential availability to marine birds. Pages 19-25 in Vermeer, K. and R.W. Butler, eds. Proceedings of a symposium sponsored by the Pacific Northwest Bird and Mammal Society and the Canadian Wildlife Service, held in Sidney, BC, 11 December 1987.

McCauley, S.J. and K.A. Bjorndal. 1999. Conservation Implications of Dietary Dilution from Debris Ingestion: Sublethal Effects in Post-Hatchling Loggerhead Sea Turtles . Conservation Biology, Vol. 13, No. 4 (Aug., 1999), pp. 925-929.

Miller, S.L., C.J. Ralph, M.G. Raphael, C. Strong, and C.W. Thompson. 2006. Pages 31-60 in M.H. Huff, M.G. Raphael, S.L. Miller, S.K. Nelson, and J. Baldwin, Technical Coordinators. Northwest Forest Plan – The First 10 Years (1994-2003): Status and Trends of Populations and Nesting Habitat for the Marbled Murrelet. General Technical Report PNW-GTR-650. U.S. Forest Service, Pacific Northwest Research Station, Portland, OR.

NMFS (National Marine Fisheries Service). 2002. Final Rule SURTASS LFA Sonar. Federal Register 67:46712-46789.

NMFS. 2003. Environmental Assessment on the Effects of Scientific Research Activities Associated with Development of a Low-Power High-Frequency Sonar System to Detect Marine Mammals. December 2003.

NPS (National Park Service). 1994. Report on Effects of Aircraft Overflights on the National Park System. Report to Congress prepared pursuant to Public Law 100-91, the national parks Overflights Act of 1987.

Navy Safety Center. 2004. 2002 – 2004 BASH Hazard Data Summaries. Navy Safety Center, Bird/Animal Hazard Strike (BASH) Division. Data downloaded from http://www.safetycenter.navy.mil/aviation/operations/bash/default.htm. Accessed 2/5/08.

Nelson, S.K. 1997. Marbled Murrelet Bra chyramphus marmoratus. Birds of North America 276:1-32. Nelson, S.K. and R.W. Peck. 1995. Behavior of marbled murrelets at nine nest sites in Oregon. Northwestern Naturalist 76(1):43-53.

Nysewander, D.R., J.R. Evenson, B.L. Murphie, and T.A. Cyra. 2005. Report of marine bird and marine mammal component, Puget Sound Ambient Monitoring Program, for July 1992 to December 1999 period. Prepared for Washington State Department of Fish and Wildlife and Puget Sound Action Team, Olympia, Washington.

Page, G.W. and L.E. Stenzel. 1981. The breeding status of the Snowy Plover in California. Western Birds 12(1):1-40.

Page, G.W., J.S. Warriner, J.C. Warriner, and P.W.C. Paton. 1995. Snowy Plover Charadrius alexandrinus. Birds of North America 154:1-24.

Piatt, J.F., J. Wetzel, K. Bell, A.R. DeGange, G.R. Balogh, G.S. Drew, T. Geernaert, C. Ladd, and G.V. Byrd. 2006. Predictable hotspots and foraging habitat of the endangered short-tailed albatross (Phoebastria albatrus) in the North Pacific: Implications for conservation. Deep-Sea Research II 53:387-398.

Plumpton, D. 2006. Review of Studies Related to Aircraft Noise Disturbance of Waterfowl, a Technical Report in Support of the Supplemental Environmental Impact Statement for the Introduction of F/A-18 E/F (Super Hornet) Aircraft to the East Coast of the United States. Ecology and Environment, Inc., San Francisco, CA prepared for Naval Facilities Engineering Command, Norfolk, VA.

Ressler, P.H., R.D. Brodeur, W.T. Peterson, S.D. Pierce, P.M. Vance, A. Røstad, and J.A. Barth. 2005. The spatial distribution of euphausiid aggregations in the Northern California Current during August 2000. Deep-Sea Research II 52:89-108.

Roberson, D. 2000. California sahort-tailed albatrosses: A summary at the turn of the 21st century. Accessed on line 23 April 2005.

SAB. 1990. CMAS (Computer Mapping and Analysis System) analysis of seabird colonies for the west coast of North America. NOAA, NOS, SAB, 6001 Executive BLVD., Suite 220, Rockville, MD.

Schreiber, R.W. and E.A. Schreiber. 1982. Essential habitat of the Brown Pelican in Florida. Florida Field Naturalist 10(1):9-1 7.

Speich, Steven M. and T.R. Wahl. 1989. Catalog of Washington Seabird Colonies. United States Fish and Wildlife Service, Minerals Management Service, United States Department of Interior. Biological Report 88(6); OCS Study MMS 89-0054.

Stern, M.A., D.J. Lauten, and K.A. Castelein. 2003. Snowy Plover Charadrius alexandrinus. Pages 203-206 in Marshall, D.B., M.G. Hunter, and A.L. Contreras, eds. Birds of Oregon: A general reference. Corvallis, Oregon: Oregon State University Press.

Stinson, D.W., J.W. Watson, and K.R. McAllister. 2001. Washington State Status Report for the Bald Eagle. Washington Department of Fish and Wildlife, Olympia, WA. October.

Strickland, R. and D.J. Chasan. 1989. Coastal Washington: A synthesis of information. Seattle, Washington: Washington Sea Grant Program, University of Washington.

Strong, C.S., B.S. Keitt, W.R. McIver, C.J. Palmer, and I. Gaffney. 1995. Distribution and population estimates of Marbled Murrelets at sea in Oregon during the summers of 1992 and 1993. Pages 339-352 in Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt, eds. Ecology and conservation of the Marbled Murrelet. USDA Forest Service General Technical Report PSW-152.

Thomson, R.E. 1994. Physical oceanography of the Strait of Georgia-Puget Sound-Juan de Fuca Strait system. Pages 36-100 in Wilson, R.C.H., R.J. Beamish, F. Aitkens, and J. Bell, eds. Review of the Marine Environment and the Biota of Strait of Georgia, Puget Sound and Juan de Fuca Strait. Canadian Technical Report of Fisheries Aquatic Sciences 1948.

Tomas, J., R. Guitart, R. Mateo, and J. A. Raga. 2002. Marine debris ingestion by loggerhead sea turtles, (Caretta caretta), from the Western Mediterranean. Marine Pollution Bulletin 44, 211-216.

Turnpenny, A.W.H. and J.R. Nedwell 1994. The effects on marine fish, diving mammals and birds of underwater sound generated by seismic surveys. FARL Report Reference: FCR 089/94. October 1994. Accessed online at: http://www.subacouostech.com/ downloads/reports/FCR089_94.pdf.

Unitt, P. 2004. San Diego County Bird Atlas. San Diego, CA: San Diego Natural History Museum. Ibis Publishing Company.

USDA (United States Department of Agriculture) 2007. Regional Population Monitoring of the Marbled Murrelet: Field and Analytical Methods. USDA Forest Service Pacific Northwest Research Division. General Technical Report PNW-GTR-716. May.

USFWS (U.S. Fish and Wildlife Service). 1983. The California brown pelican recovery plan. Prepared by the USFWS under contract with Franklin Gress (California Department of Fish and Game) and Daniel W. Anderson (University of California-Davis). 40pp.

USFWS. 1985. Endangered and threatened wildlife and plants; removal of the brown pelican in the southeastern United States from the list of endangered and threatened wildlife. Federal Register 50(23):4938-4945.

USFWS. 1993. Endangered and threatened wildlife and plants; determination of threatened status for the Pacific coast population of the western snowy plover--Final rule. Federal Register 58(42): 12864-12874.

USFWS. 1998. Endangered Species Consultation Handbook, Procedures for Conducting Consultations and Conference Activities under Section 7 of the Endangered Species Act.USFWS. 2000. Oregon coast national wildlife refuges. Newport, Oregon: Oregon Coast National Wildlife Refuge Complex.

USFWS. 2001a. Western snowy plover (Charadrius alexandrinus nivosus) Pacific coast population draft recovery plan. Portland, Oregon: U.S. Fish and Wildlife Service.

USFWS. 2001b. Short-tailed albatross (Phoebastria albatrus) threatened and endangered species. Anchorage, Alaska: U.S. Fish and Wildlife Service.

USFWS. 2005. Endangered and threatened wildlife and plants; designation of critical habitat for the Pacific coast population of the western snowy plover--Final rule. Federal Register 70(188):56970-571 19.

USFWS 2008. Endangered Species Act - Section 7 Formal Consultation Biological Opinion, United States Navy Explosive Ordnance Disposal Training Operations, Puget Sound; Whidbey Island, Island County, Washington. November 7, 2008.

VanderWerf, E., Y. Ebisu and Associates, Wil Chee-Planning, Inc. 2000. A Study to Determine the Effects of Noise from Military Training on the Endangered Oahu 'Elepaio: United States Army Engineer District, Honolulu Programs and Project Management Division Environmental/ DOD Support Branch, Contract No. DACA83-96-D-0007, Schofield Military Reservation, Island of Oahu.Varoujean II, D.H. and W.A. Williams. 1995. Abundance and distribution of Marbled Murrelets in Oregon and Washington based on aerial surveys. Pages 327-337 in Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt, eds. Ecology and conservation of the Marbled Murrelet. USDA Forest Service General Technical Report PSW-152.

Wahl, T.R. 1984. Distribution and Abundance of Seabirds Over the Continental Shelf Off Washington. Washington Department of Ecology, Olympia, WA. 92 pp.

Wahl, T.R. and B. Tweit. 2000. Seabird abundances off Washington, 1972-1998. Western Birds 31(2):69-88.

Wahl, T.R., B. Tweit, and S.G. Mlodinow, eds. 2005. Birds of Washington: Status and distribution. Corvallis, Oregon: Oregon State University Press.

Widrig, R.S. 1980. Snowy Plovers at Leadbetter Point: An opportunity for wildlife management? Prepared for the U.S. Fish and Wildlife Service, Willapa National Wildlife Refuge, Ilwaco, Washington.

3.11 TERRESTRIAL BIOLOGY

Cowardin, L. M., V. Carter, F. C. Golet, E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U. S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/1998/classwet/classwet.htm. (Version 04DEC98).

DoN (Department of the Navy). 1993. Detonation Training Range Environmental Assessment. Naval Air Station, Whidbey Island, Seaplane Base.

DoN. 1996. Integrated Natural Resources Management Plan, Naval Air Station Whidbey Island. 354 pp.

DoN. 2000. Biological Assessment for the U.S. Navy Explosive Ordnance Disposal (EOD) Operations. Puget Sound, Washington.

DoN. 2001. Integrated Natural Resource Management Plan Naval Submarine Base Bangor, Silverdale, Washington.

Larkin, R.P. 1996. Effects of Military Noise on Wildlife: A Literature Review. Center for Wildlife Ecology, Illinois natural History Survey prepared for U.S. Army Construction Engineering Research Laboratory, Champaign, Illinois.

NPS (National Park Service). 1994. Report on Effects of Aircraft Overflights on the National Park System. Report to Congress prepared pursuant to Public Law 100-91, Plumpton, D. 2006. Review of Studies Related to Aircraft Noise Disturbance of Waterfowl, a Technical Report in Support of the Supplemental Environmental Impact Statement for the Introduction of F/A-18 E/F (Super Hornet) Aircraft to the East Coast of the United States. Ecology and Environment, Inc., San Francisco, CA prepared for Naval Facilities Engineering Command, Norfolk, VA.

USAF (U.S. Air Force). 1999. Final environmental impact statement: F-22 force development evaluation2 and weapons school beddown, Nellis AFB. October.

USEPA (U.S. Environmental Protection Agency). 1971. Effects of Noise on Wildlife and Other Animals. NT1D300.5. Office of Noise Abatement and Control. Washington, D. C.

WDNR (Washington Department of Natural Resources). 1995. Significant Biological and Natural Features of Naval Air Station Whidbey Island, Island County, Washington. Washington Department of Natural Resources, Washington Natural Heritage Program, Olympia Washington.

3.12 CULTURAL RESOURCES

Blukis Onat, Astrida R. 1994. "Draft Historic and Archaeological Resources Protection Plan for the Naval Air Station Whidbey Island, Washington." Report prepared for U.S. Navy Engineering Field Activity Northwest. San Francisco, CA: Dames and Moore.

Boldt, George H. 1974. United States of America, Plaintiff, Quinault Tribe of Indians on its own behalf and on behalf of the Queets Band of Indians, et al., Intervenor-Plaintiffs, v. STATE OF WASHINGTON, Defendant, Thor C. Tollefson, Director, Washington State Department of Fisheries, et al., Intervenor-Defendants. Civ. No. 9213. United States District Court for the

Western District of Washington, Tacoma Division. 384 F. Supp. 312; 1974 U.S. Dist. LEXIS 12291. Available on the Internet at <http://www.ccrh.org/comm/river/legal/boldt.htm>.

DoN (Department of the Navy). 1993. Demolition Training Range Environmental Assessment. Naval Air Station, Whidbey Island Seaplane Base. Oakharbor, Washington.

DoN. 1997. Archaeological Resources Assessment and Protection Plan for the Naval Air Station Whidbey Island, Island County, Washington. Prepared for Engineering Field Activity Northwest, Naval Facilities Engineering Command, Poulsbo, Washington. Seattle, Washington: Historical Research Associates, Inc.

DoN. 2002. Integrated Cultural Resources Management Plan, Naval Air Station Whidbey Island, Washington.

DoN. 2005a. Final Close Out Report, Naval Magazine Indian Island, Port Hadlock, Washington. Department of the Navy, Naval Facilities Engineering Command, Engineering Field Activity Northwest, Poulsbo, Washington.

DoN. 2005b. Final Environmental Assessment for Replacement of EA-6B Aircraft with EA-18G Aircraft at Naval Air Station Whidbey, Island, Washington. U. S. Department of the Navy.

DoN. 2006. Marine Resources Assessment for the Pacific Northwest Operating Area: Final Report. Prepared for: Department of the Navy, Commander, U.S. Pacific Fleet, by Geo-Marine, Inc. Plano, Texas.

DoN. 2007. Reference Guide to Historic Properties. Accessed on the internet 18 November 2007 at: https://www.denix.osd.mil/denix/Public/ES-Programs/Conservation/Legacy/Ref-Guide/refguide.html.

FAA (Federal Aviation Administration). 1985. Aviation Noise Effects. Washington, DC: Internet web site accessed 6 August 2007 at: http://www.nonoise.org/library/ane/ane.htm#sect2.0.

HistoryLink. 2008. HistoryLink.org, the Online Encyclopedia of Washington State History. Accessed 20 May 2008 at: http://www.historylink.org/essays.

Marino, C. 1990. “History of Western Washington Since 1846.” In: Northwest Coast, edited by Wayne Suttles, pp. 169-179. Washington, D.C.: Smithsonian Institution.

Naval Historical Center. 2008. “Casualties: U.S. Navy and Coast Guard Vessels, Sunk or Damaged Beyond Repair during World War II, 7 December 1941-1 October 1945.” Accessed on the internet 28 January 2008 at: http://www.history.navy.mil/faqs/faq82-1.htm.

NMFS-NWR (National Marine Fisheries Service-Northwest Region). 2004. Puget Sound chinook harvest resource management plan. Final environmental impact statement. Volume 2. Seattle, Washington: National Marine Fisheries Service.

NOAA (National Oceanic and Atmospheric Administration). 1993. Olympic Coast National Marine Sanctuary Final Environmental Impact Statement/Management Plan, Volume I. NOAA, Sanctuaries and Reserves Division.

NOAA. 2008a. Automated Wreck and Obstruction Information System. Accessed on the internet 2 February 2008 at http://chartmaker.ncd.noaa.gov/hsd/awois/contus/wash.htm.

NOAA. 2008b. Olympic Coast National Marine Sanctuary official website. Accessed on the internet 1 February 2008 at: http://olympiccoast.noaa.gov/.

Northern Maritime Research. 2007. Wreck Reports, accessed 19 November 2007 on the internet at: (http://northernmaritimeresearch.com/shipwrecks-causes.html).

NPS (National Park Service). 2008a. History and Culture. NPS website accessed 01 February 2008 at: http://www.nps.gov/ebla/historyculture/index.htm.

NPS. 2008b. National NAGPRA Website. Accessed 01 February 2008 at: http://home.nps.gov/nacd/NACD. National Park Service, Washington, D.C.

Olympic Coast National Marine Sanctuary. 2008. Shipwrecks and Maritime History. Accessed on the internet 01 February 2008 at: http://olympiccoast.noaa.gov/living/history_and_culture/shipwrecks/welcome.html.

Stojanowski, C.M. 2002. Hydrodynamic Sorting in a Coastal Marine Skeletal Assemblage." International Journal of Osteoarchaeology, 12:259-278.

Sutherland, L. 1990. Assessment of Potential Structural Damage from Low-Altitude Subsonic Aircraft Wyle Laboratories Research Report WR 89-16 cited in Navy 2005b.)

Suttles, W. 1990. "Introduction." In: Northwest Coast, edited by Wayne Suttles, pp. 1-15. Washington, D.C.: Smithsonian Institution.

Tiller, Veronica E. Verlarde. 2005. Tiller's Guide to Indian Country: Economic Profiles of American Indian Reservations. Albuquerque, NM: BowArrow Publishing Company.

U.S. District Court. 1974. The Boldt Decision, the Hon. George H. Boldt. Accessed 19 November 2007 on the internet at: http://www.und.edu/dept/indian/Treaties/Boldt%20Decision %201974.pdf.

Wessen, G.C. 1988. Prehistoric Cultural Resources of Island County, Washington. A Report Prepared for the Washington State Department of Community Development, Office of Archaeology and Historic Preservation. Seattle, WA: Wessen & Associates.

Woods, Fronda. 2005. "Who's in Charge of Fishing?" Oregon Historical Quarterly 106(3). Available on the Internet at <http://www.historycooperative.org/journals/ohq/106.3/woods.html>.

3.13 TRAFFIC

City Data 2008. http://www.city-data.com/. Accessed 8 Mar 2008.

Wicker 2008. E-mail and conversation with Harvey Wicker Lieutenant United States Navy (USN), NASWI ATC facility officer. 22 Feb 2008, 27 Feb 2008.

3.14 SOCIOECONOMICS

PacFin 2008. http://www.psmfc.org/pacfin/overview.html. Accessed Feb 7 2008.

U.S. Department of the Navy. 2007. Environmental Assessment: Joint Task Force Exercises and Composite Training Unit Exercises. Prepared for Commander, U.S. Pacific Fleet and Commander, THIRD Fleet.

Washington State Office of Financial Management 2007. http://www.ofm.wa.gov/. Accessed Feb 5 2008.

Washington Ports 2008. http://www.washingtonports.org/. Accessed Jan 17 2008.

U.S. Department of Transportation 2007. http://www.bts.gov. 13 June 2007.

U.S. Coast Guard 2008. http://www.navcen.uscg.gov/lnm/d13/ Accessed Feb 5 2008.

Washington Department of Ecology 2004. http://www.ecy.wa.gov/. Accessed Feb 6 2008.

3.15 ENVIRONMENTAL JUSTIC AND PROTECTION OF CHILDREN

U.S. Census Bureau, Census 2000

3.16 PUBLIC SAFETY

DoD (Department of Defense). 1981. DoD Directive 4540.1, "Use of Airspace by U.S. Military Aircraft and Firings Over the High Seas".

DoN (Department of the Navy). 1981. OPNAVINST 3770.4A, "Use of Airspace by U.S. Military Aircraft and Firing Over the High Seas."

DoN. 1993. Commander Naval Surface Force, U.S. Pacific Fleet (COMNAVSURFPAC) Instruction 3120.8F.

DoN. 1997. Manual of the Third Fleet Operating Areas, FACSFACDINST 3120.1D, p. 1-78.

DoN. 1999. Southern California Offshore Range Users Manual. FACSFACDINST 3550.1. Naval Air Station North Island, San Diego, CA.

DoN. 2000. Explosive Ordnance Disposal (EOD) activities at Crescent Harbor, Indian Island, and Floral Point.

DoN. 2001. Naval Sea Systems Command (NAVSEA) OP 5, Ammunition and Explosives Ashore: Safety Regulations for Handling, Storing, Production, Renovation, and Shipping.

DoN. 2004. Southern California Offshore Range Users Manual. FACSFACDINST 3550.1. Naval Air Station North Island, San Diego, CA.

NMFS (National Marine Fisheries Service). 2008. Endangered Species Act - Section 7 Consultation Biological Opinion And Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. United States Navy Explosive Ordnance Disposal Operations, Puget Sound; Whidbey Island, Island County, HUC 171100190301, Port Townsend, Jefferson County, HUC 171100190803, and Bangor, Kitsap county, HUC 171100180801 Washington. NMFS Tracking Number: 2001/00063.

4 CUMULATIVE

Andrew, R.K., B.M. Howe,.and J.A. Mercer. 2002. Ocean ambient sound: Comparing the 1960s with the 1990s for a receiver off the California coast. Journal of the Acoustic Society of America. 3:65-70.

Arveson, P.T. and D.J. Vendittis, 2000. "Radiated noise characteristics of a modern cargo ship," Journal of the Acoustic Society of America, 107(1):118-129.

Baird, R.W. and A.M. Gorgone. 2005. False Killer Whale Dorsal Fin Disfigurements as a Possible Indicator of Long-Line Fishery Interactions in Hawaiian Waters. Pacific Science. 59:593-601.

Baird, R.W., P.J. Stacey, D.A. Duffus, and K.M. Langelier. 2002. An evaluation of gray whale (*Eschrichtius robustus*) mortality incidental to fishing operations in British Columbia, Canada. Journal of Cetacean Research and Management. 4:289-296.

Bauer, G.B., M. Fuller, A. Perry, J.R. Dunn, and J. Zoeger. 1985. Magnetoreception and biomineralization of magnetite in cetaceans. IN: J.L. Kirschvink, D.S. Jones and B.J. MacFadden, eds. Magnetite Biomineralization and Magnetoreception in Organisms. Plenum Press, New York. pp. 489-507.

Borell, A. 1993. PCB and DDTs in blubber of cetaceans from the northeastern North Atlantic. Marine Pollution Bulletin. 26:146-151.

Brabyn, M.W. and I.G. McLean. 1992. Oceanography and Coastal Topography of Herd-Stranding Sites for Whales in New Zealand. Journal of Mammalogy. 73:469-476.

Campagna, C., V. Falabella and M. Lewis. 2007. Entanglement of southern elephant seals in squid fishing gear. Marine Mammal Science. 23:414-418.

Carretta JV, Forney KA, Muto MM, Barlow J, Baker J, Lowry M. 2004. U.S. Pacific marine mammal stock assessments: 2003. NOAA Technical Memorandum NMFS-SWFSC-358. Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, CA.

CEQ 2007. Considering Cumulative Effects Under the National Environmental Policy Act. Council on Environmental Quality, January 1997. p. 17-20.

CFR 2007. http://www.csc.noaa.gov/cz/2007/Coastal_Zone_07_Proceedings/PDFs/Tuesday_Abstracts/3369.Anderson.pdf

Chambers, S. and R.N. James. 2005. Sonar termination as a cause of mass cetacean strandings in Geographe Bay, south-western Australia. Acoustics 2005, Acoustics in a Changing Environment. Proceedings of the Annual Conference of the Australian Acoustical Society, November 9 - 11, 2005, Busselton, Western Australia.

Cockcroft, V.G., G. Cliff, and G.J.B. Ross. 1989. Shark predation on Indian Ocean bottlenose dolphins (*Tursiops truncates)* off Natal, South Africa. South African Journal of Zoology. 24:305-310.

Conner, R.C. 2000. Group living in whales and dolphins. IN: J. Mann, R.C. Conner, P.L. Tyack, and H. Whitehead, eds. Cetacean Societies: Field Studies of Dolphins and Whales. University of Chicago Press, Chicago. pp. 199-218.

Constantine, R., I. Visser, D. Buurman, R. Buurman, and B. McFadden. 1998. Killer whale (*Orcinus orca*) predation on dusky dolphins (*Lagenorhynchus obscurus*) in Kaikoura, New Zealand. Marine Mammal Science. 14:324-330.

Crocker, D.E., D.P. Costa, B.J. Le Boeuf, P.M. Webb, and D.S. Houser. 2006. Impacts of El Niño on the foraging behavior of female northern elephant seals. Marine Ecology Progress Series. 309

Culik, B.M. 2002. Review on Small Cetaceans: Distribution, Behaviour, Migration and Threats, United Nations Environment Programme, Convention on Migratory Species. Marine Mammal Action Plan/Regional Seas Reports and Studies. No. 177: 343 pp.

de Stephanis, R. and E. Urquiola. 2006. Collisions between ships and cetaceans in Spain, Report to the Scientific Committee of the International Whaling Commission Annual Meeting St Kitts SC/58/BC5: 6 pp.

DJC 2008. Company pulls plan for Oregon wave energy park. Daily Journal of Commerce (Portland, OR), Apr 8, 2008

Dudok van Heel, W.H. 1966. Navigation in Cetaceans. IN: K.S. Norris, eds. Whales, Dolphins, and Porpoises. University of California Press, Berkeley, CA. pp. 597-606.

Dunn, J.L., J.D. Buck, and T.R. Robeck. 2001. Bacterial diseases of cetaceans and pinnipeds. IN: L.A. Dierauf and F.M.D. Gulland, eds. CRC Handbook of Marine Mammal Medicine. CRC Press, Boca Raton, FL.

Evans, P.G.H, P. Anderwald & M.E. Baines 2003. UK Cetacean Status Review. Report to English Nature & Countryside Council for Wales. Sea Watch Foundation, Oxford, UK.

Finneran, J.J., C.E. Schlundt, D.A. Carder, J.A. Clark, J.A. Young, J.B. Gaspin, and S.H. Ridgway. 2000. Auditory and behavioral responses of bottlenose dolphins (*Tursiops truncatus*) and a beluga whale (*Delphinapterus leucas*) to impulsive sounds resembling distant signatures of underwater explosions. Journal of the Acoustical Society of America. 108:417-431.

Finneran, J.J., R. Dear, D.A. Carder, and S.H. Ridgway. 2003. Auditory and behavioral responses of California sea lions (*Zalophus californianus*) to single underwater impulses from an arc-gap transducer. Journal of the Acoustical Society of America. 114:1667-1677.

Finneran, J.J., D.A. Carder, C.E. Schlundt and S.H. Ridgway. 2005. Temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*) exposed to mid-frequency tones. Journal of Acoustical Society of America. 118:2696-2705.

Geraci, J.R. and V.J. Lounsbury. 2005. Marine Mammals Ashore: A Field Guide for Strandings. Second Edition), National Aquarium in Baltimore, Baltimore, MD.

Geraci J.R., V. L. Trainer and D. G. Baden. 1999. High affinity binding of red tide neurotoxins to marine mammal brain. Aquatic Toxicology, Vol 46, pp 139–148.

Guinet, C., L.G. Barrett-Lennard, and B. Loyer, 2000. Co-ordinated attack behavior and prey sharing by killer whales at Crozet Archipelago:strategies for feeding on negatively-buoyant prey. Marine Mammal Science. 16:829-834.

Gulland, F.M.D. and A.J. Hall. 2005. The Role of Infectious Disease in Influencing Status and Trends. IN: J.E. Reynolds III, W.F. Perrin, R.R. Reeves, S. Montgomery, T.J. Ragen. Marine Mammal Research. John Hopkins University Press, Baltimore. pp. 47-61.

Gulland, F.M.D. and A.J. Hall. 2007. Is marine mammal health deteriorating? Trends in global reporting of marine mammal disease. EcoHealth. 4:135-150.

Harwood, J. 2002. Mass Die-offs. IN: W.F. Perrin, B. Würsig and J.G.M. Thewissen. Encyclopedia of Marine Mammals. Academic Press, San Diego: pp. 724-726.

Heithaus, M.R. 2001. Shark attacks on bottlenose dolphins (*Tursiops aduncus*) in Shark Bay, Western Australia: Attack rate, bite scar frequencies and attack seasonality. Marine Mammal Science. 17:526-539.

Hickie, B.E., R.W. Macdonald, J.K.B. Ford and P.S. Ross, 2007. “Killer whales (Orcinus orca) face protracted health risks associated with lifetime exposure to PCBs," Environmental Science and Technology, 41(18):6613-9.

Hiruki, L.M., M.K. Schwartz, and P.L. Boveng. 1999. Hunting and social behaviour of leopard seals (*Hydrurga leptonyx*) at Seal Island, South Shetland Islands, Antarctica. Journal of Zoology. 249:97-109.

ICES. 2005. Answer to DG Environment request on scientific information concerning impact of sonar activities on cetacean populations. International Council for the Exploration of the Sea. 5 pp.

Jasny, M., J. Reynolds, C. Horowitz, and A. Wetzler, 2005. Sounding the depths II: The rising toll of sonar, shipping and industrial ocean noise on marine life. Natural Resources Defense Council Report, New York, New York. 84 pp.

Kirschvink, J.L., A.E. Dizon, J.A. Westphal. 1986. Evidence from strandings for geomagnetic sensitivity in cetaceans. Journal of Experimental Biology. 120:1-24.

Klinowska, M. 1986. Cetacean Live Stranding Dates Relate to Geomagnetic Disturbances. Aquatic Mammals. 11:109-119.

Klinowska, M. 1985. Cetacean Live Stranding Sites Relate to Geomagnetic Topography. Aquatic Mammals. 11:27-32.

Knowlton, A.R., and Kraus, S.D. 2001. Mortality and serious injury of northern right whales (Eubalaena glacialis) in the western North Atlantic Ocean. Journal of Cetacean Research and Management (Special Issue). 2:193-208.

Krahn, M.M., D.P. Herman, D.P., C.O., Matkin, J.W. Durban, L. Barrett-Lennard, D.G. Burrows, M.E. Dahlheim, N. Black, N., R.G. LeDuc, and P.R. Wade, 2007. “Use of chemical tracers in assessing the dietand foraging regions of eastern North Pacific killer whales," Marine Environmental Research, 63, 91–114.

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet and M. Podesta. 2001. Collisions between ships and whales. Marine Mammal Science. 17:35–75.

Le Boeuf, B.J. and J. Reiter. 1991. Biological effects associated with El Nino Southern Oscillation, 1982-83 on northern elephant seals breeding at Ano Nuevo, California. IN: F. Trillmich and K.A. Ono, eds. Pinnipeds and El Nino: Responses to Environmental Stress, Springer-Verlag, Berlin. Pp. 206-218.

Learmonth, J.A., C.D. MacLeod, M.B. Santos, G.J. Pierce, H.Q.P. Crick and R.A. Robinson. 2006. Potential effects of climate change on marine mammals. Oceanography and Marine Biology. 44:431-464.

Maldini, D., L. Mazzuca and S. Atkinson. 2005. Odontocete Stranding Patterns in the Main Hawaiian Islands. 19372002): How Do They Compare with Live Animal Surveys? Pacific Science. 59:55-67.

Mazzuca, L., S. Atkinson, B. Keating and E. Nitta. 1999. Cetacean Mass Strandings in the Hawaiian Archipelago, 1957-1998. Aquatic Mammals. 25:105-114.

McDonald, M.A., J.A Hildebrand, and S.M. Wiggins. 2006. "Increases in deep ocean ambient noise in the Northeast Pacific west of San Nicolas Island, California," Journal of the Acoustical Society of America. 120:711-718.

Moore, S. E. 2005. Long-term Environmental Change and Marine Mammals. IN: J.E. Reynolds III, W.F. Perrin, R.R. Reeves, S. Montgomery, T.J. Ragen. Marine Mammal Research: Conservation Beyond Crisis. John Hopkins University Press, Baltimore. pp 137-147.

Nieri, M., E. Grau, B. Lamarche, A. Aguilar. 1999. Mass mortality of Atlantic spotted dolphins. *Stenella frontalis*) caused by a fishing interaction in Mauritania. Marine Mammal Science. 15:847–854.

NMFS. 2005. Long-Finned Pilot Whale (*Globicephala melas*): Western North Atlantic Stock. Stock Assessment Report. December, 2005.

NMFS. 2007a. http://www.nmfs.noaa.gov/pr/pdfs/health/stranding_fact_sheet.pdf. Accessed 1/29/07

NMFS. 2007b. http://www.afsc.noaa.gov/NMML/education/cetaceans/cetaceastrand.htm Accessed 1/31/07.

NMFS. 2007c. NMFS Marine Mammal Unusual Mortality Events website: http://www.nmfs.noaa.gov/pr/health/mmume/

NMFS. 2008. Endangered Species Act Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. United States Navy Explosive Ordnance Disposal Operations, Puget Sound; Whidbey Island, Island County, HUC 171100190301, Port Townsend, Jefferson County, HUC 171100190803, and Bangor, Kitsap County, HUC 171100180801 Washington. June.

NRC. 2006. Dynamic Changes in Marine Ecosystems: Fishing, Food Webs, and Future Options, Committee on Ecosystem Effects of Fishing: Phase II - Assessments of the Extent of Change and the Implications for Policy, National Research Council.

NRC. 2005. Marine mammal populations and ocean noise: determining when noise causes biologically significant effects. Washington, DC, National Academies Press.

NRC. 2003. Ocean noise and marine mammals. The National Academic Press, Washington D.C. 208 pp.

NRC. 1994. Low-Frequency Sound and Marine Mammals: Current Knowledge and Research Needs. Washington, DC: National Academy Press.

O'Hara, T.M., M.M. Krahn, D. Boyd, P.R. Becker, L.M. Philo, 1999. Organochlorine contaminant levels in eskimo harvested bowhead whales of arctic Alaska. Journal of Wildlife Diseases 35(4):741-752.

O'Hara, T.M. and C. Rice, 1996. Polychlorinated biphenyls. In: A. Fairbrother, L. Locke, and G Hoff (eds). Noninfectious diseases of wildlife, 2nd edition. Iowa State University Press, Ames, Iowa.

O'Shea, T. J., and R.L. Brownell Jr., 1994. Organochlorine and metal contaminants in baleen whales: a review and evaluation of conservation implications. Science of the Total Environment 154:179-200.

PacFIN 2008. http://www.psmfc.org/pacfin/overview.html Accessed June 19 2008

Perrin, W. F. and J. R. Geraci. 2002. Stranding. IN: W.F. Perrin, B. Würsig, and J.G.M. Thewissen, eds. Encyclopedia of Marine Mammals. San Diego, Academic Press: pp. 1192-1197.

Pitman, R. L., L. T. Ballance, S. L. Mesnick, and S. J. Chivers, 2001. Killer whale predation on sperm whales: Observations and implications, Mar. Mammal Sci. 17, 494-507.

Polefka, S., 2004. Anthropogenic Noise and the Channel Islands National Marine Sanctuary. Report by Environmental Defense Center, Santa Barbara, CA. 51 pp.

Read, A.J., P. Drinker and S. Northridge. 2006. Bycatch of Marine Mammals in U.S. and Global Fisheries. Conservation Biology. 20:163-169.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thompson, 1995. Marine mammals and noise, funded by Minerals Management Service, Office of Naval Research, LGL, Ltd., Greeneride Sciences, Inc., and BBN Systems and Technologies under MMS Contract 14-12-0001-30673. San Diego: Academic Press, Inc.

Robinson, S., L. Wynen, and S. Goldsworthy, 1999. "Predation by a Hooker's sea lion (*Phocarctos hookeri*) on a small population of fur seals Arctocephalus spp.) at Macquarie Island," Mar. Mammal Sci. 15, 888-893.

Ross, D., 1976. Mechanics of Underwater Noise. Pergamon Press, New York, 375pp.

Seattle 2007. Seattle pi.com. Plans to dump PCB-tainted soil in Elliott Bay raise concerns. Kristen Millares Bolt with Seattle p-i. September 10, 2007.

Seattle 2008a. Seattle pi.com. Firm fined for toxic dumping in sewers. By Lisa Stiffler with Seattle p-i. March 3, 2006.

Seattle 2008b. Seattle pi.com. Egyptian shipper pays $7.25 million for ocean dumping. William McCall with The Associated Press. April 29, 2008.

Selzer, L.A. and P.M. Payne. 1988. The distribution of white-sided dolphins *(Lagenorhynchus acutus*) and common dolphins (*Delphinus delphis*) vs. environmental features of the continental shelf of the northeastern United States. Marine Mammal Science. 4:141-153

Southall, B.L., 2005. Final Report of the National Oceanic and Atmospheric Administration (NOAA) International Symposium: Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology, 18-19 May 2004. Released 27 April 2005.

USAF (United States Air Force). 1976. Environmental Assessment for the Okanagan Military Operating Area. 25 Air Division / NORAD Region (ADCOM). 26 November 1976.

Vanderlaan, A. S.M. and C.T. Taggart. 2007. Vessel collisions with whales: the probability of lethal injury based on vessel speed. Marine Mammal Science. 23(1): 144-196.

Van Dolah, F.M. 2005. Effects of Harmful Algal Blooms. IN: J.E. Reynolds III, W.F. Perrin, R.R. Reeves, S. Montgomery, T.J. Ragen. Marine Mammal Research. John Hopkins University Press, Baltimore. pp. 85-99.

Visser, I.K.G., J.S. Teppema, and A.D.M.E. Ostrhaus. 1991. Virus infections of seals and other pinnipeds. Reviews in Medical Microbiology. 2:105-114.

Walker, R.J., E.O. Keith, A.E. Yankovsky and D.K. Odell. 2005. Environmental correlates of cetacean mass stranding in sites in Florida. Marine Mammal Science. 21:327-335.

Walker, M.M., J.L. Kirschvink, G. Ahmed and A.E. Dizon. 1992. Evidence that fin whales respond to the geomagnetic field during migration. Journal of Experimental Biology. 171:67-78.

Walsh, M.T., R.Y. Ewing, D.K. Odell and G.D. Bossart. 2001. Mass Stranding of Cetaceans. CRC Handbook of Marine Mammals. L.A. Dierauf and F.M.D. Gulland, CRC Press: pp. 83-93.

Wartzok, D., and Ketten, D. 1999. Marine mammal sensory systems. IN: J.E. Reynolds III and S. A. Rommel, eds. The Biology of Marine Mammals. Smithsonian Institution Press, Washington, DC.

Weise, M.J., D.P. Costa, and R.M. Kudela. 2006. Movement and diving behavior of male California sea lion (*Zalophus californianus*) during anomalous oceanographic conditions of 2005. Geophysical Research Letters. 33:L22S10.

Whitehead, H. 2003. Sperm whales: Social evolution in the ocean. Chicago: University of Chicago Press.

Zeeberg, J., A. Corten and E. de Graaf. 2006. Bycatch and release of pelagic megafauna in industrial trawler fisheries off Northwest Africa. Fisheries Research. 78: 186-195.

5 MITIGATION MEASURES

No References in this section.

6 OTHER CONSIDERATIONS

No References in this section.

7 LIST OF PREPARERS

No References in this section.

9 Distribution List

9 DISTRIBUTION LIST

Following is a list of public officials, government agencies, Native American Tribes and Nations, organizations, and individuals who attended the public scoping meetings, provided comments during the scoping process, or have been identified by the Navy to be on the distribution list for the Northwest Training Range Complex Draft Environmental Impact Statement (DEIS).

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Pacific Beach, WA

Peggy Willis
Seattle, WA

Appendix A

Notice of Intent

DEPARTMENT OF DEFENSE

Department of the Navy

Notice of Intent To Prepare an Environmental Impact Statement/ Overseas Environmental Impact Statement for Navy Training Operations in the Northwest Training Range Complex and Notice of Public Scoping Meetings

AGENCY: Department of the Navy, DoD.

ACTION: Notice.

SUMMARY: Pursuant to section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969, as implemented by the Council on Environmental Quality Regulations (40 CFR Parts 1500–1508), and Executive Order 12114, the Department of the Navy (Navy) announces its intent to prepare an Environmental Impact Statement (EIS)/ Overseas EIS to evaluate the potential environmental effects of maintaining Fleet readiness through the use of the Northwest Training Range Complex (NWTRC) to support current, emerging, and future training activities. The proposed action serves to implement range enhancements to upgrade and modernize range capabilities within the NWTRC thereby ensuring critical Fleet requirements are met. The Navy will invite the U.S. Fish and Wildlife Service and National Marine Fisheries Service to be cooperating agencies in preparation of this EIS/OEIS.

DATES AND ADDRESSES: Five public scoping meetings will be held in Washington, Oregon and California to receive oral and written comments on environmental concerns that should be addressed in the EIS/OEIS. Public scoping meetings will be held at the following dates, times and locations: September 10, 2007, from 6 p.m. to 9 p.m. at Coachman Inn, 32959 State Route 20, Oak Harbor, Washington, September 11, 2007, from 6 p.m. to 9 p.m., at Pacific Beach Fire Hall, 4586 State Route 109, Pacific Beach, Washington, September 12, 2007, from 6 p.m. to 9 p.m., at Grays Harbor College Cafeteria, 1620 Edward P. Smith Drive, Aberdeen, Washington, September 13, 2007, from 6 p.m. to 9 p.m., at Spouting Horn Restaurant, 110 Southeast Highway 101, Depoe Bay, Oregon, and September 15, 2007, from 6 p.m. to 9 p.m., at Eureka's Women's Club, 1531 J Street, Eureka, California.

Each of the five scoping meetings will consist of an informal, open house session with information stations staffed by Navy representatives. Details of the meeting locations and time will be announced in local newspapers. Additional information concerning meeting times will be available on the EIS/OEIS web page located at: *http://www.NWTRangeComplexEIS.com.*

FOR FURTHER INFORMATION CONTACT: Kimberly Kler, Naval Facilities Engineering Command, Northwest, Attention: NWTRC EIS/OEIS, 1101 Tautog Circle Suite 203, Silverdale, Washington, 98315–1101.

SUPPLEMENTARY INFORMATION: The NWTRC consists of airspace, surface operating areas, and land range facilities in the Pacific Northwest. Components of the NWTRC encompass 126,630 nm^2 of surface/subsurface ocean operating area, 33,997 nm^2 of special use airspace, and 22 nm^2 of restricted airspace. The EIS/ OEIS study area lies within the NWTRC, and encompasses surface and subsurface ocean operating areas, land training areas and special use airspace in Washington, and over-ocean special use airspace offshore of Washington, Oregon and northern California. These ranges and operating areas are used to conduct training involving military hardware, personnel, tactics, munitions, explosives, and electronic combat systems. The NWTRC serves as a backyard range for those units homeported in the Pacific Northwest area including those aviation, surface ship, submarine, and Explosive Ordnance Disposal units homeported at Naval Air Station Whidbey Island, Naval Station Everett, Naval Base Kitsap—Bremerton, Naval Base Kitsap—Bangor, and Puget Sound Naval Shipyard.

The purpose of the Proposed Action is to: (1) Achieve and maintain Fleet readiness using the NWTRC to support and conduct current, emerging, and future training activities and research, development, test, and evaluation (RDT&E) events (primarily unmanned aerial vehicles); (2) expand warfare missions supported by the NWTRC, consistent with the requirements of the Fleet Readiness Training Plan (FRTP) and other transformation initiatives; and (3) upgrade and modernize existing range capabilities to enhance and sustain Navy training and RDT&E.

The need for the Proposed Action is to: (1) Maintain current levels of military readiness by training in the NWTRC; (2) accommodate future increases in operational training tempo in the NWTRC and support the rapid deployment of naval units or strike groups; (3) achieve and sustain readiness of ships, submarines, and aviation squadrons using the NWTRC so that they can quickly surge significant combat power in the event of a national crisis or contingency operation and consistent with the FRTP; (4) support the acquisition and implementation of advance military technology into the Fleet; (5) identify shortfalls in range capabilities, particularly training infrastructure and instrumentation, and address through range investments and enhancements; and (6) maintain the long-term viability of the NWTRC while protecting human health and the environment and enhancing the quality and communication capability and safety of the range complex.

The No Action Alternative is the continuation of training and RDT&E. Alternative 1 consists of an increase in the number of training activities from baseline levels and force structure changes associated with the introduction of new weapon systems, vessels, and aircraft into the Fleet. Alternative 2 consists of all elements of Alternative 1. In addition, Alternative 2 includes an increase in the number of training activities over Alternative 1 levels and implementation of range enhancements.

Environmental issues that will be addressed in the EIS/OEIS, as applicable, include but are not limited to: air quality; airspace; biological resources, including threatened and endangered species; cultural resources; geology and soils; hazardous materials and waste; health and safety; land use; noise; socioeconomics; transportation; and water resources.

The Navy is initiating the scoping process to identify community concerns and local issues that will be addressed in the EIS/OEIS. Federal agencies, state agencies, and local agencies, Native American Indian Tribes and Nations, the public, and interested persons are encouraged to provide oral and/or written comments to the Navy to identify specific issues or topics of environmental concern that the commenter believes the Navy should consider. All comments, written or provided orally at the scoping meetings, will receive the same consideration during EIS/OEIS preparation. Written comments must be postmarked no later than September 29, 2007, and should be mailed to: Naval Facilities Engineering Command, Northwest, 1101 Tautog Circle, Suite 203, Silverdale, Washington, 98315–1101, Attention: Ms. Kimberly Kler—NWTRC EIS/OEIS.

Dated: July 25, 2007.

M.C. Holley,

Lieutenant Commander, Office of the Judge Advocate General, U.S. Navy, Administrative Law Division, Alternate Federal Register Liaison Officer.

[FR Doc. E7–14784 Filed 7–30–07; 8:45 am]

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Appendix B

Cooperating Agency Correspondence

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, DC 20350-2000

IN REPLY REFER TO

5090
Ser N456E/7U158218
2 Aug 2007

Dr. William T. Hogarth
Assistant Administrator
National Oceanic and Atmospheric
Administration (NOAA) Fisheries
1315 East West Highway
Silver Spring, MD 20910

Dear Dr. Hogarth:

In accordance with the National Environmental Policy Act (NEPA) and Executive Order 12114, the Department of the Navy (Navy) is initiating the preparation of an Environmental Impact Statement/ Overseas Environmental Impact Statement (EIS/OEIS) to evaluate potential environmental effects of using the Northwest Training Range Complex (NWTRC) to achieve and maintain Fleet readiness and to support and conduct current, emerging, and future training activities and research, development, test, and evaluation (RDT&E) events.

In order to adequately evaluate the potential environmental effects of the Proposed Action, Navy and the National Marine Fisheries Service would need to work together on acoustic effects to marine species protected under the Marine Mammal Protection Act (MMPA) and the Endangered Species Act. To assist in this effort and in accordance with 40 CFR Part 1501 and the Council on Environmental Quality Cooperating Agency guidance issued on January 30, 2002, Navy requests NMFS serve as a cooperating agency for the development of the NWTRC EIS/OEIS.

The Proposed Action for the Navy NWTRC EIS/OEIS is to:

- Maintain baseline operations at current levels;
- Increase training operations from current levels as necessary to support the Fleet Readiness Training Plan;
- Accommodate mission requirements associated with force structure change;
- Implement enhanced range complex capabilities;

- Increase and accommodate planned RDT&E events (primarily Unmanned Aerial Vehicles).

The Proposed Action will further our statutory obligations under Title 10 of the United States Code governing the roles and responsibilities of the Navy.

The No Action Alternative is the continuation of training activities and major range events in the NWTRC at the current level. Two action alternatives are proposed to accomplish the Proposed Action. Alternative 1 consists of an increase in the number of training activities, from levels described in the No Action Alternative, along with force structure changes associated with the introduction of new weapon systems, vessels, and aircraft into the Fleet. Alternative 2 consists of all elements of Alternative 1 with an increase in the number of training activities and implementation of range enhancements.

The EIS/OEIS will address measurably foreseeable activities in the particular geographical areas affected by the No-Action Alternative and action alternatives. This EIS/OEIS will analyze the effects of sound in the water on marine mammals in the areas where NWTRC activities occur. In addition, other environmental resource areas that will be addressed applicable in the EIS/OEIS include: air quality; airspace; biological resources, including threatened and endangered species; cultural resources; geology and soils; hazardous materials and waste; health and safety; land use; noise; socioeconomics; transportation; and water resources.

As the lead agency, the Navy will be responsible for overseeing preparation of the EIS/OEIS that includes but is not limited to the following:

- Gathering all necessary background information and preparing the EIS/OEIS and all necessary permit application associated with acoustic issues on the underwater ranges.

- Working with NMFS personnel to determine the method of estimating potential effects to protected marine species, including threatened and endangered species.

- Determining the scope of the IES/OEIS, including the alternatives evaluated.

- Circulating the appropriate NEPA documentation to the general public and any other interested parties.

- Scheduling and supervising meetings held in support of the NEPA process, and compiling any comments received.

- Maintaining an administrative record and responding to any Freedom of Information Act requests relating to the EIS/OEIS.

As a cooperating agency, the Navy requests NMFS support the Navy in the following manner:

- Provide timely comments after the Agency Information Meeting (which will be held at the onset of the EIS/OEIS process) and on working drafts of the EIS/OEIS documents. The Navy requests that comments on draft EIS/OEIS documents be provided within 21 calendar days.

- Respond to Navy requests for information. Timely NMFS input will be critical to ensure a successful NEPA process.

- Coordinate, to the maximum extent practicable, any public comment periods that is necessary in the MMPA permitting process with the Navy's NEPA public comment periods.

- Participate, as necessary, in meetings hosted by the Navy for discussion of EIS/OEIS related issues.

- Adhere to the overall project schedule as agreed upon by the Navy and NMFS.

- Provide a formal, written response to this request.

The Navy views this agreement as important to the successful completion of the NEPA process for the Northwest Training Range Complex EIS/OEIS. It is Navy's goal to complete the analysis as expeditiously as possible, while using the best scientific information available. NMFS assistance will be invaluable in this endeavor.

My point of contact for this action is Ms. Karen M. Foskey, (703) 602-2859, email:Karen.Foskey@navy.mil.

Sincerely,

WILLIAM G. MATTHEIS
Acting Director, Environmental
Readiness Division (OPNAV N45)

Copy to:
Deputy Assistant Secretary of the Navy (Environment)
Office of Assistant General Counsel (Installation & Environment)
Commander, U.S. Fleet Forces Command (N73, N77)
Commander, U.S. Pacific Fleet (N01CE, N7)
Commander, Naval Installations Command (N45)
Commander, Navy Region Northwest (N40)
Commander, Navy Region Southwest (N40)

DEPARTMENT OF THE NAVY
COMMANDER
UNITED STATES PACIFIC FLEET
250 MAKALAPA DRIVE
PEARL HARBOR, HAWAII 96860-3131

IN REPLY REFER TO:
5090
N01CEB/0692
9 Aug 07

Ren Lohoefener
Regional Director
U.S. Fish & Wildlife Service – Pacific Region
911 NE 11th Ave
Portland, OR 97232

Dear Mr. Lohoefener:

In accordance with the National Environmental Policy Act (NEPA), the Department of the Navy (Navy) is initiating the preparation of an Environmental Impact Statement (EIS)/Overseas EIS (OEIS) to support decisions by the Navy concerning the Proposed Action to increase usage and to enhance capability of the Northwest Training Range Complex (NWTRC). In order to adequately evaluate the potential environmental effects of the Proposed Action on threatened and endangered species, the Navy is requesting, in accordance with 40 CFR Part 1501 and the Council on Environmental Quality Cooperating Agency guidance issued on January 30, 2002, that U.S. Fish & Wildlife Service serve as a cooperating agency for the development of the EIS/OEIS.

The No Action Alternative is the continuation of training activities and major range events in the NWTRC. Two action alternatives are proposed to accomplish the Proposed Action. Alternative 1 consists of an increase in the number of training activities from levels described in the No Action Alternative, along with force structure changes associated with the introduction of new weapon systems, vessels, and aircraft into the Fleet. Alternative 2 consists of all elements of Alternative 1 with an increase in the number of training activities and implementation of range enhancements.

The purpose of the proposed action is to:

- Achieve and maintain Fleet readiness using the NWTRC to support and conduct current, emerging, and future training activities and research, development, test, and evaluation (RDT&E) events (primarily Unmanned Aerial Vehicles);

1

- Expand Warfare Missions supported by the NWTRC, consistent with the requirements of the Fleet Readiness Training Plan (FRTP) and other transformation initiatives; and

- Upgrade/modernize existing range capabilities to enhance and sustain Navy training and RDT&E events.

The EIS/OEIS will address measurably foreseeable activities in the particular geographical areas affected by the No-Action Alternative and action alternatives. The EIS/OEIS will also analyze the potential impacts of additional training missions. This EIS/OEIS will analyze the effects of sound in the water on marine mammals in the areas where NWTRC activities occur. In addition, other environmental resource areas that will be addressed as applicable in the EIS/OEIS include but not limited to: air quality; airspace; biological resources, including threatened and endangered species; cultural resources; geology and soils; hazardous materials and waste; health and safety; land use; noise; socioeconomics; transportation; and water resources.

As the lead agency, the Navy will be responsible for overseeing preparation of the EIS/OEIS that includes but is not limited to the following:

- Gathering all necessary background information and preparing the EIS/OEIS.

- Working with U.S. Fish & Wildlife Service personnel to evaluate potential impacts of changes and enhancements on wildlife refuges, critical habitat, and wildlife resources including threatened and endangered species.

- Determining the scope of the EIS/OEIS, including the alternatives evaluated.

- Circulating the appropriate NEPA documentation to the general public and any other interested parties.

- Scheduling and supervising meetings held in support of the NEPA process, and compiling any comments received.

5090
N01CEB/0692
9 Aug 07

- Maintaining an administrative record and responding to any Freedom of Information Act requests relating to the EIS/OEIS.

As a cooperating agency, the Navy requests the U.S. Fish & Wildlife Service support the Navy in the following manner:

- Providing timely comments throughout the EIS process, to include, on working drafts of the EIS/OEIS documents. The Navy requests that comments on draft EIS/OEIS documents be provided within 30 calendar days.

- Responding to Navy requests for information. Timely U.S. Fish & Wildlife Service input will be critical to ensure a successful NEPA process.

- Participating, as necessary, in meetings hosted by the Navy for discussion of EIS/OEIS related issues.

- Adhering to the overall schedule as set forth by the Navy.

- Providing a formal, written response to this request.

My point of contact for this is Carolyn L. Winters, (360) 315-5092 or at Email: carolyn.winters@navy.mil.

Sincerely,

J. P. RIOS
Captain, U.S. Navy
Deputy Fleet Civil Engineer
By direction

Copy to:
Chief of Naval Operations (N45)
Commander, U.S. Fleet Forces Command (N73, N77)
Commander, U.S. Pacific Fleet (N7)
Commander, Naval Installations Command (N45)
Commander, Navy Region Northwest (N40)
Commander, Navy Region Southwest (N40)
Commander, Naval Facilities Engineering Command, Northwest (N45)
Commander, Naval Facilities Engineering Command, Soqthwest (N45)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1315 East-West Highway
Silver Spring, Maryland 20910

THE DIRECTOR

SEP : / 2007

William G. Mattheis
Acting Director, Environmental Readiness Division
Department of the Navy
2000 Navy Pentagon
Washington, DC 20350-2000

Dear Mr. Mattheis:

Thank you for your letter requesting that NOAA's National Marine Fisheries Service (NMFS) be a cooperating agency in the preparation of an Environmental Impact Statement (EIS) to evaluate potential environmental effects of using the Department of the Navy's Northwest Training Range Complex to achieve and maintain military readiness and to support and conduct training activities and research, development, test, and evaluation events.

We support the Navy's decision to prepare an EIS on these activities and agree to be a cooperating agency, due, in part, to our responsibilities under section 101(a)(5)(A) of the Marine Mammal Protection Act and section 7 of the Endangered Species Act. As agreed upon with Navy staff, NMFS staff will provide comments on draft EISs to the Navy within 28 days of receipt of the document. Otherwise, NMFS will make every effort to support the Navy in the specific ways described in your letter.

If you need any additional information, please contact Ms. Jolie Harrison at (301) 713-2289, ext. 166.

Sincerely,

William T. Hogarth, Ph.D.

THE ASSISTANT ADMINISTRATOR
FOR FISHERIES

Appendix C

Air Emissions Calculations

Table C-1. Surface Ship Air Emissions—No Action Alternative

Scenario	Type Training	Number of Ships	Program Totals	Nomenclature	Ship/Boat Type	Vessel Mode	Ship Time on Range (hrs)	Percent at Each Power Level	Total Time on Range (hrs)	Percentage 0-3 nm from shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore	Total Time 3-12 nm from shore	Total Time >12 nm from shore	Emissions Factors (lb/hr) CO	NOx	HC	SOx	PM10	Emissions 0-3 nm Offshore (lbs) CO	Nox	HC	Sox	PM	Emissions 3-12 nm Offshore - US Territory (lbs) CO	Nox	HC	Sox	PM	Emissions >12 nm Offshore - Outside US Territory CO	Nox	HC	Sox	PM
							Hours	%	Hours	Percent			Hours																						
Training Exercises																																			
1	Air Combat Maneuvers	0																																	
2	A-A Missiles	0																																	
3	S-A Gunnery Exercise	17		DDG	Guided Missile Destroyer	DDG-2	3.0	100%	51.0	0%	0%	100%	0.0	0.0	51.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5303.5	2493.9	409.5	914.9	125.5
		51		FFG	Guided Missile Frigate	FFG-2	3.0	100%	153.0	0%	0%	100%	0.0	0.0	153.0	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10223.5	10361.2	1194.9	1770.2	497.3
		4		AOE	Logistics/Support	AOE-1	3.0	100%	12.0	0%	0%	100%	0.0	0.0	12.0	3.73	22.0	2.8	66.1	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.8	263.9	33.5	793.7	159.4
4	S-A Missiles	0		CVN	Nuclear Carrier (No emissions)		4.0			0%	0%	100%	0.0	0.0	0.0																				
5	S-S GUNEX	4		CVN	Nuclear Carrier (No emissions)		2.0	100%	8.0	0%	0%	100%	0.0	0.0	8.0																				
		23		DDG	Guided Missile Destroyer	DDG-1	2.0	100%	46.0	0%	0%	100%	0.0	0.0	46.0	102.98	47.3	8.1	17.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4737.1	2177.6	372.6	783.8	108.1
		70		FFG	Guided Missile Frigate	FFG-1	2.0	100%	140.0	0%	0%	100%	0.0	0.0	140.0	65.75	66.4	7.9	10.9	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9205.0	9289.0	1104.6	1524.6	439.6
		2		AOE	Logistics/Support	AOE-1	2.0	100%	4.0	0%	0%	100%	0.0	0.0	4.0	3.73	22.0	2.8	66.1	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.9	88.0	11.2	264.6	53.1
6	A-S BOMBEX	0																																	
7	SINKEX	2		CG	Cruiser	CG-2	8.0	100%	16.0	0%	0%	100%	0.0	0.0	16.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1724.5	753.9	141.1	336.3	42.1
		4		DDG	Guided Missile Destroyer	DDG-2	8.0	100%	32.0	0%	0%	100%	0.0	0.0	32.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3327.7	1564.8	257.0	574.1	78.7
		2		FFG	Guided Missile Frigate	FFG-2	8.0	100%	16.0	0%	0%	100%	0.0	0.0	16.0	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1069.1	1083.5	125.0	185.1	52.0
		1		SSN	Submarines (No emissions)		8.0	100%	8.0	0%	0%	100%	0.0	0.0	8.0																				
8	MPA ASW TRACKEX	32		SSN	Submarines (No emissions)		8.0	100%	256.0	0%	0%	100%	0.0	0.0	256.0																				
9	EER/IEER ASW																																		
10	Surface Ship ASW TRACKEX	24		DDG	Guided Missile Destroyer	DDG-3	36.0	100%	864.0	1%	2%	97%	8.6	17.3	838.1	106.67	53.8	7.8	21.2	2.8	921.6	465.2	67.7	183.3	24.2	1843.3	930.4	135.5	366.7	48.4	89398.0	45122.2	6570.5	17784.1	2346.6
		36		FFG	Guided Missile Frigate	FFG-3	36.0	100%	1296.0	1%	2%	97%	13.0	25.9	1257.1	120.04	78.1	11.6	16.1	4.3	1555.7	1012.3	150.9	208.4	55.7	3111.4	2024.6	301.7	416.8	111.5	150904.7	98193.6	14632.9	20214.5	5405.6
11	Sub ASW Trackex	64		SSBN	Submarines (No emissions)																														
		32		SSGN	Submarines (No emissions)																														
12	Elec Combat	0		CVN	Nuclear Carrier (No emissions)		2.0	100%	0.0	0%	50%	50%																							
		0		DDG	Guided Missile Destroyer	DDG-2	2.0	100%	0.0	0%	50%	50%	0.0	0.0	0.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		0		FFG	Guided Missile Frigate	FFG-2	2.0	100%	0.0	0%	50%	50%	0.0	0.0	0.0	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		0		AOE	Logistics/Support	AOE-1	2.0	100%	0.0	0%	50%	50%	0.0	0.0	0.0	3.73	22.0	2.8	66.1	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		0		SSBN	Submarines (No emissions)		2.0	100%	0.0	0%	50%	50%																							
		0		SSGN	Submarines (No emissions)		2.0	100%	0.0	0%	50%	50%																							
13	Mine Countermeasures	58		RHIB	Rigid Hull Inflatable Boat	RIB-4	5.0	100%	290.0	100%	0%	0%	290.0	0.0	0.0	0.34	9.1	0.1	1.4	0.2	98.6	2650.6	17.4	417.6	43.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	Land Demolition Training																																		
15	Insertion/Extraction	0																																	
16	NSW Training	35		RHIB	Rigid Hull Inflatable Boat	RIB-4	6.0	100%	210.0	100%	0%	0%	210.0	0.0	0.0	0.34	9.1	0.1	1.4	0.2	71.4	1919.4	12.6	302.4	31.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		70		SDB	Seal Delivery Vehicle																														
17	HARMEX	0																																	
18	ISR	0																																	
19	UAV	0																																	
	Total	426														Total Emissions tons					1.32	3.02	0.12	0.56	0.08	2.48	1.48	0.22	0.39	0.08	137.98	85.70	12.43	22.57	4.65
																Total Emissions within US Territory					3.80	4.50	0.34	0.95	0.16										

Table C-2. Surface Ship Air Emissions—Alternative 1

Scenario	Type Training	Number of Ships	Program Totals	Nomenclature	Ship/Boat Type	Vessel Mode	Ship Time on Range (hrs) (Hours)	Percent at Each Power Level (%)	Total Time on Range (hrs) (Hours)	Percentage 0-3 nm from shore (Percent)	Percentage 3-12 nm from Shore (Percent)	Percentage >12 nm from Shore (Percent)	Total Time 0-3 nm from shore (Hours)	Total Time 3-12 nm from shore (Hours)	Total Time >12 nm from shore (Hours)	Emissions Factors (lb/hr) CO	NOx	HC	SOx	PM10	Emissions 0-3 nm Offshore (lbs) CO	Nox	HC	Sox	PM	Emissions 3-12 nm Offshore - US Territory (lbs) CO	Nox	HC	Sox	PM	Emissions >12 nm Offshore - Outside US Territory CO	Nox	HC	Sox	PM
Training Exercises																																				
1	Air Combat Maneuvers	0																																		
2	A-A Missiles	0																																		
3	S-A Gunnery Exercise	19		DDG	Guided Missile Destroyer	DDG-2	3.0	100%	57.0	0%	0%	100%	0.0	0.0	57.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5927.4	2787.3	457.7	1022.6	140.2
		57		FFG	Guided Missile Frigate	FFG-2	3.0	100%	171.0	0%	0%	100%	0.0	0.0	171.0	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11426.2	11580.1	1335.5	1978.5	555.8
		4		AOE	Logistics/Support	AOE-1	3.0	100%	12.0	0%	0%	100%	0.0	0.0	12.0	3.73	22.0	2.8	66.1	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.8	263.9	33.5	793.7	159.4
4	S-A Missiles	0		CVN	Nuclear Carrier (No emissions)		4.0			0%	0%	100%	0.0	0.0	0.0																				
5	S-S GUNEX	4		CVN	Nuclear Carrier (No emissions)		2.0	100%	8.0	0%	0%	100%	0.0	0.0	8.0																				
		21		DDG	Guided Missile Destroyer	DDG-1	2.0	100%	42.0	0%	0%	100%	0.0	0.0	42.0	102.98	47.3	8.1	17.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4325.2	1988.3	340.2	715.7	98.7
		63		FFG	Guided Missile Frigate	FFG-1	2.0	100%	126.0	0%	0%	100%	0.0	0.0	126.0	65.75	66.4	7.9	10.9	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8284.5	8360.1	994.1	1372.1	395.6
		2		AOE	Logistics/Support	AOE-1	2.0	100%	4.0	0%	0%	100%	0.0	0.0	4.0	3.73	22.0	2.8	66.1	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.9	88.0	11.2	264.6	53.1
6	A-S BOMBEX	0																																		
7	SINKEX	4		CG	Cruiser	CG-2	8.0	100%	32.0	0%	0%	100%	0.0	0.0	32.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3449.0	1507.8	282.2	672.6	84.2
		8		DDG	Guided Missile Destroyer	DDG-2	8.0	100%	64.0	0%	0%	100%	0.0	0.0	64.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6655.4	3129.6	513.9	1148.2	157.4
		4		FFG	Guided Missile Frigate	FFG-2	8.0	100%	32.0	0%	0%	100%	0.0	0.0	32.0	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2138.2	2167.0	249.9	370.2	104.0
		2		SSN	Submarines (No emissions)		8.0	100%	16.0	0%	0%	100%	0.0	0.0	16.0																				
8	MPA ASW TRACKEX	33		SSN	Submarines (No emissions)		8.0	100%	264.0	0%	0%	100%	0.0	0.0	264.0																				
9	EER/IEER ASW																																			
10	Surface Ship ASW TRACKEX	26		DDG	Guided Missile Destroyer	DDG-3	36.0	100%	936.0	1%	2%	97%	9.4	18.7	907.9	106.67	53.8	7.8	21.2	2.8	998.4	503.9	73.4	198.6	26.2	1996.9	1007.9	146.8	397.2	52.4	96847.8	48882.4	7118.1	19266.1	2542.2
		39		FFG	Guided Missile Frigate	FFG-3	36.0	100%	1404.0	1%	2%	97%	14.0	28.1	1361.9	120.04	78.1	11.6	16.1	4.3	1685.4	1096.7	163.4	225.8	60.4	3370.7	2193.3	326.9	451.5	120.7	163480.1	106376.4	15852.3	21899.0	5856.1
11	Sub ASW Trackex	67		SSBN	Submarines (No emissions)																															
		33		SSGN	Submarines (No emissions)																															
12	Elec Combat	0		CVN	Nuclear Carrier (No emissions)		2.0	100%	0.0	0%	50%	50%																								
		0		DDG	Guided Missile Destroyer	DDG-2	2.0	100%	0.0	0%	50%	50%	0.0	0.0	0.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		0		FFG	Guided Missile Frigate	FFG-2	2.0	100%	0.0	0%	50%	50%	0.0	0.0	0.0	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		0		AOE	Logistics/Support	AOE-1	2.0	100%	0.0	0%	50%	50%	0.0	0.0	0.0	3.73	22.0	2.8	66.1	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		0		SSBN	Submarines (No emissions)		2.0	100%	0.0	0%	50%	50%																								
		0		SSGN	Submarines (No emissions)		2.0	100%	0.0	0%	50%	50%																								
13	Mine Countermeasures	68		RHIB	Rigid Hull Inflatable Boat	RIB-4	5.0	100%	340.0	100%	0%	0%	340.0	0.0	0.0	0.34	9.1	0.1	1.4	0.2	115.6	3107.6	20.4	489.6	51.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	Land Demolition Training																																			
15	Insertion/Extraction	0																																		
16	NSW Training	35		RHIB	Rigid Hull Inflatable Boat	RIB-4	6.0	100%	210.0	100%	0%	0%	210.0	0.0	0.0	0.34	9.1	0.1	1.4	0.2	71.4	1919.4	12.6	302.4	31.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		70		SDB	Seal Delivery Vehicle																															
17	HARMEX	0																																		
18	ISR	0																																		
19	UAV	0																																		
	Total	454														**Total Emissions tons**					**1.44**	**3.31**	**0.13**	**0.61**	**0.08**	**2.68**	**1.60**	**0.24**	**0.42**	**0.09**	**151.30**	**93.57**	**13.59**	**24.75**	**5.07**
																Total Emissions within US Territory					**4.12**	**4.91**	**0.37**	**1.03**	**0.17**										

Table C-3. Surface Ship Air Emissions—Alternative 2

Scenario	Type Training	Number of Ships	Program Totals	Nomenclature	Ship/Boat Type	Vessel Mode	Ship Time on Range (hrs)	Percent at Each Power Level	Total Time on Range (hrs)	Percentage 0-3 nm from shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore	Total Time 3-12 nm from shore	Total Time >12 nm from shore	Emissions Factors (lb/hr) CO	NOx	HC	SOx	PM10	Emissions 0-3 nm Offshore (lbs) CO	Nox	HC	Sox	PM	Emissions 3-12 nm Offshore - US Territory (lbs) CO	Nox	HC	Sox	PM	Emissions >12 nm Offshore - Outside US Territory CO	Nox	HC	Sox	PM
							Hours	%	Hours	Percent			Hours																						
Training Exercises																																			
1	Air Combat Maneuvers	0																																	
2	A-A Missiles	0																																	
3	S-A Gunnery Exercise	38		DDG	Guided Missile Destroyer	DDG-2	3.0	100%	114.0	0%	0%	100%	0.0	0.0	114.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11854.9	5574.6	915.4	2045.2	280.4
		113		FFG	Guided Missile Frigate	FFG-2	3.0	100%	339.0	0%	0%	100%	0.0	0.0	339.0	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22652.0	22957.1	2647.6	3922.2	1101.8
		9		AOE	Logistics/Support	AOE-1	3.0	100%	27.0	0%	0%	100%	0.0	0.0	27.0	3.73	22.0	2.8	66.1	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.7	593.7	75.3	1785.8	358.6
4	S-A Missiles	0		CVN	Nuclear Carrier (No emissions)		4.0			0%	0%	100%	0.0	0.0	0.0																				
5	S-S GUNEX	9		CVN	Nuclear Carrier (No emissions)		2.0	100%	18.0	0%	0%	100%	0.0	0.0	18.0																				
		42		DDG	Guided Missile Destroyer	DDG-1	2.0	100%	84.0	0%	0%	100%	0.0	0.0	84.0	102.98	47.3	8.1	17.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8650.3	3976.6	680.4	1431.4	197.4
		126		FFG	Guided Missile Frigate	FFG-1	2.0	100%	252.0	0%	0%	100%	0.0	0.0	252.0	65.75	66.4	7.9	10.9	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16569.0	16720.2	1988.3	2744.3	791.3
		4		AOE	Logistics/Support	AOE-1	2.0	100%	8.0	0%	0%	100%	0.0	0.0	8.0	3.73	22.0	2.8	66.1	13.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.8	175.9	22.3	529.1	106.2
6	A-S BOMBEX	0																																	
7	SINKEX	4		CG	Cruiser	CG-2	8.0	100%	32.0	0%	0%	100%	0.0	0.0	32.0	107.78	47.1	8.8	21.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3449.0	1507.8	282.2	672.6	84.2
		8		DDG	Guided Missile Destroyer	DDG-2	8.0	100%	64.0	0%	0%	100%	0.0	0.0	64.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6655.4	3129.6	513.9	1148.2	157.4
		4		FFG	Guided Missile Frigate	FFG-2	8.0	100%	32.0	0%	0%	100%	0.0	0.0	32.0	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2138.2	2167.0	249.9	370.2	104.0
		2		SSN	Submarines (No emissions)		8.0	100%	16.0	0%	0%	100%	0.0	0.0	16.0																				
8	MPA ASW TRACKEX	34		SSN	Submarines (No emissions)		8.0	100%	272.0	0%	0%	100%	0.0	0.0	272.0																				
9	EER/IEER ASW																																		
10	Surface Ship ASW TRACKEX	26		DDG	Guided Missile Destroyer	DDG-3	36.0	100%	936.0	1%	2%	97%	9.4	18.7	907.9	106.67	53.8	7.8	21.2	2.8	998.4	503.9	73.4	198.6	26.2	1996.9	1007.9	146.8	397.2	52.4	96847.8	48882.4	7118.1	19266.1	2542.2
		39		FFG	Guided Missile Frigate	FFG-3	36.0	100%	1404.0	1%	2%	97%	14.0	28.1	1361.9	120.04	78.1	11.6	16.1	4.3	1685.4	1096.7	163.4	225.8	60.4	3370.7	2193.3	326.9	451.5	120.7	163480.1	106376.4	15852.3	21899.0	5856.1
11	Sub ASW Trackex	67		SSBN	Submarines (No emissions)																														
		33		SSGN	Submarines (No emissions)																														
12	Elec Combat	50		CVN	Nuclear Carrier (No emissions)		2.0	100%	100.0	0%	50%	50%																							
		50		DDG	Guided Missile Destroyer	DDG-2	2.0	100%	100.0	0%	50%	50%	0.0	50.0	50.0	103.99	48.9	8.0	17.9	2.5	0.0	0.0	0.0	0.0	0.0	5199.5	2445.0	401.5	897.0	123.0	5199.5	2445.0	401.5	897.0	123.0
		100		FFG	Guided Missile Frigate	FFG-2	2.0	100%	200.0	0%	50%	50%	0.0	100.0	100.0	66.82	67.7	7.8	11.6	3.3	0.0	0.0	0.0	0.0	0.0	6682.0	6772.0	781.0	1157.0	325.0	6682.0	6772.0	781.0	1157.0	325.0
		25		AOE	Logistics/Support	AOE-1	2.0	100%	50.0	0%	50%	50%	0.0	25.0	25.0	3.73	22.0	2.8	66.1	13.3	0.0	0.0	0.0	0.0	0.0	93.3	549.8	69.8	1653.5	332.0	93.3	549.8	69.8	1653.5	332.0
		25		SSBN	Submarines (No emissions)		2.0	100%	50.0	0%	50%	50%																							
		25		SSGN	Submarines (No emissions)		2.0	100%	50.0	0%	50%	50%																							
13	Mine Countermeasures	68		RHIB	Rigid Hull Inflatable Boat	RIB-4	5.0	100%	340.0	100%	0%	0%	340.0	0.0	0.0	0.34	9.1	0.1	1.4	0.2	115.6	3107.6	20.4	489.6	51.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	Land Demolition Training																																		
15	Insertion/Extraction	0																																	
16	NSW Training	35		RHIB	Rigid Hull Inflatable Boat	RIB-4	6.0	100%	210.0	100%	0%	0%	210.0	0.0	0.0	0.34	9.1	0.1	1.4	0.2	71.4	1919.4	12.6	302.4	31.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		70		SDB	Seal Delivery Vehicle		6.0	100%	420.0	100%	0%	0%	420.0	0.0	0.0																				
17	HARMEX	0																																	
18	ISR	0																																	
19	UAV	0																																	
	Total	901														**Total Emissions tons**					**1.44**	**3.31**	**0.13**	**0.61**	**0.08**	**8.67**	**6.48**	**0.86**	**2.28**	**0.48**	**172.20**	**110.91**	**15.80**	**29.76**	**6.18**
																Total Emissions within US Territory					**10.11**	**9.80**	**1.00**	**2.89**	**0.56**										

Table C-4. Aircraft Air Emissions—No Action Alternative

Scenario	Type Training	A/C Sorties	Nomenclature	Ave. A/C Time on Range (hrs)	Total Time on Range (hrs)	% Below 3,000 ft	Time Below 3,000 ft	Percentage 0-3 nm from shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore	Total Time 3-12 nm from shore	Total Time >12 nm from shore	Scenario	Aircraft	Engines		Fuel Flow	Emission Indices, lbs/1,000 lbs fuel					Emissions Factors (lb/hr)					Emissions 0-3 nm Offshore (lbs)					Emissions 3-12 nm Offshore—US Territory (lbs)					Emissions >12 nm Offshore—Outside US Territory				
No.		No.		Hours	Hours	%	Hours	Percent			Hours			No.	Type	Engine Model	No.	lbs/hr	CO	NOx	HC	SOx	PM10	CO	NOx	HC	SOx	PM10	CO	NOx	HC	SOx	PM	CO	NOx	HC	SOx	PM	CO	NOx	HC	SOx	PM
Training Operations																																											
1	Air Combat Maneuvers	4	FA-18E/F	1.5	6.0			100%							FA-18E/F	F414-GE-400 (assume approach)	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10															
		2021	EA-6B	1.5	3031.5			100%							EA-6B	J52-P-408A (assume approach)	2	4227	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60															
		18	F-16	1.5	27.0			100%							F-16	F110-GE-400 (assume approach)	1	3859	1.35	8.44	0.76	0.40	5.98	5.21	32.57	2.93	1.54	23.08															
2	A-A MISSILEX		EA16G	2.0						100%					EA16G	J52-P-408A (assume approach)	2	4227	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60															
3	S-A GUNEX	18	Learjet	3.0	54.0	50%	27.0	1%	2%	97%	0.27	0.54	26.19		Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47	6.43	1.69	1.23	0.16	1.21	12.85	3.39	2.46	0.31	2.41	623.36	164.34	119.21	15.04	116.99
4	S-A MISSILEX		P-3	3.0		67%		1%	2%	97%					P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06															
			Learjet	3.0		67%		1%	2%	97%					Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47															
			C-130	3.0		67%		1%	2%	97%					C-130	T56-A-425 (assume approach)	4	850	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50															
5	S-S GUNEX																																										
6	A-S BOMBEX	24	P-3	1.0	24.0	90%	21.6	1%	2%	97%	0.22	0.43	20.95		P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06	1.89	8.74	0.43	0.41	4.12	3.77	17.48	0.85	0.83	8.23	183.04	847.80	41.23	40.23	399.26
7	SINKEX	2	E-2	16.0	32.0	10%	3.2			100%			3.20		E-2	T56-A-425 (assume 30% SHP)	2	1100	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73											15.21	56.74	3.45	2.82	27.95
		8	FA-18E/F	16.0	128.0	10%	12.8			100%			12.80		FA-18E/F	F414-GE-400 (assume approach)	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10											92.25	1200.32	12.44	41.46	654.06
		1	P-3	16.0	16.0	10%	1.6			100%			1.60		P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06											13.98	64.74	3.15	3.07	30.49
		2	SH-60B	16.0	32.0	10%	3.2			100%			3.20		SH-60B	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04											24.00	24.58	2.11	1.54	16.13
8	MPA ASW TRACKEX	200	P-3	6.0	1200.0	75%	900.0	5%	10%	85%	45.00	90.00	765.00		P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06	393.12	1820.88	88.56	86.40	857.52	786.24	3641.76	177.12	172.80	1715.04	6683.04	30954.96	1505.52	1468.80	14577.84
9	EER/IEER ASW	10	P-3	6.0	60.0	50%	30.0	17%	17%	66%	5.10	5.10	19.80		P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06	44.55	206.37	10.04	9.79	97.19	44.55	206.37	10.04	9.79	97.19	172.97	801.19	38.97	38.02	377.31
10	Surface Ship ASW TRACKEX																																										
11	Submarine ASW TORPEX																																										
12	Electronic Combat Exercise	13	P-3	1.5	19.5				3%	97%					P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06															
		182	EP-3	1.5	273.0				3%	97%					EP-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06															
		2135	EA-6B	1.5	3202.5				3%	97%					EA-6B	J52-P-408A (assume approach)	2	4227	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60															
13	Mine Countermeasures	10	SH-60B	2.0	20.0	100%	20.0	100%			20.00				SH-60B	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04	150.00	153.60	13.20	9.60	100.80										
14	Land Demolition Training																																										
15	Insertion/Extraction	24	C-130	1.0	24.0			100%							C-130	T56-A-425 (assume approach)	4	850	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50															
		84	SH-60B	2.0	168.0	100%	168.0	100%			168.00				SH-60B	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04	1260.00	1290.24	110.88	80.64	846.72										
16	NSW Training																																										
17	HARMEX	2724	EA-6B	1.5	4086.0				3%	97%					EA-6B	J52-P-408A (assume approach)	2	4227	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60															
18	ISR	94	P-3	6.0	564.0	40%	225.6			100%			225.60		P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06											1970.84	9128.68	443.98	433.15	4299.03
																		hp	lbs/hp-hr																								
19	UAV	12	Scan Eagle	6.0	72.0	100%	72.0	100%			72.00				Scan Eagle	2.5 hp engine	1	2.5	6.68E-03	3.10E-02	2.51E-03	2.05E-03	2.20E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00										
Totals		7586																						Total Emissions tons					0.93	1.74	0.11	0.09	0.95	0.42	1.93	0.10	0.09	0.91	4.89	21.62	1.09	1.02	10.25
																								Total Emissions within US Territory					1.35	3.68	0.21	0.19	1.87										

Table C-5. Aircraft Air Emissions—Alternative 1

Scenario	Type Training	A/C Sorties	Nomenclature	Ave. A/C Time on Range (hrs)	Total Time on Range (hrs)	% Below 3,000 ft	Time Below 3,000 ft	Percentage 0-3 nm from shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore	Total Time 3-12 nm from shore	Total Time >12 nm from shore	Scenario	Aircraft	Engines		Fuel Flow	Emission Indices, lbs/1,000 lbs fuel					Emissions Factors (lb/hr)					Emissions: Emissions 0-3 nm Offshore (lbs)					Emissions 3-12 nm Offshore—US Territory (lbs)					Emissions >12 nm Offshore—Outside US Territory				
		No.		Hours	Hours	%	Hours	Percent			Hours			No.	Type	Engine Model	No.	lbs/hr	CO	NOx	HC	SOx	PM10	CO	NOx	HC	SOx	PM10	CO	NOx	HC	SOx	PM	CO	NOx	HC	SOx	PM	CO	NOx	HC	SOx	PM
Training Operations																																											
1	Air Combat Maneuvers	6	FA-18E/F	1.5	9.0			100%							FA-18E/F	F414-GE-400 (assume approach)	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10															
		2987	EA-6B	1.5	4480.5			100%							EA-6B	J52-P-408A (assume approach)	2	4227	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60															
		27	F-16	1.5	40.5			100%							F-16	F110-GE-400 (assume approach)	1	3859	1.35	8.44	0.76	0.40	5.98	5.21	32.57	2.93	1.54	23.08															
2	A-A MISSILEX	48	EA16G	2.0	96.0					100%					EA16G	J52-P-408A (assume approach)	2	4227	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60															
3	S-A GUNEX	20	Learjet	3.0	60.0	50%	30.0	1%	2%	97%	0.30	0.60	29.10		Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47	7.14	1.88	1.37	0.17	1.34	14.28	3.76	2.73	0.34	2.68	692.63	182.60	132.46	16.71	129.98
4	S-A MISSILEX		P-3	3.0		67%		1%	2%	97%					P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06															
			Learjet	3.0		67%		1%	2%	97%					Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47															
			C-130	3.0		67%		1%	2%	97%					C-130	T56-A-425 (assume approach)	4	850	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50															
5	S-S GUNEX																																										
6	A-S BOMBEX	30	P-3	1.0	30.0	90%	27.0	1%	2%	97%	0.27	0.54	26.19		P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06	2.36	10.93	0.53	0.52	5.15	4.72	21.85	1.06	1.04	10.29	228.80	1059.75	51.54	50.28	499.08
7	SINKEX	4	E-2	16.0	64.0	10%	6.4			100%			6.40		E-2	T56-A-425 (assume 30% SHP)	2	1100	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73											30.41	113.48	6.90	5.63	55.90
		16	FA-18E/F	16.0	256.0	10%	25.6			100%			25.60		FA-18E/F	F414-GE-400 (assume approach)	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10											184.50	2400.64	24.88	82.92	1308.12
		2	P-3	16.0	32.0	10%	3.2			100%			3.20		P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06											27.96	129.48	6.30	6.14	60.98
		4	SH-60B	16.0	64.0	10%	6.4			100%			6.40		SH-60B	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04											48.00	49.15	4.22	3.07	32.26
8	MPA ASW TRACKEX	205	P-3	6.0	1230.0	75%	922.5	5%	10%	85%	46.13	92.25	784.13		P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06	402.95	1866.40	90.77	88.56	878.96	805.90	3732.80	181.55	177.12	1757.92	6850.12	31728.83	1543.16	1505.52	14942.29
9	EER/IEER ASW	11	P-3	6.0	66.0	50%	33.0	17%	17%	66%	5.61	5.61	21.78		P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06	49.01	227.00	11.04	10.77	106.90	49.01	227.00	11.04	10.77	106.90	190.27	881.31	42.86	41.82	415.04
10	Surface Ship ASW TRACKEX																																										
11	Submarine ASW TORPEX																																										
12	Electronic Combat Exercise	14	P-3	1.5	21.0				3%	97%					P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06															
		195	EP-3	1.5	292.5				3%	97%					EP-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06															
		2291	EA-6B	1.5	3436.5				3%	97%					EA-6B	J52-P-408A (assume approach)	2	4227	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60															
13	Mine Countermeasures	12	SH-60B	2.0	24.0	100%	24.0	100%			24.00				SH-60B	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04	180.00	184.32	15.84	11.52	120.96										
14	Land Demolition Training																																										
15	Insertion/Extraction	27	C-130	1.0	27.0			100%							C-130	T56-A-425 (assume approach)	4	850	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50															
		93	SH-60B	2.0	186.0	100%	186.0	100%			186.00				SH-60B	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04	1395.00	1428.48	122.76	89.28	937.44										
16	NSW Training																																										
17	HARMEX	3000	EA-6B	1.5	4500.0				3%	97%					EA-6B	J52-P-408A (assume approach)	2	4227	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60															
18	ISR	100	P-3	6.0	600.0	40%	240.0			100%			240.00		P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06											2096.64	9711.36	472.32	460.80	4573.44
																		hp																									
19	UAV	12	Scan Eagle	6.0	72.0	10%	7.2	100%			7.20				Scan Eagle	2.5 hp engine	1	2.5	6.68E-03	3.10E-02	2.51E-03	2.05E-03	2.20E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00										
		100	Global Hawk	6.0	600.0	10%	60.0	100%			60.00				Global Hawk	2.5 hp engine	1	2.5	6.68E-03	3.10E-02	2.51E-03	2.05E-03	2.20E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00										
	Totals	9204																						**Total Emissions tons**					**1.02**	**1.86**	**0.12**	**0.10**	**1.03**	**0.44**	**1.99**	**0.10**	**0.09**	**0.94**	**5.17**	**23.13**	**1.14**	**1.09**	**11.01**

Table C-6. Aircraft Air Emissions—Alternative 2

Scenario	Type Training	A/C Sorties	Nomenclature	Ave. A/C Time on Range (hrs)	Total Time on Range (hrs)	% Below 3,000 ft	Time Below 3,000 ft	Percentage 0-3 nm from shore	Percentage 3-12 nm from Shore	Percentage >12 nm from Shore	Total Time 0-3 nm from shore	Total Time 3-12 nm from shore	Total Time >12 nm from shore	Aircraft	Engines		Fuel Flow	Emission Indices, lbs/1,000 lbs fuel					Emissions Factors (lb/hr)					Emissions: Emissions 0-3 nm Offshore (lbs)					Emissions 3-12 nm Offshore—US Territory (lbs)					Emissions >12 nm Offshore—Outside US Territory				
		No.		Hours	Hours	%	Hours	Percent			Hours			Type	Engine Model	No.	lbs/hr	CO	NOx	HC	SOx	PM10	CO	NOx	HC	SOx	PM10	CO	NOx	HC	SOx	PM	CO	NOx	HC	SOx	PM	CO	NOx	HC	SOx	PM
Training Operations																																										
1	Air Combat Maneuvers	6	FA-18E/F	1.5	9.0			100%						FA-18E/F	F414-GE-400 (assume approach)	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10															
		2987	EA-6B	1.5	4480.5			100%						EA-6B	J52-P-408A (assume approach)	2	4227	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60															
		27	F-16	1.5	40.5			100%						F-16	F110-GE-400 (assume approach)	1	3859	1.35	8.44	0.76	0.40	5.98	5.21	32.57	2.93	1.54	23.08															
2	A-A MISSILEX	96	EA16G	2.0	192.0					100%				EA16G	J52-P-408A (assume approach)	2	4227	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60															
3	S-A GUNEX	40	Learjet	3.0	120.0	50%	60.0	1%	2%	97%	0.60	1.20	58.20	Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47	14.28	3.76	2.73	0.34	2.68	28.56	7.53	5.46	0.69	5.36	1385.25	365.19	264.92	33.42	259.97
4	S-A MISSILEX	4	P-3	3.0	12.0	67%	8.0	1%	2%	97%	0.08	0.16	7.76	P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06	0.70	3.24	0.16	0.15	1.53	1.40	6.48	0.32	0.31	3.05	67.83	314.16	15.28	14.91	147.95
		4	Learjet	3.0	12.0	67%	8.0	1%	2%	97%	0.08	0.16	7.76	Learjet	TFE 731-2-2B	2	531.76	22.38	5.90	4.28	0.54	4.20	23.80	6.27	4.55	0.57	4.47	1.91	0.50	0.36	0.05	0.36	3.81	1.00	0.73	0.09	0.72	184.79	48.72	35.34	4.46	34.68
			C-130	3.0		67%		1%	2%	97%				C-130	T56-A-425 (assume approach)	4	850	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50															
5	S-S GUNEX																																									
6	A-S BOMBEX	30	P-3	1.0	30.0	90%	27.0	1%	2%	97%	0.27	0.54	26.19	P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06	2.36	10.93	0.53	0.52	5.15	4.72	21.85	1.06	1.04	10.29	228.80	1059.75	51.54	50.28	499.08
7	SINKEX	4	E-2	16.0	64.0	10%	6.4			100%			6.40	E-2	T56-A-425 (assume 30% SHP)	2	1100	2.16	8.06	0.49	0.40	3.97	4.75	17.73	1.08	0.88	8.73											30.41	113.48	6.90	5.63	55.90
		16	FA-18E/F	16.0	256.0	10%	25.6			100%			25.60	FA-18E/F	F414-GE-400 (assume approach)	2	4049	0.89	11.58	0.12	0.40	6.31	7.21	93.77	0.97	3.24	51.10											184.50	2400.64	24.88	82.92	1308.12
		2	P-3	16.0	32.0	10%	3.2			100%			3.20	P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06											27.96	129.48	6.30	6.14	60.98
		4	SH-60B	16.0	64.0	10%	6.4			100%			6.40	SH-60B	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04											48.00	49.15	4.22	3.07	32.26
8	MPA ASW TRACKEX	210	P-3	6.0	1260.0	75%	945.0	5%	10%	85%	47.25	94.50	803.25	P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06	412.78	1911.92	92.99	90.72	900.40	825.55	3823.85	185.98	181.44	1800.79	7017.19	32502.71	1580.80	1542.24	15306.73
9	EER/IEER ASW	12	P-3	6.0	72.0	50%	36.0	17%	17%	66%	6.12	6.12	23.76	P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06	53.46	247.64	12.04	11.75	116.62	53.46	247.64	12.04	11.75	116.62	207.57	961.42	46.76	45.62	452.77
10	Surface Ship ASW TRACKEX																																									
11	Submarine ASW TORPEX																																									
12	Electronic Combat Exercise	28	P-3	1.5	42.0				3%	97%				P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06															
		391	EP-3	1.5	586.5				3%	97%				EP-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06															
		4582	EA-6B	1.5	6873.0				3%	97%				EA-6B	J52-P-408A (assume approach)	2	4227	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60															
13	Mine Countermeasures	12	SH-60B	2.0	24.0	100%	24.0	100%			24.00			SH-60B	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04	180.00	184.32	15.84	11.52	120.96										
14	Land Demolition Training																																									
15	Insertion/Extraction	27	C-130	1.0	27.0			100%						C-130	T56-A-425 (assume approach)	4	850	4.03	6.71	0.97	0.40	3.97	13.70	22.81	3.30	1.36	13.50															
		93	SH-60B	2.0	186.0	100%	186.0	100%			186.00			SH-60B	T700-GE-401C	2	600	6.25	6.40	0.55	0.40	4.20	7.50	7.68	0.66	0.48	5.04	1395.00	1428.48	122.76	89.28	937.44										
16	NSW Training																																									
17	HARMEX	3000	EA-6B	1.5	4500.0				3%	97%				EA-6B	J52-P-408A (assume approach)	2	4227	5.19	6.77	0.84	0.40	10.48	43.88	57.23	7.10	3.38	88.60															
18	ISR	100	P-3	6.0	600.0	40%	240.0			100%			240.00	P-3	T56-A-14 (assume ASUW)	4	1200	1.82	8.43	0.41	0.40	3.97	8.74	40.46	1.97	1.92	19.06											2096.64	9711.36	472.32	460.80	4573.44
																	hp																									
19	UAV	12	Scan Eagle	6.0	72.0	10%	7.2	100%			7.20			Scan Eagle	2.5 hp engine	1	2.5	6.68E-03	3.10E-02	2.51E-03	2.05E-03	2.20E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00										
		100	Global Hawk	6.0	600.0	10%	60.0	100%			60.00			Global Hawk	2.5 hp engine	1	2.5	6.68E-03	3.10E-02	2.51E-03	2.05E-03	2.20E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00										
	Totals	11787																					**Total Emissions tons**					**1.03**	**1.90**	**0.12**	**0.10**	**1.04**	**0.46**	**2.05**	**0.10**	**0.10**	**0.97**	**5.74**	**23.83**	**1.25**	**1.12**	**11.37**
																							Total Emissions within US Territory					**1.49**	**3.95**	**0.23**	**0.20**	**2.01**										

Table C-7. Ordnance Expenditures—Baseline

NOTE: Units of Measure (UOM) for ordnance rounds are 1 each (ea.) and for Demolitions and Other Ordnance are in pounds Net Explosive Weight (NEW).						Emission Factor (lb per lb or lb per item)							Emissions, tons/year						
Ordnance Group	**AQ Data**	**Ordnance Type**	**Quantity Fired**	**NEW ea.**	**UOM/ Cum NEW**	**CO2**	**CO**	**Nox**	**PM10**	**PM2.5**	**SO2**	**Lead**	**CO2**	**CO**	**Nox**	**PM10**	**PM2.5**	**SO2**	**Lead**
BOMB		CBU MK20 ROCKEYE		99	ea.														
	No Data	GBU32I JDAM		385	ea.														
	No Data	LGTR		0	ea.														
		MK76		Neg.	ea.														
	No Data	BDU 48		Neg.	ea.														
		MK82 HE	12	192	ea.		0.3184						0	0.3667968	0	0	0	0	0
	No Data	GBU12 500 lb		192	ea.														
	NA	MK82 INERT	88	0	ea.														
	No Data	BDU 45		0	ea.														
		MK83 HE	4	445	ea.		0.1482						0	0.131898	0	0	0	0	0
	No Data	GBU 16		445	ea.														
	NA	MK83 INERT		0	ea.														
		Total:	**104**																
OTHER ORD	**No AQ data**	**Type**	**No.**	**NEW**															
	CNAP & SPAWAR	EER/IEER AN/SQQ-110	124	4.2	520.8	1.2	0.0044	0.011				0.00004	0.31248	0.0011458	0.0028644	0	0	0	0.000010416
	No Data	BLASTING CAP MK11	2,890	Neg.	0														
	No Data	FIRING DEVICE	97	Neg.	0														
		Fuse	17,340																
	No Data	Igniters	510	Neg.	0														
		GRENADE SIMULATOR		0.0813	0.0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
		Grenades	170	0.0813	13.8	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.0043536	0.0001451	4.35362E-05	0.0001451	0.000104	8.2926E-07	9.6747E-07
	No Data	M1A2 BANGALORE TORP		10.00	0								0	0	0	0	0	0	0
		M7 BANDOLEER MK57 (Claymore mine)		8.16	0		0.15108						0	0	0	0	0	0	0
	AP-42	M112 DEMO CHARGE	1,060	1.20	1272	7.90E-01	2.60E-02	7.90E-03	2.60E-02	1.90E-02		1.70E-04	0.50244	0.016536	0.0050244	0.016536	0.012084	0	0.00010812
	No Data	M700 BLASTING FUSE		0.001	0														
	No Data	MK20 Cable Cutter		0.0028	0.0														
	No Data	MK22 Projectile Unit		Neg.	Neg.														
	No Data	MK36 M0 DEMO CHARGE		4.10	0								0	0	0	0	0	0	0
	No Data	MK75 CHARGE		50.00	0								0	0	0	0	0	0	0
	No Data	MK84 [86] EOD Shaped Charge	4	0.08	0.32								0	0	0	0	0	0	0
	No Data	MK120 NONELEC DET (ft)		0.00001	0.0000														
	No Data	MK123 NONELEC DET (ft)		0.00001	0.0000														
	No Data	MK138 DEMO CHG ASSEMBLY		20.00	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
	No Data	MK140 FLEXIBLE CHARGE		0.04	0														
		MK174	901																
	No Data	PBXN-109 TEST Det Cord		0.0060	0														
	No Data	SIGNAL MK 18(G950) SMOKE		0.23	0														
	No Data	C4 0.5 LB	3	0.50	1.5	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	4.73E-04	1.575E-05	0.000004725	1.575E-05	1.13E-05	0.00000009	0.000000105
	No Data	C4 2.5 LB	51	2.50	127.5	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	4.02E-02	0.0013388	0.000401625	0.0013388	0.000956	0.00000765	0.000008925
	No Data	C4 5 LB	511	5.00	2555	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.804825	0.0268275	0.00804825	0.0268275	0.019163	0.0001533	0.00017885
	No Data	C4 20 LB	65	20.00	1300	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.4095	0.01365	0.004095	0.01365	0.00975	0.000078	0.000091
	No Data	C4 300 LB		1.00	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
	No Data	C4 500 LB		1.00	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
	No Data	TNT Blocks 0.5 lbd		1.00	0		0.398							0					
	No Data	DEMO SHEET	1,105	6.00	6630														
	No Data	DETONATING CORD	34,000	0.006	204														
	No Data	DEMO CHARGE		5.00	0														
	AP-42	SIMULATED ARTILLERY		0.1375	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
		Totals	**-58,831**		**12,625**														
GUNFIRE (Large)	AP-42	155MM HE			ea.	6.51	2.35E+01	1.43E+00	0.496	0.2418		2.26E-03	0	0	0	0	0	0	0
	AP-42	155MM ILL			ea.	1.8	2.62E-02	9.40E-02	3	3		5.80E-05	0	0	0	0	0	0	0
5"/54		5"/54 BLP	1,216		ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.009728	0.01216	0	0.0007296	0.000565	0	0.000003648
		5"/54 HCVT+32 (EOD)			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/54 HECVT			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/54 HEPD			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/54 HEVT			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/54 ILL			ea.	1.50E-02	1.40E-02	3.60E-04	9.20E-04	7.60E-04		1.30E-06	0	0	0	0	0	0	0
		5"54/54 VTNF			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
5"/62		5"/62	500		ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.004	0.005	0	0.0003	0.000233	0	0.0000015
		5"/62 HE-MFF			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/62 HECVT			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/62 HEET			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/62 KEET			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
60mm	AP-42	60MM	630		ea.	2.90E-01	3.00E-02	4.20E-03	3.20E-02	1.70E-02		2.30E-04	0.09135	0.00945	0.001323	0.01008	0.005355	0	0.00007245
		60MM WP			ea.	2.90E-01	3.00E-02	4.20E-03	3.20E-02	1.70E-02		2.30E-04	0	0	0	0	0	0	0
76mm		76MM BLP	560		ea.	1.44E-02	1.80E-02		1.08E-03	8.37E-04		5.40E-06	0.004032	0.00504	0	0.0003024	0.000234	0	0.000001512
	AP-42	81MM HE			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
	AP-42	81MM ILL			ea.	1.50E-02	1.40E-02	3.60E-04	9.20E-04	7.60E-04		1.30E-06	0	0	0	0	0	0	0
CAS	No data	GAU-17 30mm			ea.														
		Total:	**2,906**																
GUNFIRE (small)	AMW 114,1125	20MM	7,200		ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0.000936	0.00126	0.0001296	0.0000936	8.28E-05	0	0.002412
		25MM	15,750		ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0.0020475	0.0027563	0.0002835	0.0002048	0.000181	0	0.00527625
	No Data	30MM EFV Main Gun			ea.														
	AP-42	40MM			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0	0	0	0	0	0	0
	AP-42	40MM HE			ea.	6.60E-02	7.00E-03	1.60E-03	1.30E-02	6.60E-03		7.30E-05	0	0	0	0	0	0	0
	No Data	40MM ILL			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0	0	0	0	0	0	0
	AP-42	40MM PRACTICE			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0	0	0	0	0	0	0
	AP-42	.45 CAL			ea.	2.20E-04	2.60E-04	8.10E-06	3.70E-05	3.10E-05		1.20E-05	0	0	0	0	0	0	0
	AP-42	5.56			ea.	8.70E-04	1.60E-03	8.50E-05	3.90E-05	2.80E-05		5.10E-06	0	0	0	0	0	0	0
	AP-42	5.56 BLANK			ea.	2.30E-04	2.80E-04	2.00E-05	6.90E-06	2.00E-06		9.70E-07	0	0	0	0	0	0	0
	AP-42	.50CAL	58,500		ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0.149175	0.32175	0.0351	0.0090675	0.005558	0	0.00038025
		.50CAL			ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0	0	0	0	0	0	0
	AP-42	.50CAL BLANK			ea.	2.10E-03	1.80E-03	2.80E-05	9.80E-05	8.80E-05		1.20E-05	0	0	0	0	0	0	0
	AP-42	7.62	1,224		ea.	1.20E-03	2.30E-03	9.70E-05	5.10E-05	3.80E-05		4.90E-06	0.0007344	0.0014076	0.000059364	3.121E-05	2.33E-05	0	2.9988E-06
		7.62			ea.	1.20E-03	2.30E-03	9.70E-05	5.10E-05	3.80E-05		4.90E-06	0	0	0	0	0	0	0
	AP-42	9MM			ea.	2.00E-04	3.10E-04	1.50E-05	2.40E-05	2.00E-05		6.80E-06	0	0	0	0	0	0	0
	No Data	.300 WIN MAG			ea.	2.00E-04	3.10E-04	1.50E-05	2.40E-05	2.00E-05		6.80E-06	0	0	0	0	0	0	0
	No Data	.223 Rifle Rounds			ea.	6.80E-05	7.20E-05	3.10E-06	2.60E-06	1.90E-06		1.80E-06	0	0	0	0	0	0	0
	No Data	.22 Magnum			ea.	7.50E-05	8.00E-05	5.00E-06	3.40E-06	2.60E-06		1.90E-06	0	0	0	0	0	0	0
	AP-42	.22 Long Rifle			ea.	6.80E-05	7.20E-05	3.10E-06	2.60E-06	1.90E-06		1.80E-06	0	0	0	0	0	0	0
		12 Guage Shotgun			ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0	0	0	0	0	0	0
		Total:	**82,674**																
MINE SHAPE	AP-42	M18A1			ea.	1.6	2.00E-02	1.80E-02	4.90E-02	2.60E-02		5.70E-05	0	0	0	0	0	0	0
		MK76			ea.														
		MK62			ea.	No emissions													
		Total:	**0**																
MISSILE		AGM-114B	1		ea.														
		AGM-65 Maverick	3		ea.														
		AGM-84 Harpoon	3		ea.														
		AIM-120			ea.														
		AIM-7			ea.														
		AIM-9			ea.														
		BGM-71E TOW-A			ea.														
		HARM	2		ea.														
AW 25		NSM			ea.														
		JSOW			ea.														
		Japanese Missile Tests			ea.														
		Tactical Tomahawk			ea.														
		SLAM	1		ea.														
		SM2 or equivalent	1		ea.														
		Total:	**11**																
ROCKET		2.75" RKT			ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0	0	0	0	0	0	0
		2.75" RKT HE			ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0	0	0	0	0	0	0
		2.75" RKT I			ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0	0	0	0	0	0	0
		Total:	**0**																
FLARES		**FLARES****			**ea.**														
SMOKE		MK58 Marine Location Marker	8		ea.	1	1.30E-02	1.20E-02	3.20E-02	1.70E-02	6.10E-05	3.80E-05	0.004	0.000052	0.000048	0.000128	0.000068	0.000000244	0.000000152
		SMOKE GRENADE	739		ea.	1	1.30E-02	1.20E-02	3.20E-02	1.70E-02	6.10E-05	3.80E-05	0.3695	0.0048035	0.004434	0.011824	0.006282	2.25395E-05	0.000014041
		Total:	**747**																
TORPEDO	NA	MK46			ea.														
	NA	MK48-ADCAP	1		ea.														
		Total:	**1**																
		GRAND TOTAL ROUNDS	**27,612**																
		GRAND TOTAL POUNDS NEW			**12,625**														
											NWTRC		2.7097365	0.922033	0.0618594	0.0912742	0.060649	0.000262653	0.008563185

Table C-8. Ordnance Expenditures—Alternative 1

NOTE: Units of Measure (UOM) for ordnance rounds are 1 each (ea.) and for Demolitions and Other Ordnance are in pounds Net Explosive Weight (NEW).						Emission Factor (lb per lb or lb per item)							Emissions, tons/year						
Ordnance Group	AQ Data	Ordnance Type	Quantity Fired	NEW ea.	UOM/ Cum NEW	CO2	CO	Nox	PM10	PM2.5	SO2	Lead	CO2	CO	Nox	PM10	PM2.5	SO2	Lead
BOMB		CBU MK20 ROCKEYE		99	ea.														
	No Data	GBU32I JDAM		385	ea.														
	No Data	LGTR		0	ea.														
		MK76		Neg.	ea.														
	No Data	BDU 48		Neg.	ea.														
		MK82 HE	18	192	ea.		0.3184						0	0.550195	0	0	0	0	0
	No Data	GBU12 500 lb		192	ea.														
	NA	MK82 INERT	110	0	ea.														
	No Data	BDU 45		0	ea.														
		MK83 HE	8	445	ea.		0.1482						0	0.263796	0	0	0	0	0
	No Data	GBU 16		445	ea.														
	NA	MK83 INERT		0	ea.														
		Total:	136																
OTHER ORD	No AQ data	Type	No.	NEW															
	CNAP & SPAWAR	EER/IEER AN/SQQ-110	136	4.2	571.2	1.2	0.0044	0.011				0.00004	0.34272	0.001257	0.0031416	0	0	0	1.14E-05
	No Data	BLASTING CAP MK11	3,117	Neg.	0														
	No Data	FIRING DEVICE	105	Neg.	0														
		Fuse	18,700																
	No Data	Igniters	550	Neg.	0														
		GRENADE SIMULATOR		0.0813	0.0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
		Grenades	183	0.0813	14.9	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.004687	0.000156	4.68654E-05	0.000156	0.000112	8.92674E-07	1.04E-06
	No Data	M1A2 BANGALORE TORP		10.00	0								0	0	0	0	0	0	0
		M7 BANDOLEER MK57 (Claymore mine)		8.16	0		0.15108						0	0	0	0	0	0	0
	AP-42	M112 DEMO CHARGE	1,143	1.20	1371.6	7.90E-01	2.60E-02	7.90E-03	2.60E-02	1.90E-02		1.70E-04	0.541782	0.017831	0.00541782	0.017831	0.01303	0	0.000117
	No Data	M700 BLASTING FUSE		0.001	0														
	No Data	MK20 Cable Cutter		0.0028	0.0														
	No Data	MK22 Projectile Unit		Neg.	Neg.														
	No Data	MK36 M0 DEMO CHARGE		4.10	0								0	0	0	0	0	0	0
	No Data	MK75 CHARGE		50.00	0								0	0	0	0	0	0	0
	No Data	MK84 [86] EOD Shaped Charge	8	0.08	0.64								0	0	0	0	0	0	0
	No Data	MK120 NONELEC DET (ft)		0.00001	0.0000														
	No Data	MK123 NONELEC DET (ft)		0.00001	0.0000														
	No Data	MK138 DEMO CHG ASSEMBLY		20.00	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
	No Data	MK140 FLEXIBLE CHARGE		0.04	0														
		MK174	972																
	No Data	PBXN-109 TEST Det Cord		0.0060	0														
	No Data	SIGNAL MK 18(G950) SMOKE		0.23	0														
	No Data	C4 0.5 LB	4	0.50	2	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	6.30E-04	0.000021	0.0000063	0.000021	0.000015	0.00000012	1.4E-07
	No Data	C4 2.5 LB	60	2.50	150	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	4.73E-02	0.001575	0.0004725	0.001575	0.001125	0.000009	1.05E-05
	No Data	C4 5 LB	551	5.00	2755	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.867825	0.028928	0.00867825	0.028928	0.020663	0.0001653	0.000193
	No Data	C4 20 LB	76	20.00	1520	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.4788	0.01596	0.004788	0.01596	0.0114	0.0000912	0.000106
	No Data	C4 300 LB		1.00	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
	No Data	C4 500 LB		1.00	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
	No Data	TNT Blocks 0.5 lbd		1.00	0		0.398							0					
	No Data	DEMO SHEET	1,192	6.00	7152														
	No Data	DETONATING CORD	36,667	0.006	220.002														
	No Data	DEMO CHARGE		5.00	0														
	AP-42	SIMULATED ARTILLERY		0.1375	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
		Totals	63,464		13,757														
GUNFIRE (Large)	AP-42	155MM HE			ea.	6.51	2.35E+01	1.43E+00	0.496	0.2418		2.26E-03	0	0	0	0	0	0	0
	AP-42	155MM ILL			ea.	1.8	2.62E-02	9.40E-02	3	3		5.80E-05	0	0	0	0	0	0	0
5"/54		5"/54 BLP	1,351		ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.010808	0.01351	0	0.000811	0.000628	0	4.05E-06
		5"/54 HCVT+32 (EOD)			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/54 HECVT			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/54 HEPD			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/54 HEVT			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/54 ILL			ea.	1.50E-02	1.40E-02	3.60E-04	9.20E-04	7.60E-04		1.30E-06	0	0	0	0	0	0	0
		5"54/54 VTNF			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
5"/62		5"/62	1,000		ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.008	0.01	0	0.0006	0.000465	0	0.000003
		5"/62 HE-MFF			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/62 HECVT			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/62 HEET			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/62 KEET			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
60mm	AP-42	60MM	700		ea.	2.90E-01	3.00E-02	4.20E-03	3.20E-02	1.70E-02		2.30E-04	0.1015	0.0105	0.00147	0.0112	0.00595	0	8.05E-05
		60MM WP			ea.	2.90E-01	3.00E-02	4.20E-03	3.20E-02	1.70E-02		2.30E-04	0	0	0	0	0	0	0
76mm		76MM BLP	800		ea.	1.44E-02	1.80E-02		1.08E-03	8.37E-04		5.40E-06	0.00576	0.0072	0	0.000432	0.000335	0	2.16E-06
	AP-42	81MM HE			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
	AP-42	81MM ILL			ea.	1.50E-02	1.40E-02	3.60E-04	9.20E-04	7.60E-04		1.30E-06	0	0	0	0	0	0	0
CAS	No data	GAU-17 30mm			ea.														
		Total:	3,851																
GUNFIRE (small)	AMW 114,1125	20MM	11,600		ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0.001508	0.00203	0.0002088	0.000151	0.000133	0	0.003886
		25MM	17,500		ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0.002275	0.003063	0.000315	0.000228	0.000201	0	0.005863
	No Data	30MM EFV Main Gun			ea.														
	AP-42	40MM			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0	0	0	0	0	0	0
	AP-42	40MM HE			ea.	6.60E-02	7.00E-03	1.60E-03	1.30E-02	6.60E-03		7.30E-05	0	0	0	0	0	0	0
	No Data	40MM ILL			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0	0	0	0	0	0	0
	AP-42	40MM PRACTICE			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0	0	0	0	0	0	0
	AP-42	.45 CAL			ea.	2.20E-04	2.60E-04	8.10E-06	3.70E-05	3.10E-05		1.20E-05	0	0	0	0	0	0	0
	AP-42	5.56			ea.	8.70E-04	1.60E-03	8.50E-05	3.90E-05	2.80E-05		5.10E-06	0	0	0	0	0	0	0
	AP-42	5.56 BLANK			ea.	2.30E-04	2.80E-04	2.00E-05	6.90E-06	2.00E-06		9.70E-07	0	0	0	0	0	0	0
	AP-42	.50CAL	65,000		ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0.16575	0.3575	0.039	0.010075	0.006175	0	0.000423
		.50CAL			ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0	0	0	0	0	0	0
	AP-42	.50CAL BLANK			ea.	2.10E-03	1.80E-03	2.80E-05	9.80E-05	8.80E-05		1.20E-05	0	0	0	0	0	0	0
	AP-42	7.62	1,360		ea.	1.20E-03	2.30E-03	9.70E-05	5.10E-05	3.80E-05		4.90E-06	0.000816	0.001564	0.00006596	3.47E-05	2.58E-05	0	3.33E-06
		7.62			ea.	1.20E-03	2.30E-03	9.70E-05	5.10E-05	3.80E-05		4.90E-06	0	0	0	0	0	0	0
	AP-42	9MM			ea.	2.00E-04	3.10E-04	1.50E-05	2.40E-05	2.00E-05		6.80E-06	0	0	0	0	0	0	0
	No Data	.300 WIN MAG			ea.	2.00E-04	3.10E-04	1.50E-05	2.40E-05	2.00E-05		6.80E-06	0	0	0	0	0	0	0
	No Data	.223 Rifle Rounds			ea.	6.80E-05	7.20E-05	3.10E-06	2.60E-06	1.90E-06		1.80E-06	0	0	0	0	0	0	0
	No Data	.22 Magnum			ea.	7.50E-05	8.00E-05	5.00E-06	3.40E-06	2.60E-06		1.90E-06	0	0	0	0	0	0	0
	AP-42	.22 Long Rifle			ea.	6.80E-05	7.20E-05	3.10E-06	2.60E-06	1.90E-06		1.80E-06	0	0	0	0	0	0	0
		12 Guage Shotgun			ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0	0	0	0	0	0	0
		Total:	95,460																
MINE SHAPE	AP-42	M18A1			ea.	1.6	2.00E-02	1.80E-02	4.90E-02	2.60E-02		5.70E-05	0	0	0	0	0	0	0
		MK76			ea.														
		MK62			ea.	No emissions													
		Total:	0																
MISSILE		AGM-114B	2		ea.														
		AGM-65 Maverick	6		ea.														
		AGM-84 Harpoon	6		ea.														
		AIM-120	4		ea.														
		AIM-7	6		ea.														
		AIM-9	5		ea.														
		BQM74E	4		ea.														
		HARM	4		ea.														
AW 25		NSM			ea.														
		JSOW			ea.														
		Japanese Missile Tests			ea.														
		Seasparrow	2		ea.														
		SLAM	2		ea.														
		SM2 or equivalent	2		ea.														
		Total:	43																
ROCKET		2.75" RKT			ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0	0	0	0	0	0	0
		2.75" RKT HE			ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0	0	0	0	0	0	0
		2.75" RKT I			ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0	0	0	0	0	0	0
		Total:	0																
FLARES		FLARES**			ea.														
SMOKE		MK58 Marine Location Marker	8		ea.	1	1.30E-02	1.20E-02	3.20E-02	1.70E-02	6.10E-05	3.80E-05	0.004	0.000052	0.000048	0.000128	0.000068	0.000000244	1.52E-07
		SMOKE GRENADE	787		ea.	1	1.30E-02	1.20E-02	3.20E-02	1.70E-02	6.10E-05	3.80E-05	0.3935	0.005116	0.004722	0.012592	0.00669	2.40035E-05	1.5E-05
		Total:	795																
TORPEDO	NA	MK46			ea.														
	NA	MK48-ADCAP	2		ea.														
		Total:	2																
		GRAND TOTAL ROUNDS	163,751																
		GRAND TOTAL POUNDS NEW			13,757														
												NWTRC	2.977611	1.290252	0.068381095	0.100721	0.067015	0.00029076	0.010718

Table C-9. Ordnance Expenditures—Alternative 2

	NOTE: Units of Measure (UOM) for ordnance rounds are 1 each (ea.) and for Demolitions and Other Ordnance are in pounds Net Explosive Weight (NEW).					Emission Factor (lb per lb or lb per item)							Emissions, tons/year						
Ordnance Group	**AQ Data**	**Ordnance Type**	**Quantity Fired**	**NEW ea.**	**UOM/ Cum NEW**	**CO2**	**CO**	**Nox**	**PM10**	**PM2.5**	**SO2**	**Lead**	**CO2**	**CO**	**Nox**	**PM10**	**PM2.5**	**SO2**	**Lead**
BOMB		CBU MK20 ROCKEYE		99	ea.														
	No Data	GBU32I JDAM		385	ea.														
	No Data	LGTR		0	ea.														
		MK76		Neg.	ea.														
	No Data	BDU 48		Neg.	ea.														
		MK82 HE	18	192	ea.		0.3184						0	0.550195	0	0	0	0	0
	No Data	GBU12 500 lb		192	ea.														
	NA	MK82 INERT	110	0	ea.														
	No Data	BDU 45		0	ea.														
		MK83 HE	8	445	ea.		0.1482						0	0.263796	0	0	0	0	0
	No Data	GBU 16		445	ea.														
	NA	MK83 INERT		0	ea.														
		Total:	**136**																
OTHER ORD	**No AQ data**	**Type**	**No.**	**NEW**															
	CNAP & SPAWAR	EER/IEER AN/SQQ-110	149	4.2	625.8	1.2	0.0044	0.011				0.00004	0.37548	0.001377	0.0034419	0	0	0	1.25E-05
	No Data	BLASTING CAP MK11	3,117	Neg.	0														
	No Data	FIRING DEVICE	105	Neg.	0														
		Fuse	18,700																
	No Data	Igniters	550	Neg.	0														
		GRENADE SIMULATOR		0.0813	0.0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
		Grenades	183	0.0813	14.9	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.004687	0.000156	4.68654E-05	0.000156	0.000112	8.92674E-07	1.04E-06
	No Data	M1A2 BANGALORE TORP		10.00	0								0	0	0	0	0	0	0
		M7 BANDOLEER MK57 (Claymore mine)		8.16	0		0.15108						0	0	0	0	0	0	0
	AP-42	M112 DEMO CHARGE	1,143	1.20	1371.6	7.90E-01	2.60E-02	7.90E-03	2.60E-02	1.90E-02		1.70E-04	0.541782	0.017831	0.00541782	0.017831	0.01303	0	0.000117
	No Data	M700 BLASTING FUSE		0.001	0														
	No Data	MK20 Cable Cutter		0.0028	0.0														
	No Data	MK22 Projectile Unit		Neg.	Neg.														
	No Data	MK36 M0 DEMO CHARGE		4.10	0								0	0	0	0	0	0	0
	No Data	MK75 CHARGE		50.00	0								0	0	0	0	0	0	0
	No Data	MK84 [86] EOD Shaped Charge	8	0.08	0.64								0	0	0	0	0	0	0
	No Data	MK120 NONELEC DET (ft)		0.00001	0.0000														
	No Data	MK123 NONELEC DET (ft)		0.00001	0.0000														
	No Data	MK138 DEMO CHG ASSEMBLY		20.00	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
	No Data	MK140 FLEXIBLE CHARGE		0.04	0														
		MK174	972																
	No Data	PBXN-109 TEST Det Cord		0.0060	0														
	No Data	SIGNAL MK 18(G950) SMOKE		0.23	0														
	No Data	C4 0.5 LB	4	0.50	2	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	6.30E-04	0.000021	0.0000063	0.000021	0.000015	0.00000012	1.4E-07
	No Data	C4 2.5 LB	60	2.50	150	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	4.73E-02	0.001575	0.0004725	0.001575	0.001125	0.000009	1.05E-05
	No Data	C4 5 LB	551	5.00	2755	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.867825	0.028928	0.00867825	0.028928	0.020663	0.0001653	0.000193
	No Data	C4 20 LB	76	20.00	1520	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0.4788	0.01596	0.004788	0.01596	0.0114	0.0000912	0.000106
	No Data	C4 300 LB		1.00	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
	No Data	C4 500 LB		1.00	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
	No Data	TNT Blocks 0.5 lbd		1.00	0		0.398							0					
	No Data	DEMO SHEET	1,192	6.00	7152														
	No Data	DETONATING CORD	36,667	0.006	220.002														
	No Data	DEMO CHARGE		5.00	0														
	AP-42	SIMULATED ARTILLERY		0.1375	0	6.30E-01	0.021	6.30E-03	2.10E-02	1.50E-02	1.20E-04	1.40E-04	0	0	0	0	0	0	0
		Totals	**63,477**		**13,812**														
GUNFIRE (Large)	AP-42	155MM HE			ea.	6.51	2.35E+01	1.43E+00	0.496	0.2418		2.26E-03	0	0	0	0	0	0	0
	AP-42	155MM ILL			ea.	1.8	2.62E-02	9.40E-02	3	3		5.80E-05	0	0	0	0	0	0	0
5"/54		5"/54 BLP	2,463		ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.019704	0.02463	0	0.001478	0.001145	0	7.39E-06
		5"/54 HCVT+32 (EOD)			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/54 HECVT			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/54 HEPD			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/54 HEVT			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/54 ILL			ea.	1.50E-02	1.40E-02	3.60E-04	9.20E-04	7.60E-04		1.30E-06	0	0	0	0	0	0	0
		5"54/54 VTNF			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
5"/62		5"/62	1,000		ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0.008	0.01	0	0.0006	0.000465	0	0.000003
		5"/62 HE-MFF			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/62 HECVT			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/62 HEET			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
		5"/62 KEET			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
60mm	AP-42	60MM	1,260		ea.	2.90E-01	3.00E-02	4.20E-03	3.20E-02	1.70E-02		2.30E-04	0.1827	0.0189	0.002646	0.02016	0.01071	0	0.000145
		60MM WP			ea.	2.90E-01	3.00E-02	4.20E-03	3.20E-02	1.70E-02		2.30E-04	0	0	0	0	0	0	0
76mm		76MM BLP	1,120		ea.	1.44E-02	1.80E-02		1.08E-03	8.37E-04		5.40E-06	0.008064	0.01008	0	0.000605	0.000469	0	3.02E-06
	AP-42	81MM HE			ea.	1.60E-02	2.00E-02		1.20E-03	9.30E-04		6.00E-06	0	0	0	0	0	0	0
	AP-42	81MM ILL			ea.	1.50E-02	1.40E-02	3.60E-04	9.20E-04	7.60E-04		1.30E-06	0	0	0	0	0	0	0
CAS	No data	GAU-17 30mm			ea.														
		Total:	**5,843**																
GUNFIRE (small)	AMW 114,1125	20MM	23,200		ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0.003016	0.00406	0.0004176	0.000302	0.000267	0	0.007772
		25MM	31,500		ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0.004095	0.005513	0.000567	0.00041	0.000362	0	0.010553
	No Data	30MM EFV Main Gun			ea.														
	AP-42	40MM			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0	0	0	0	0	0	0
	AP-42	40MM HE			ea.	6.60E-02	7.00E-03	1.60E-03	1.30E-02	6.60E-03		7.30E-05	0	0	0	0	0	0	0
	No Data	40MM ILL			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0	0	0	0	0	0	0
	AP-42	40MM PRACTICE			ea.	2.60E-04	3.50E-04	3.60E-05	2.60E-05	2.30E-05		6.70E-04	0	0	0	0	0	0	0
	AP-42	.45 CAL			ea.	2.20E-04	2.60E-04	8.10E-06	3.70E-05	3.10E-05		1.20E-05	0	0	0	0	0	0	0
	AP-42	5.56			ea.	8.70E-04	1.60E-03	8.50E-05	3.90E-05	2.80E-05		5.10E-06	0	0	0	0	0	0	0
	AP-42	5.56 BLANK			ea.	2.30E-04	2.80E-04	2.00E-05	6.90E-06	2.00E-06		9.70E-07	0	0	0	0	0	0	0
	AP-42	.50CAL	117,000		ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0.29835	0.6435	0.0702	0.018135	0.011115	0	0.000761
		.50CAL			ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0	0	0	0	0	0	0
	AP-42	.50CAL BLANK			ea.	2.10E-03	1.80E-03	2.80E-05	9.80E-05	8.80E-05		1.20E-05	0	0	0	0	0	0	0
	AP-42	7.62	2,720		ea.	1.20E-03	2.30E-03	9.70E-05	5.10E-05	3.80E-05		4.90E-06	0.001632	0.003128	0.00013192	6.94E-05	5.17E-05	0	6.66E-06
		7.62			ea.	1.20E-03	2.30E-03	9.70E-05	5.10E-05	3.80E-05		4.90E-06	0	0	0	0	0	0	0
	AP-42	9MM			ea.	2.00E-04	3.10E-04	1.50E-05	2.40E-05	2.00E-05		6.80E-06	0	0	0	0	0	0	0
	No Data	.300 WIN MAG			ea.	2.00E-04	3.10E-04	1.50E-05	2.40E-05	2.00E-05		6.80E-06	0	0	0	0	0	0	0
	No Data	.223 Rifle Rounds			ea.	6.80E-05	7.20E-05	3.10E-06	2.60E-06	1.90E-06		1.80E-06	0	0	0	0	0	0	0
	No Data	.22 Magnum			ea.	7.50E-05	8.00E-05	5.00E-06	3.40E-06	2.60E-06		1.90E-06	0	0	0	0	0	0	0
	AP-42	.22 Long Rifle			ea.	6.80E-05	7.20E-05	3.10E-06	2.60E-06	1.90E-06		1.80E-06	0	0	0	0	0	0	0
		12 Guage Shotgun			ea.	5.10E-03	1.10E-02	1.20E-03	3.10E-04	1.90E-04		1.30E-05	0	0	0	0	0	0	0
		Total:	**174,420**																
MINE SHAPE	AP-42	M18A1			ea.	1.6	2.00E-02	1.80E-02	4.90E-02	2.60E-02		5.70E-05	0	0	0	0	0	0	0
		MK76			ea.														
		MK62			ea.	No emissions													
		Total:	**0**																
MISSILE		AGM-114B	2		ea.														
		AGM-65 Maverick	6		ea.														
		AGM-84 Harpoon	6		ea.														
		AIM-120	7		ea.														
		AIM-7	13		ea.														
		AIM-9	9		ea.														
		BQM74E	16		ea.														
		HARM	4		ea.														
AW 25		NSM			ea.														
		JSOW			ea.														
		Japanese Missile Tests			ea.														
		Seasparrow	8		ea.														
		SLAM	2		ea.														
		SM2 or equivalent	2		ea.														
		Total:	**75**																
ROCKET		2.75" RKT			ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0	0	0	0	0	0	0
		2.75" RKT HE			ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0	0	0	0	0	0	0
		2.75" RKT I			ea.	4.50E-01	5.60E-02	7.10E-03	6.10E-02	3.80E-02		1.20E-03	0	0	0	0	0	0	0
		Total:	**0**																
FLARES		**FLARES****			**ea.**														
SMOKE		MK58 Marine Location Marker	8		ea.	1	1.30E-02	1.20E-02	3.20E-02	1.70E-02	6.10E-05	3.80E-05	0.004	0.000052	0.000048	0.000128	0.000068	0.000000244	1.52E-07
		SMOKE GRENADE	792		ea.	1	1.30E-02	1.20E-02	3.20E-02	1.70E-02	6.10E-05	3.80E-05	0.396	0.005148	0.004752	0.012672	0.006732	0.000024156	1.5E-05
		Total:	**800**																
TORPEDO	NA	MK46			ea.														
	NA	MK48-ADCAP	2		ea.														
		Total:	**2**																
		GRAND TOTAL ROUNDS	**244,753**																
		GRAND TOTAL POUNDS NEW			**13,812**														
											NWTRC		3.242015	1.604849	0.101614155	0.119029	0.077729	0.000290913	0.019705

Table C-10. Ground Vehicle Emissions - No Action Alternative

Scenario	Type Training	Days	Ground Vehicles	Number	Engine Load	Hours per day	Emissions Factors (lb/hr)					Emissions (lbs)				
Training Exercises							**CO**	**NOx**	**HC**	**SOx**	**PM10**	**CO**	**Nox**	**HC**	**Sox**	**PM**
1	Air Combat Maneuvers		None													
2	A-A Missiles		None													
3	S-A Gunnery Exercise		None													
4	S-A Missiles		None													
5	S-S GUNEX		None													
6	A-S BOMBEX		None													
7	SINKEX		None													
8	ASW TRACKEX - MPA		None													
9	EER-IEER		None													
10	Surface Ship ASW TRACKEX		None													
11	Sub ASW TRACKEX		None													
12	Elec Combat		None													
13	Mine Countermeasures Training		None													
14	Land Demolition Training	102	Pickup Trucks	12	1.0	8	0.30	0.03	0.02	0.00	0.00	2980.86	249.60	156.04	2.74	8.92
15	Insertion/Extraction		None													
16	NSW Training		None													
17	HARMEX		None													
18	ISR		None													
19	UAV		None													
	Total						**Total Ground Vehicle Emissions, tons**					1.49043095	0.1247989	0.078018	0.001371	0.004458

Table C-11. Ground Vehicle Emissions - Alternative 1

Scenario	Type Training	Days	Ground Vehicles	Number	Engine Load	Hours per day	Emissions Factors (lb/hr)					Emissions (lbs)				
Training Exercises							**CO**	**NOx**	**HC**	**SOx**	**PM10**	**CO**	**Nox**	**HC**	**Sox**	**PM**
1	Air Combat Maneuvers		None													
2	A-A Missiles		None													
3	S-A Gunnery Exercise		None													
4	S-A Missiles		None													
5	S-S GUNEX		None													
6	A-S BOMBEX		None													
7	SINKEX		None													
8	ASW TRACKEX - MPA		None													
9	EER-IEER		None													
10	Surface Ship ASW TRACKEX		None													
11	Sub ASW TRACKEX		None													
12	Elec Combat		None													
13	Mine Countermeasures Training		None													
14	Land Demolition Training	110	Pickup Trucks	13	1.0	8	0.30	0.03	0.02	0.00	0.00	3482.54	291.61	182.30	3.20	10.42
15	Insertion/Extraction		None													
16	NSW Training		None													
17	HARMEX		None													
18	ISR		None													
19	UAV		None													
	Total						**Total Ground Vehicle Emissions, tons**					1.74127146	0.1458027	0.091149	0.001602	0.005208

Table C-12. Ground Vehicle Emissions - Alternative 2

Scenario	Type Training	Days	Ground Vehicles	Number	Engine Load	Hours per day	Emissions Factors (lb/hr)					Emissions (lbs)				
Training Exercises							CO	NOx	HC	SOx	PM10	CO	Nox	HC	Sox	PM
1	Air Combat Maneuvers		None													
2	A-A Missiles		None													
3	S-A Gunnery Exercise		None													
4	S-A Missiles		None													
5	S-S GUNEX		None													
6	A-S BOMBEX		None													
7	SINKEX		None													
8	ASW TRACKEX - MPA		None													
9	EER-IEER		None													
10	Surface Ship ASW TRACKEX		None													
11	Sub ASW TRACKEX		None													
12	Elec Combat		None													
13	Mine Countermeasures Training		None													
14	Land Demolition Training	110	Pickup Trucks	13	1.0	8	0.30	0.03	0.02	0.00	0.00	3482.54	291.61	182.30	3.20	10.42
15	Insertion/Extraction		None													
16	NSW Training		None													
17	HARMEX		None													
18	ISR		None													
19	UAV		None													
	Total						**Total Ground Vehicle Emissions, tons**					1.74127146	0.1458027	0.091149	0.001602	0.005208

Table C-13. Total Emissions within 3 nm of Shore

No Action Alternative	CO	NOx	HC	SOx	PM10	PM2.5
Aircraft–Operations	0.93	1.74	0.11	0.09	0.95	0.94
Surface Ships	1.32	3.02	0.12	0.56	0.08	0.08
Ordnance	0.92	0.06	0.00	0.00	0.09	0.09
Ground Vehicles	1.49	0.12	0.08	0.00	0.00	0.00
Total	**4.66**	**4.95**	**0.31**	**0.65**	**1.13**	**1.12**
Alternative 1						
Aircraft–Operations	1.02	1.86	0.12	0.10	1.03	1.02
Surface Ships	1.44	3.31	0.13	0.61	0.08	0.08
Ordnance	1.29	0.07	0.00	0.00	0.10	0.10
Ground Vehicles	1.74	0.15	0.09	0.00	0.01	0.01
Total	**5.49**	**5.39**	**0.35**	**0.71**	**1.22**	**1.20**
Alternative 2						
Aircraft–Operations	1.03	1.90	0.12	0.10	1.04	1.03
Surface Ships	1.44	3.31	0.13	0.61	0.08	0.08
Ordnance	1.60	0.10	0.00	0.00	0.12	0.12
Ground Vehicles	1.74	0.15	0.09	0.00	0.01	0.01
Total	**5.81**	**5.46**	**0.35**	**0.71**	**1.25**	**1.24**
Increases over Baseline						
Alternative 1	0.82	0.44	0.03	0.06	0.09	0.09
Alternative 2	1.15	0.51	0.04	0.06	0.12	0.12
Major Source Threshold	**100.00**	**100.00**	**10.00**	**100.00**	**100.00**	**100.00**
Alternative 1 Above?	NO	NO	NO	NO	NO	NO
Alternative 2 Above?	NO	NO	NO	NO	NO	NO

Table C-14. Total Emissions within U.S. Territory

No Action Alternative	CO	NOx	HC	SOx	PM10	PM2.5
Aircraft–Operations	0.00	0.00	0.00	0.00	0.00	0.00
Surface Ships	0.00	0.00	0.00	0.00	0.00	0.00
Ordnance	0.00	0.00	0.00	0.00	0.00	0.00
Ground Vehicles	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Alternative 1						
Aircraft–Operations	0.00	0.00	0.00	0.00	0.00	0.00
Surface Ships	0.00	0.00	0.00	0.00	0.00	0.00
Ordnance	0.00	0.00	0.00	0.00	0.00	0.00
Ground Vehicles	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Alternative 2						
Aircraft–Operations	0.00	0.00	0.00	0.00	0.00	0.00
Surface Ships	0.00	0.00	0.00	0.00	0.00	0.00
Ordnance	0.00	0.00	0.00	0.00	0.00	0.00
Ground Vehicles	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Increases over Baseline						
Alternative 1	0.00	0.00	0.00	0.00	0.00	0.00
Alternative 2	0.00	0.00	0.00	0.00	0.00	0.00
Major Source Threshold	**100.00**	**100.00**	**10.00**	**100.00**	**100.00**	**100.00**
Alternative 1 Above?	NO	NO	NO	NO	NO	NO
Alternative 2 Above?	NO	NO	NO	NO	NO	NO

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Appendix D

Marine Mammal Modeling

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D MARINE MAMMAL MODELING

D.1 BACKGROUND AND OVERVIEW

All marine mammals are protected under the Marine Mammal Protection Act (MMPA). The MMPA prohibits, with certain exceptions, the take of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the United States.

The Endangered Species Act of 1973 (ESA) provides for the conservation of species that are endangered or threatened throughout all or a significant portion of their range, and the conservation of their ecosystems. A species is considered endangered if it is in danger of extinction throughout all or a significant portion of its range. A species is considered threatened if it is likely to become an endangered species within the foreseeable future. There are marine mammals, already protected under MMPA, listed as either endangered or threatened under ESA, and afforded special protections.

Actions involving sound in the water include the potential to harass marine animals in the surrounding waters. Demonstration of compliance with MMPA and the ESA, using best available science, has been assessed using criteria and thresholds accepted or negotiated, and described here.

Sections of the MMPA (16 United States Code [U.S.C.] 1361 et seq.) direct the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity, other than commercial fishing, within a specified geographical region. Through a specific process, if certain findings are made and regulations are issued or, if the taking is limited to harassment, notice of a proposed authorization is provided to the public for review.

Authorization for incidental takings may be granted if the National Marine Fisheries Service (NMFS) finds that the taking will have no more than a negligible impact on the species or stock(s), will not have an immitigable adverse impact on the availability of the species or stock(s) for subsistence uses, and that the permissible methods of taking, and requirements pertaining to the mitigation, monitoring and reporting of such taking are set forth.

NMFS has defined negligible impact in 50 Code of Federal Regulations (CFR) 216.103 as an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.

Subsection 101(a)(5)(D) of the MMPA established an expedited process by which citizens of the United States can apply for an authorization to incidentally take small numbers of marine mammals by harassment. The National Defense Authorization Act of 2004 (NDAA) (Public Law 108-136) removed the small numbers limitation and amended the definition of “harassment” as it applies to a military readiness activity to read as follows:

> (i) *any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild [Level A Harassment]; or* (ii) *any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered [Level B Harassment].*

The primary potential impact to marine mammals from underwater acoustics is Level B harassment from noise. For explosions of ordnance planned for use in the Northwest Training Range Complex (NWTRC), in the absence of any mitigation or monitoring measures, there is a very small chance that a marine mammal could be injured or killed when exposed to the energy generated from an explosive force.

Analysis of noise impacts is based on criteria and thresholds initially presented in U.S. Navy Environmental Impact Statements for ship shock trials of the Seawolf submarine and the Winston Churchill (DDG 81), and subsequently adopted by NMFS.

Non-lethal injurious impacts (Level A Harassment) are defined in those documents as tympanic membrane (TM) rupture and the onset of slight lung injury. The threshold for Level A Harassment corresponds to a 50-percent rate of TM rupture, which can be stated in terms of an energy flux density (EFD) value of 205 decibels (dB) re 1 micro Pascal squared–second (µPa2-s). TM rupture is well-correlated with permanent hearing impairment. Ketten (1998) indicates a 30-percent incidence of permanent threshold shift (PTS) at the same threshold.

The criteria for onset of slight lung injury were established using partial impulse because the impulse of an underwater blast wave was the parameter that governed damage during a study using mammals, not peak pressure or energy (Yelverton, 1981). Goertner (1982) determined a way to calculate impulse values for injury at greater depths, known as the Goertner "modified" impulse pressure. Those values are valid only near the surface because as hydrostatic pressure increases with depth, organs like the lung, filled with air, compress. Therefore the "modified" impulse pressure thresholds vary from the shallow depth starting point as a function of depth.

The shallow depth starting points for calculation of the "modified" impulse pressures are mass-dependent values derived from empirical data for underwater blast injury (Yelverton, 1981). During the calculations, the lowest impulse and body mass for which slight, and then extensive, lung injury found during a previous study (Yelverton et al., 1973) were used to determine the positive impulse that may cause lung injury. The Goertner model is sensitive to mammal weight such that smaller masses have lower thresholds for positive impulse so injury and harassment will be predicted at greater distances from the source for them. Impulse thresholds of 13.0 and 31.0 pounds per square inch-millisecond (psi-msec), found to cause slight and extensive injury in a dolphin calf, were used as thresholds in the analysis contained in this document.

D.1.1 Metrics for Physiological Effect Thresholds

Effect thresholds used for acoustic impact modeling in this document are expressed in terms of EFD / Sound Exposure Level (SEL), which is total energy received over time in an area, or in terms of Sound Pressure Level (SPL), which is the level (root mean square) without reference to any time component for the exposure at that level. Marine and terrestrial mammal data show that, for continuous-type sounds of interest, Temporary Threshold Shift (TTS) and PTS are more closely related to the energy in the sound exposure than to the exposure SPL.

The Energy Level (EL) for each individual ping is calculated from the following equation:

$$EL = SPL + 10\log10(duration)$$

The EL includes both the ping SPL and duration. Longer-duration pings and/or higher-SPL pings will have a higher EL.

If an animal is exposed to multiple pings, the EFD in each individual ping is summed to calculate the total EL. Since mammalian Threshold Shift (TS) data show less effect from intermittent exposures compared to continuous exposures with the same energy (Ward, 1997), basing the effect thresholds on the total received EL is a conservative approach for treating multiple pings; in reality, some recovery will occur between pings and lessen the effect of a particular exposure. Therefore, estimates are conservative because recovery is not taken into account (given that generally applicable recovery times have not been experimentally established) and as a result, intermittent exposures from sonar are modeled as if they were continuous exposures.

The total EL depends on the SPL, duration, and number of pings received. The TTS and PTS thresholds do not imply any specific SPL, duration, or number of pings. The SPL and duration of each received ping are used to calculate the total EL and determine whether the received EL meets or exceeds the effect thresholds. For example, the TTS threshold would be reached through any of the following exposures:

- A single ping with SPL = 195 dB re 1 µPa and duration = 1 second.
- A single ping with SPL = 192 dB re 1 µPa and duration = 2 seconds.
- Two pings with SPL = 192 dB re 1 µPa and duration = 1 second.

Two pings with SPL = 189 dB re 1 µPa and duration = 2 seconds.

D.1.2 Derivation of an Effects Threshold Based on EFD

As described in detail in Section 3.9.2.1 of the NWTRC EIS, SEL (EFD level) exposure threshold established for onset-TTS is 195 dB re 1 μPa^2-s. This result is corroborated by the short-duration tone data of Finneran et al. (2000, 2003) and the long-duration sound data from Nachtigall et al. (2003a, b). Together, these data demonstrate that TTS in small odontocetes is correlated with the received EL and that onset-TTS exposures are fit well by an equal-energy line passing through 195 dB re 1 μPa^2-s. Absent any additional data for other species and being that it is likely that small odontocetes are more sensitive to the mid-frequency active/high-frequency active (MFA/HFA) frequency levels of concern, this threshold is used for analysis for all cetacea.

The PTS thresholds established for use in this analysis are based on a 20 dB increase in exposure EL over that required for onset-TTS. The 20 dB value is based on estimates from terrestrial mammal data of PTS occurring at 40 dB or more of TS, and on TS growth occurring at a rate of 1.6 dB/dB increase in exposure EL. This is conservative because: (1) 40 dB of TS is actually an upper limit for TTS used to approximate onset-PTS, and (2) the 1.6 dB/dB growth rate is the highest observed in the data from Ward et al. (1958, 1959). Using this estimation method (20 dB up from onset-TTS) for the NWTRC analysis, the PTS threshold for cetacea is 215 dB re 1µPa2-s.

The threshold levels for analyzing acoustic impacts to pinnipeds from MFA/HFA sonar are based on specific species data when available. For the Stellar sea lion and Northern fur seal, the California sea lion data was used. Morphologically, the Stellar sea lion, Northern fur seal, and California sea lion are related. They are "eared" seals (Family Otarridae w/external ear flaps), vice the true seals (Family Phocidae w/out external ear flaps) such as harbor seals. In addition, the habitats and natural history (foraging, breeding, etc) are similar between Stellar sea lion, Northern fur seal, and California sea lion. The threshold levels for pinnipeds are given below:

Level A Harassment (onset PTS)

- Stellar Sea Lion 226 dB re 1 µPa2 ·s
- Northern Fur Seal 226 dB re 1 µPa2 ·s
- California Sea Lion 226 dB re 1 µPa2 ·s
- Northern Elephant Seal 224 dB re 1 µPa2 ·s
- Harbor Seal 203 dB re 1 µPa2 ·s

Level B Harassment (onset TTS)

- Stellar Sea Lion 206 dB re 1 µPa2 ·s
- Northern Fur Seal 206 dB re 1 µPa2 ·s
- California Sea Lion 206 dB re 1 µPa2 ·s
- Northern Elephant Seal 204 dB re 1 µPa2 ·s
- Harbor Seal 183 dB re 1 µPa2 ·s

Level B (non-injurious) Harassment also includes a TTS threshold consisting of 182 dB re 1 µPa2-s maximum EFD level in any 1/3-octave band above 100 hertz (Hz) for toothed whales (e.g., dolphins). A second criterion, 23 psi, has recently been established by NMFS to provide a more conservative range for TTS when the explosive or animal approaches the sea surface, in which case explosive energy is reduced, but the peak pressure of 1 µPa2-s is not (Table D-1). NMFS applies the more conservative of these two.

For Multiple Successive Explosions (MSEs), the acoustic criterion for sub-TTS behavioral disturbance is used to account for behavioral effects significant enough to be judged as harassment, but occurring at lower sound energy levels than those that may cause TTS. The sub-TTS threshold is derived following the approach of the Churchill Final Environmental Impact Statement (FEIS) for the energy-based TTS threshold. The research on pure-tone exposures reported in Schlundt et al. (2000) and Finneran and Schlundt (2004) provided a threshold of 192 dB re 1 µPa2-s as the lowest TTS value. This value for pure-tone exposures is modified for explosives by (a) interpreting it as an energy metric, (b) reducing it by 10 dB to account for the time constant of the mammal ear, and (c) measuring the energy in 1/3 octave bands, the natural filter band of the ear. The resulting TTS threshold for explosives is 182 dB re 1 μPa^2-s in any 1/3 octave band. As reported by Schlundt et al. (2000) and Finneran and Schlundt (2004), instances of altered behavior in the pure-tone research generally began five dB lower than those causing TTS. The sub-TTS threshold is therefore derived by subtracting 5 dB from the 182 dB re 1 μPa^2-s in any 1/3 octave band threshold, resulting in a 177 dB re 1 μPa^2-s (EL) sub-TTS behavioral disturbance threshold for MSE. Table D-1 lists the harassment thresholds for explosives.

Table D-1. Harassment Thresholds–Explosives

Threshold Type (Explosives)	Threshold Level
Sub-TTS Threshold for Multiple Successive Explosions (peak one-third octave energy)	177 dB
Level B - Temporary Threshold Shift (TTS) (peak one-third octave energy)	182 dB
Level B - Temporary Threshold Shift (TTS) (peak pressure)	23 psi
Level A – Slight lung injury (positive impulse)	13 psi-ms
Level A – 50% Eardrum rupture	205 dB
Mortality – 1% Mortal lung injury (positive impulse)	31 psi-ms

D.1.3 Derivation of a Behavioral Effect Threshold Based on SPL

Over the past several years, the Navy and NMFS have worked on developing alternative criteria to replace and/or to supplement the acoustic thresholds used in the past to estimate the probability of marine mammals being behaviorally harassed by received levels of MFA and HFA sonar. The Navy continues working with the NMFS to refine a mathematically representative curve for assessment of behavioral effects modeling associated with the use of MFA/HFA sonar. As detailed in Section 4.1.2, the NMFS Office of Protected Resources made the decision to use a risk function and applicable input parameters to estimate the probability of behavioral responses that NMFS would classify as harassment for the purposes of the MMPA given exposure to specific received levels of MFA/HFA sonar. This decision was based on the recommendation of the two NMFS scientists, consideration of the independent reviews from six scientists, and NMFS MMPA regulations affecting the Navy's use of Surveillance Towed Array Sensor System Low-Frequency Active (SURTASS LFA) sonar (DoN, 2002; National Oceanic and Atmospheric Administration [NOAA], 2007).

The particular acoustic risk function developed by the Navy and NMFS is derived from a solution in Feller (1968) with input parameters modified by NMFS for MFA/HFA sonar for mysticetes, odontocetes, and pinnipeds. In order to represent a probability of risk in developing this function, the function would have a value near zero at very low exposures, and a value near one for very high exposures. One class of functions that satisfies this criterion is cumulative probability distributions, a type of cumulative distribution function. In selecting a particular functional expression for risk, several criteria were identified:

- The function must use parameters to focus discussion on areas of uncertainty;
- The function should contain a limited number of parameters;
- The function should be capable of accurately fitting experimental data; and
- The function should be reasonably convenient for algebraic manipulations.

As described in DoN 2001, the mathematical function below is adapted from a solution in Feller (1968).

$$R = \frac{1 - \left(\frac{L-B}{K}\right)^{-A}}{1 - \left(\frac{L-B}{K}\right)^{-2A}}$$

Where: R = risk (0 – 1.0);

L = Received Level (RL) in dB

B = basement RL in dB (120 dB)

K = the RL increment above basement in dB at which there is 50% risk

A = risk transition sharpness parameter (10)

It is important to note that the probabilities associated with acoustic modeling do not represent an individual's probability of responding; they identify the proportion of an exposed population (as represented by an evenly distributed density of marine mammals per unit area) that is likely to respond to an exposure. In addition, modeling does not take into account reductions from any of the Navy's standard protective mitigation measures which should significantly reduce or eliminate actual exposures that may have otherwise occurred during training.

D.2 ACOUSTIC SOURCES

The acoustic sources employed in the NWTRC are categorized as either broadband (producing sound over a wide frequency band) or narrowband (producing sound over a frequency band that that is small in comparison to the center frequency). In general, the narrowband sources in this exercise are Anti-

Submarine Warfare (ASW) sonars and the broadband sources are explosives. This delineation of source types has a couple of implications. First, the transmission loss used to determine the impact ranges of narrowband ASW sonars can be adequately characterized by model estimates at a single frequency. Broadband explosives, on the other hand, produce significant acoustic energy across several frequency decades of bandwidth. Propagation loss is sufficiently sensitive to frequency as to require model estimates at several frequencies over such a wide band.

Second, the types of sources have different sets of harassment metrics and thresholds. Energy metrics are defined for both types. However, explosives are impulsive sources that produce a shock wave that dictates additional pressure-related metrics (peak pressure and positive impulse). Detailed descriptions of both types of sources are provided in the following subsections.

D.2.1 Sonars

Operations in the NWTRC involve five types of narrowband sonars. Harassment estimates are calculated for each sonar according to the manner in which it operates. For example, the SQS-53C is a hull-mounted, surface ship sonar that operates for many hours at a time, so it is useful to calculate and report SQS-53C harassments per hour of operation. The AQS-22 is a helicopter-deployed sonar, which is lowered into the water, pings a number of times, and then moves to a new location. For the AQS-22, it is useful to calculate and report harassments per dip. The AN/SSQ-62 is a sonobuoy that is dropped into the water from an aircraft or helicopter and pings about 10 to 30 times in an hour. For the AN/SSQ-62, it is most helpful to calculate and report exposures per sonobuoy. For the MK-48 torpedo, the sonar is modeled for a typical training event and the MK-48 reporting metric is the number of torpedo runs. Table D-2 presents the deploying platform, frequency class, and the reporting metrics for each narrow-band sonar used in the NWTRC.

Table D-2. Active Sonars Employed in NWTRC

Sonar	Description	Frequency Class	Exposures Reported	Units per Hour
MK-48	Torpedo sonar	High-frequency	Per torpedo	One torpedo run
AN/SQS-53C	Surface ship sonar	Mid-frequency	Per hour	120 sonar pings
AN/SQS-56	Surface ship sonar	Mid-frequency	Per hour	120 sonar pings
AN/SSQ-62	Sonobuoy sonar	Mid-frequency	Per sonobuoy	8 sonobuoys
AN/AQS-22	Helicopter-dipping sonar	Mid-frequency	Per dip	2 dips
AN/BQS-15	Submarine sonar	High-frequency	Not modeled	Not modeled

Note that MK-48 source described here is the active pinger on the torpedo; the explosive source of the detonating torpedo is described in the next subsection.

The acoustic modeling that is necessary to support the harassment estimates for each of these sonars relies on a generalized description of the manner of the sonar's operating modes. This description includes the following:

- "Effective" energy source level—This is the level relative to 1 μPa^2-s of the integral over frequency and time of the square of the pressure and is given by the total energy level across the band of the source, scaled by the pulse length (10 $\log_{10}$ [pulse length]).
- Source depth—Depth of the source in meters.
- Nominal frequency—Typically the center band of the source emission. These are frequencies that have been reported in open literature and are used to avoid classification issues.

Differences between these nominal values and actual source frequencies are small enough to be of little consequence to the output impact volumes.

- Source directivity—The source beam is modeled as the product of a horizontal beam pattern and a vertical beam pattern. Two parameters define the horizontal beam pattern:
  - Horizontal beam width—Width of the source beam (degrees) in the horizontal plane (assumed constant for all horizontal steer directions).
  - Horizontal steer direction—Direction in the horizontal in which the beam is steered relative to the direction in which the platform is heading.

  The horizontal beam is assumed to have constant level across the width of the beam with flat, 20-dB down sidelobes at all other angles.

  Similarly, two parameters define the vertical beam pattern:

  - Vertical beam width—Width of the source beam (degrees) in the vertical plane measured at the 3-dB down point (assumed constant for all vertical steer directions).
  - Vertical steer direction—Direction in the vertical plane that the beam is steered relative to the horizontal (upward looking angles are positive).

  To avoid sharp transitions that a rectangular beam might introduce, the power response at vertical angle θ is

  $$\text{Power} = \max \{ \sin^2 [n(\theta_s - \theta)] / [n \sin (\theta_s - \theta)]^2,\ 0.01 \},$$

  where θ_s is the vertical beam steer direction, and $n = 2{*}L/\lambda$ (L = array length, λ = wavelength).

  The beamwidth of a line source is determined by n (the length of the array in half-wavelengths) as $\theta_w = 180^o/n$.

- Ping spacing—Distance between pings. For most sources this is generally just the product of the speed of advance of the platform and the repetition rate of the sonar. Animal motion is generally of no consequence as long as the source motion is greater than the speed of the animal (nominally, 3 knots). For stationary (or nearly stationary) sources, the "average" speed of the animal is used in place of the platform speed. The attendant assumption is that the animals are all moving in the same constant direction.

Many of the actual parameters and capabilities of these sonars are classified. Parameters used for modeling were derived to be as representative as possible taking into account the manner with which the sonar would be used in various training scenarios. However, when there was a wide range of potential modeling input values, the default was to model using a nominal parameter likely to result in the most impact, so that the model would err towards the maximum potential exposures.

For the sources that are essentially stationary (AN/SSQ-62 and AN/AQS-22), emission spacing is the product of the ping cycle time and the average animal speed.

D.2.2 Explosives

Explosives detonated underwater introduce loud, impulsive, broadband sounds into the marine environment. Three source parameters influence the effect of an explosive: the weight of the explosive material, the type of explosive material, and the detonation depth. The net explosive weight (or NEW) accounts for the first two parameters. The NEW of an explosive is the weight of TNT required to produce an equivalent explosive power.

The detonation depth of an explosive is particularly important due to a propagation effect known as surface-image interference. For sources located near the sea surface, a distinct interference pattern arises from the coherent sum of the two paths that differ only by a single reflection from the pressure-release surface. As the source depth and/or the source frequency decreases, these two paths increasingly, destructively interfere with each other, reaching total cancellation at the surface (barring surface-reflection scattering loss). For the NWTRC there are three types of explosive sources: AN/SSQ-110 Extended Echo Ranging (EER) sonobuoys, demolition charges, and munitions (MK-48 torpedo, Maverick, Harpoon, HARM, HELLFIRE and SLAM missiles, MK-82, MK-83, MK-84, GBU-10, GBU-12 and GBU-16 bombs, 5-inch rounds and 76 mm gunnery rounds). The EER source can be detonated at several depths within the water column. For this analysis a relatively shallow depth of 20 meters is used to optimize the likelihood of the source being positioned in a surface duct. Demolition charges are typically modeled as detonating near the bottom. For a SINKEX the demolition charge would be on the hull. The MK-48 detonates immediately below the hull of its target (nominally 50 feet). A source depth of 2 meters is used for bombs and missiles that do not strike their target. For the gunnery rounds, a source depth of 1 foot is used. The NEWs for these sources are as follows:

- EER Source—5 pounds
- Demolition charge—10 pounds in Explosive Ordnance Disposal (EOD), 100 pounds in a sinking exercise (SINKEX)
- MK-48—851 pounds
- Maverick—78.5 pounds
- Harpoon—448 pounds
- HARM—41.6 pounds
- HELLFIRE—16.4 pounds
- SLAM—164.25 pounds
- MK-82—238 pounds
- GBU-10—945 pounds
- GBU-12—238 pounds
- GBU-16—445 pounds
- 5-inch rounds—9.54 pounds
- 76 mm rounds—1.6 pounds

The exposures expected to result from these sources are computed on a per in-water explosive basis. The cumulative effect of a series of explosives can often be derived by simple addition if the detonations are spaced widely in time or space, allowing for sufficient animal movements as to ensure a different population of animals is considered for each detonation. There may be rare occasions when MSEs are part of a static location event. For these events, the Churchill FEIS approach was extended to cover events occurring at the same location. For MSE exposures, accumulated energy over the entire training time is the natural extension for energy thresholds since energy accumulates with each subsequent shot; this is consistent with the treatment of multiple arrivals in Churchill. For positive impulse, it is consistent with the Churchill FEIS to use the maximum value over all impulses received.

For MSEs, the acoustic criterion for sub-TTS behavioral disturbance is used to account for behavioral effects significant enough to be judged as harassment, but occurring at lower sound energy levels than those that may cause TTS.

A special case in which simple addition of the harassment estimates may not be appropriate is addressed by the modeling of a "representative" SINKEX. In a SINKEX, a decommissioned surface ship is towed to a specified deep-water location and there used as a target for a variety of weapons. Although no two SINKEXs are ever the same, a representative case derived from past exercises is described in the *Programmatic SINKEX Overseas Environmental Assessment* (March 2006) for the Western North Atlantic.

In a SINKEX, weapons are typically fired in order of decreasing range from the source, with weapons fired until the target is sunk. A torpedo is used after all munitions have been expended if the target is still afloat. Since the target may sink at any time during the exercise, the actual number of weapons used can vary widely. In the representative case, however, all of the ordnances are assumed expended; this represents the worst case with maximum exposure. The sequence of weapons firing for the representative SINKEX is described in Table D-3.

Table D-3. Representative SINKEX Weapons Firing Sequence

Time (Local)	Event Description
0900	Range Control Officer receives reports that the exercise area is clear of non-participant ship traffic, marine mammals, and sea turtles.
0910	2 HARM missiles fired, both hit target (5 minutes apart).
0925	3 Harpoon missiles fired, all hit target (1 minute apart).
0945	1 SLAM-ER missile fired, hits target.
1030	Surface gunfire commences – 500 five-inch rounds fired (one every 6 seconds), 350 hit target, 150 miss target. 200 76-mm rounds fired, 140 hit target, 60 miss.
1200	1 Hellfire missile fired, hits target.
1230	3 Maverick missiles fired, 2 hit target, 1 misses (5 minutes apart).
1330	4 live GBU-12 bombs dropped – 3 hit target, 1 misses target (2 minutes apart). 4 live GBU-16 bombs dropped – 3 hit target, 1 misses target (2 minutes apart). 4 live GBU-10 bombs dropped – 3 hit target, 1 misses target (2 minutes apart).
1500	MK 48 Torpedo fired, hits, and does not sink target.
1700	Underwater demolition to sink target.

Guided weapons are nearly 100% accurate and are modeled as hitting the target (that is, no underwater acoustic effect) in all but two cases: (1) the Maverick is modeled as a miss to represent the occasional miss, and (2) the MK-48 torpedo intentionally detonates in the water column immediately below the hull of the target. Unguided weapons are more frequently off-target and are modeled according to the statistical hit/miss ratios. Note that these hit/miss ratios are artificially low in order to demonstrate a worst-case scenario; they should not be taken as indicative of weapon or platform reliability.

D.3 ENVIRONMENTAL PROVINCES

Propagation loss ultimately determines the extent of the Zone of Influence (ZOI) for a particular source activity. In turn, propagation loss as a function of range responds to a number of environmental parameters:

- Water depth
- Sound speed variability throughout the water column

- Bottom geo-acoustic properties, and
- Surface roughness, as determined by wind speed

Due to the importance that propagation loss plays in ASW, the Navy has, over the last four to five decades, invested heavily in measuring and modeling these environmental parameters. The result of this effort is the following collection of global databases of these environmental parameters, which are accepted as standards for Navy modeling efforts.

- Water depth—Digital Bathymetry Data Base Variable Resolution (DBDBV)
- Sound speed—Generalized Digital Environmental Model (GDEM)
- Bottom loss—Low-Frequency Bottom Loss (LFBL), Sediment Thickness Database, and High-Frequency Bottom Loss (HFBL), and
- Wind speed—U.S. Navy Marine Climatic Atlas of the World

This section provides a discussion of the relative impact of these various environmental parameters. These examples then are used as guidance for determining environmental provinces (that is, regions in which the environmental parameters are relatively homogeneous and can be represented by a single set of environmental parameters) within the NWTRC.

D.3.1 Impact of Environmental Parameters

Within a typical operating area, the environmental parameter that tends to vary the most is bathymetry. It is not unusual for water depths to vary by an order of magnitude or more, resulting in significant impacts on the ZOI calculations. Bottom loss can also vary considerably over typical operating areas, but its impact on ZOI calculations tends to be limited to waters on the continental shelf and the upper portion of the slope. Generally, the primary propagation paths in deep water, from the source to most of the ZOI volume, do not involve any interaction with bottom. In shallow water, particularly if the sound velocity profile directs all propagation paths to interact with the bottom, bottom loss variability can play a larger role.

The spatial variability of the sound speed field is generally small over operating areas of typical size. The presence of a strong oceanographic front is a noteworthy exception to this rule. To a lesser extent, variability in the depth and strength of a surface duct can be of some importance. In the mid-latitudes, seasonal variation often provides the most significant variation in the sound speed field. For this reason, both summer and winter profiles are modeled for each selected environment.

D.3.2 Environmental Provincing Methodology

The underwater acoustic environment can be quite variable over ranges in excess of 10 kilometers (km). For ASW applications, ranges of interest are often sufficiently large as to warrant the modeling of the spatial variability of the environment. In the propagation loss calculations, each of the environmental parameters is allowed to vary (either continuously or discretely) along the path from acoustic source to receiver. In such applications, each propagation loss calculation is conditioned upon the particular locations of the source and receiver.

On the other hand, the range of interest for marine animal harassment by most Naval activities is more limited. This reduces the importance of the exact location of source and marine animal and makes the modeling required more manageable in scope.

In lieu of trying to model every environmental profile that can be encountered in an operating area, this effort utilizes a limited set of representative environments. Each environment is characterized by a fixed water depth, sound velocity profile, and bottom loss type. The operating area is then partitioned into homogeneous regions (or provinces), and the most appropriately representative environment is assigned to each. This process is aided by some initial provincing of the individual environmental parameters. The

Navy-standard high-frequency bottom loss database in its native form is globally partitioned into nine classes. Low-frequency bottom loss is likewise provinced in its native form, although it is not considered in the process of selecting environmental provinces. Only the broadband sources produce acoustic energy at the frequencies of interest for low-frequency bottom loss (typically less than 1 kHz); even for those sources the low-frequency acoustic energy is secondary to the energy above 1 kHz. The Navy-standard sound velocity profiles database is also available as a provinced subset. Only the Navy-standard bathymetry database varies continuously over the world’s oceans. However, even this environmental parameter is easily provinced by selecting a finite set of water depth intervals. For this analysis “octave-spaced” intervals (10, 20, 50, 100, 200, 500, 1,000, 2,000, and 5,000 meters) provide an adequate sampling of water depth dependence.

ZOI volumes are then computed using propagation loss estimates derived for the representative environments. Finally, a weighted average of the ZOI volumes is taken over all representative environments; the weighting factor is proportional to the geographic area spanned by the environmental province.

The selection of representative environments is subjective. However, the uncertainty introduced by this subjectivity can be mitigated by selecting more environments and by selecting the environments that occur most frequently over the operating area of interest.

As discussed in the previous subsection, ZOI estimates are most sensitive to water depth. Unless otherwise warranted, at least one representative environment is selected in each bathymetry province. Within a bathymetry province, additional representative environments are selected as needed to meet the following requirements.

- In shallow water (less than 1,000 meters), bottom interactions occur at shorter ranges and more frequently; thus significant variations in bottom loss need to be represented.
- Surface ducts provide an efficient propagation channel that can greatly influence ZOI estimates. Variations in the mixed layer depth need to be accounted for if the water is deep enough to support the full extent of the surface duct.

Depending upon the size and complexity of the operating area, the number of environmental provinces tends to range from 5 to 20.

D.3.3 Description of Environmental Provinces

The NWTRC encompasses a large area off the U.S. West Coast. For this analysis, the general operating area is bounded to the north and south by 48^{o} 30’ N and 40^{o} N and to the west by meridian of 130^{o} W and to the east by land. Within this large region a sub-area used for SINKEX operations is defined by the following additional restrictions:

- More than 50 nautical miles (nm) from land, and
- Water depth greater than 1,000 fathoms (1,852 meters).

Some of the active sonars are limited to Warning Area 237 (W-237), an irregularly-shaped region with the following vertices:

48^{o} 21’ 03” N 130^{o} 00’ 00” W

48^{o} 20’ 00” N 128o 00’ 00” W

48o 08’ 59” N 125o 55’ 00” W

46o 32’ 00” N 126o 42’ 00” W

45o 50’ 00” N 128^{o} 10’ 00” W

The surface ship sonars are deployed throughout the general operating area. The air-deployed sonars, including the AN/SSQ-110, are limited to W-237. The explosive sources and demolition charges are limited to the SINKEX subarea.

This subsection describes the representative environmental provinces selected for the NWTRC. For all of these provinces, the average winter wind speed is 14 knots, whereas the average summer wind speed is 8 knots.

The general operating area of the NWTRC contains a total of 47 distinct environmental provinces. These represent various combinations of nine bathymetry provinces, four Sound Velocity Profile (SVP) provinces, and six HFBL classes. Among these 47 provinces, some share important characteristics while others occur infrequently, so the provinces were reduced to a generalized class of 16 fundamental provinces.

The bathymetry provinces represent depths ranging from very shallow to typical deep-water depths. However, nearly 90% of the NWTRC is characterized as deep-water (depths of 1,000 meters or more). The distribution of the bathymetry provinces over the NWTRC is provided in Table D-4.

Four SVP provinces describe the sound speed field in the NWTRC; however, only two (provinces 30 and 35) make any significant contribution to the analysis. The variability among the four provinces is relatively small as demonstrated by the summer profiles presented in Figure D-1. The dominant difference among the profiles is the relative strength of a suppressed secondary sound channel. This feature is most clearly in the two dominant provinces.

Table D-4. Distribution of Bathymetry Provinces in NWTRC

Province Depth (m)	Frequency of Occurrence
10	0.32 %
20	0.68 %
50	2.24 %
100	3.71 %
200	3.12 %
500	3.00 %
1,000	4.55 %
2,000	55.48 %
5,000	26.90 %

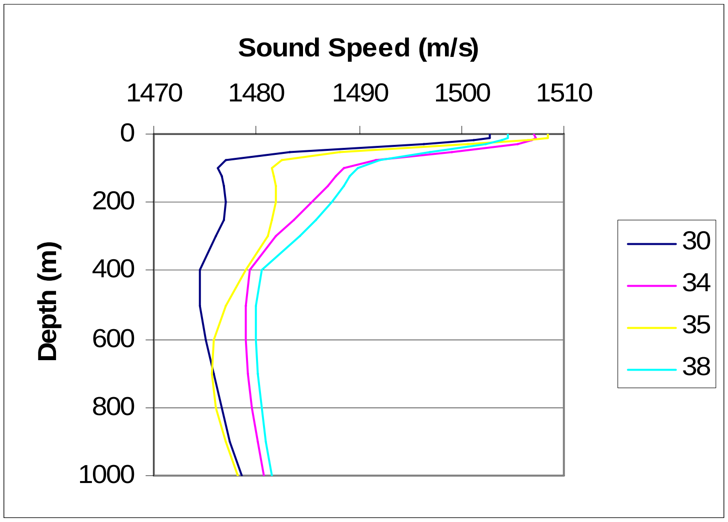


Figure D-1. Summer SVPs in NWTRC

The variation in the winter SVPs among the provinces is a bit more pronounced (Figure D-2). All four provinces display a surface duct but the two dominant provinces have a much deeper mixed layer (as much as 350 meters). This feature provides an efficient propagation channel when source and receiver are both located above the mixed layer.

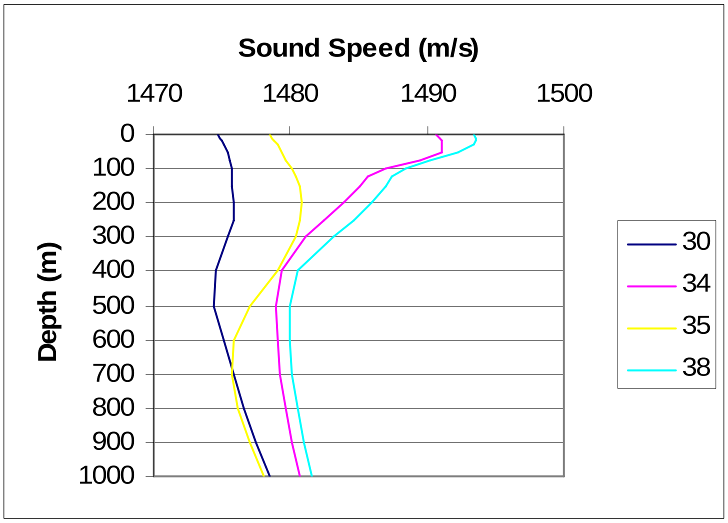


Figure D-2. Winter SVPs in NWTRC

The distribution of the SVP provinces across the NWTRC is provided in Table D-5.

Table D-5. Distribution of SVP Provinces in NWTRC

SVP Province	Frequency of Occurrence
30	87.39 %
34	0.78 %
35	11.53 %
38	0.30 %

The six HFBL classes represented in the NWTRC range from low-loss bottoms (class 2 and 3) to high-loss bottoms (classes 7 and 8). The distribution of HFBL classes summarized in Table D-6 indicates that both low- and high-loss classes are approximately equally distributed.

Table D-6. Distribution of High-Frequency Bottom Loss Classes in NWTRC

HFBL Class	Frequency of Occurrence
2	23.60 %
3	6.15 %
4	21.79 %
6	18.20 %
7	2.26 %
8	28.00 %

The logic for consolidating the environmental provinces focuses on water depth, using the sound speed profile (in deep water) and the HFBL class (in shallow water) as secondary differentiating factors. The first consideration was to ensure that all nine bathymetry provinces are represented. Then within each bathymetry province further partitioning of provinces proceeded as follows:

- The four shallowest bathymetry provinces are each represented by one environmental province. In each case, the bathymetry province is dominated by a single, low-loss bottom, so that the secondary differentiating environmental parameter is of no consequence.
- The 200- and 500-meter bathymetry provinces each consist of two environmental provinces in order to reflect both low- and high-loss bottoms that are prevalent at these depths. The 1,000-meter bathymetry province includes only high-loss bottoms and therefore does not need to be partitioned
- The 2,000-meter bathymetry province contains negligible variability in sound speed profiles. However, the 2,000-meter bathymetry province is significantly large as to warrant some partitioning based upon bottom loss. This bathymetry province is subdivided into three environmental provinces using HFBL classes 4, 6 and 8.
- The 5,000-meter bathymetry province is also a prevalent water depth in the NWTRC. For this analysis, it is partitioned into four environment provinces to capture both SVP province (30 and 35), and bottoms that are low-loss (HFBL classes 2 and 3) and high-loss (HFBL class 7).

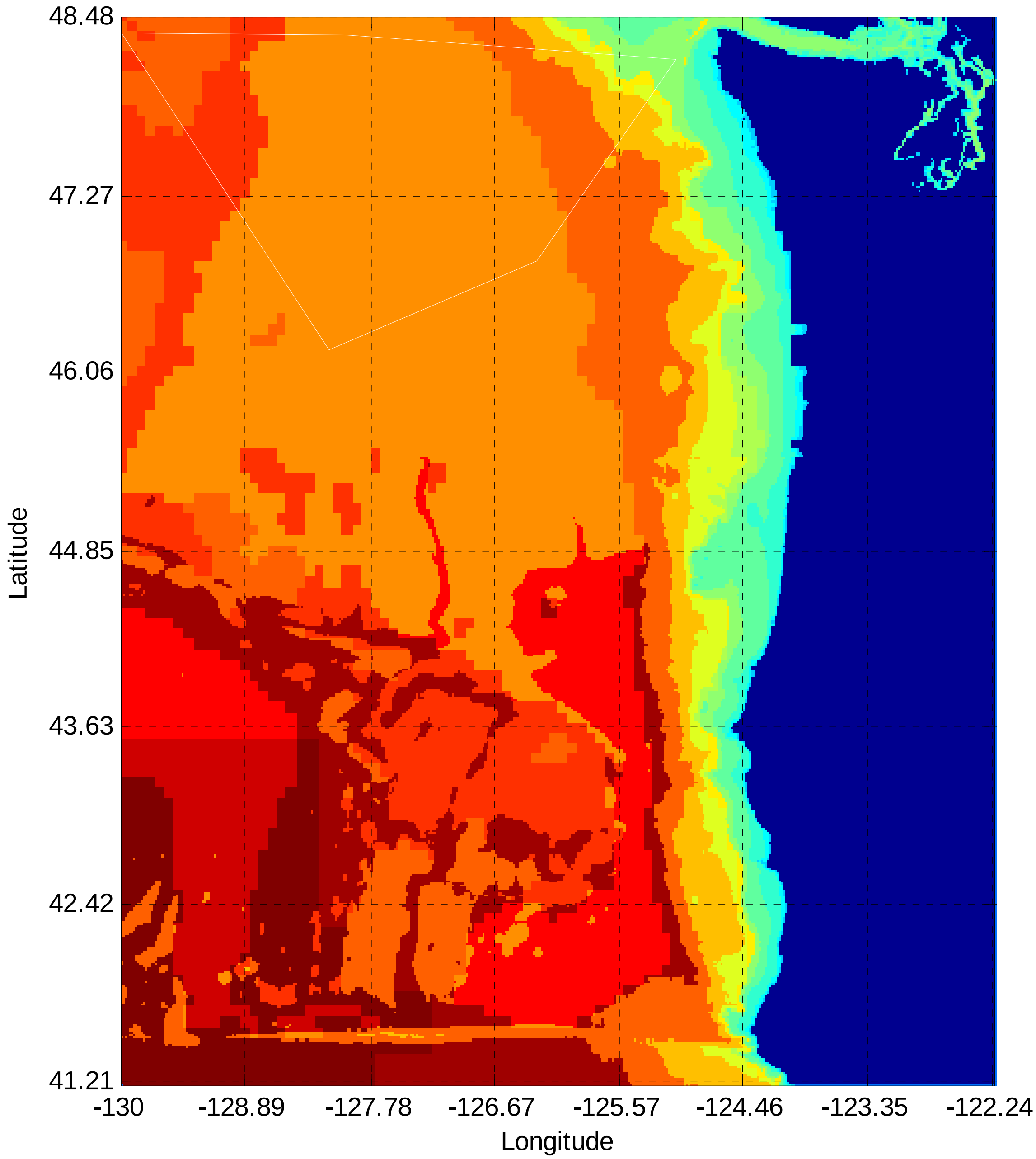
The resulting 16 environmental provinces used in the NWTRC acoustic modeling are described in Table D-7.

The percentages given in the preceding table indicate the frequency of occurrence of each environmental province across the general operating area in the NWTRC. Geographically, the distribution of these 16 environmental provinces is exhibited in Figure D-3.

Table D-7. Distribution of Environmental Provinces in General OPAREA of NWTRC

Environmental Province	Water Depth	SVP Province	HFBL Class	LFBL Province	Sediment Thickness	Frequency of Occurrence
1	10 m	30	2	0	0.2 secs	0.324%
2	20 m	30	2	0	0.2 secs	0.688%
3	50 m	30	2	0	0.27 secs	2.268%
4	100 m	30	2	– 10	0.41 secs	3.751%
5	200 m	30	2	– 10*	0.33 secs	2.577%
6	200 m	30	8	– 10*	0.62 secs	0.582%
7	500 m	30	8	14	0.31 secs	2.484%
8	500 m	30	2	– 10	0.23 secs	0.550%
9	1,000 m	30	8	14	0.21 secs	4.605%
10	2,000 m	30	4	18	0.82 secs	29.627%
11	2,000 m	30	8	18	0.41 secs	15.460%
12	2,000 m	30	6	19	0.2 secs	11.026%
13	5,000 m	30	2	14	0.74 secs	8.396%
14	5,000 m	35	3	18	0.36 secs	3.960%
15	5,000 m	30	7	14	0.88 secs	7.815%
16	5,000 m	35	7	18	0.29 secs	5.886%

* Negative province numbers indicate shallow water provinces



Note: the northwestern coast of the United States is in blue, and higher province index numbers correspond to redder colors. The white polygon represents W-237.

Figure D-3. NWTRC Environmental Provinces over OPAREA

The distribution of the environments within the SINKEX area is, by definition, limited to the two deepest bathymetry provinces as indicated in Table D-8.

Table D-8. Distribution of Environmental Provinces within SINKEX Area

Environmental Province	Frequency of Occurrence
10	38.48 %
11	13.92 %
12	14.21 %
13	9.67 %
14	5.13 %
15	9.19 %
16	9.40 %

The air-deployed sonars are also restricted in their use. They are limited to W-237 for which the distribution of provinces is provided in Table D-9.

Table D-9. Distribution of Environmental Provinces within W-237

Environmental Province	Frequency of Occurrence
5	1.112 %
6	0/015 %
7	0.846 %
8	0.395 %
9	3.111 %
10	71.883 %
11	7.976 %
12	14.662 %

D.4 IMPACT VOLUMES AND IMPACT RANGES

Many naval actions include the potential to injure or harass marine animals in the neighboring waters through noise emissions. The number of animals exposed to potential harassment in any such action is dictated by the propagation field and the characteristics of the noise source.

The impact volume associated with a particular activity is defined as the volume of water in which some acoustic metric exceeds a specified threshold. The product of this impact volume with a volumetric animal density yields the expected value of the number of animals exposed to that acoustic metric at a level that exceeds the threshold. The acoustic metric can either be an energy term (EFD, either in a limited frequency band or across the full band) or a pressure term (such as peak pressure or positive impulse). The thresholds associated with each of these metrics define the levels at which half of the animals exposed will experience some degree of harassment (ranging from behavioral change to mortality).

Impact volume is particularly relevant when trying to estimate the effect of repeated source emissions separated in either time or space. Impact range, which is defined as the maximum range at which a particular threshold is exceeded for a single source emission, defines the range to which marine mammal activity is monitored in order to meet mitigation requirements.

With the exception of explosive sources, the sole relevant measure of potential harm to the marine wildlife due to sonar is the accumulated (summed over all source emissions) EFD received by the animal over the duration of the activity. Harassment measures for explosive sources include EFD and pressure-related metrics (peak pressure and positive impulse).

Regardless of the type of source, estimating the number of animals that may be injured or otherwise harassed in a particular environment entails the following steps.

Each source emission is modeled according to the particular operating mode of the sonar. The “effective” energy source level is computed by integrating over the bandwidth of the source, scaling by the pulse length, and adjusting for gains due to source directivity. The location of the source at the time of each emission must also be specified.

For the relevant environmental acoustic parameters, transmission loss (TL) estimates are computed, sampling the water column over the appropriate depth and range intervals. TL data are sampled at the typical depth(s) of the source and at the nominal center frequency of the source. If the source is relatively broadband, an average over several frequency samples is required.

The accumulated energy within the waters that the source is “operating” is sampled over a volumetric grid. At each grid point, the received energy from each source emission is modeled as the effective energy source level reduced by the appropriate propagation loss from the location of the source at the time of the emission to that grid point and summed. For the peak pressure or positive impulse, the appropriate metric is similarly modeled for each emission. The maximum value of that metric, over all emissions, is stored at each grid point.

The impact volume for a given threshold is estimated by summing the incremental volumes represented by each grid point for which the appropriate metric exceeds that threshold.

Finally, the number of exposures is estimated as the “product” (scalar or vector, depending on whether an animal density depth profile is available) of the impact volume and the animal densities.

This section describes in detail the process of computing impact volumes (that is, the first four steps described above). This discussion is presented in two parts: active sonars and explosive sources. The relevant assumptions associated with this approach and the limitations that are implied are also presented. The final step, computing the number of exposures, is discussed in subsection D.5.

D.4.1 Computing Impact Volumes for Active Sonars

This section provides a detailed description of the approach taken to compute impact volumes for active sonars. Included in this discussion are:

- Identification of the underwater propagation model used to compute transmission loss data, a listing of the source-related inputs to that model, and a description of the output parameters that are passed to the energy accumulation algorithm.
- Definitions of the parameters describing each sonar type.

Description of the algorithms and sampling rates associated with the energy accumulation algorithm.

D.4.1.1 Transmission Loss Calculations

TL data are pre-computed for each of two seasons in each of the environmental provinces described in the previous subsection using the GRAB propagation loss model (Keenan, 2000). The TL output consists of a parametric description of each significant eigenray (or propagation path) from source to animal. The description of each eigenray includes the departure angle from the source (used to model the source vertical directivity later in this process), the propagation time from the source to the animal (used to make corrections to absorption loss for minor differences in frequency and to incorporate a surface-image interference correction at low frequencies), and the TL suffered along the eigenray path.

The eigenray data for a single GRAB model run are sampled at uniform increments in range out to a maximum range for a specific "animal" (or "target" in GRAB terminology) depth. Multiple GRAB runs are made to sample the animal depth dependence. The depth and range sampling parameters are summarized in Table D-10. Note that some of the low-power sources do not require TL data to large maximum ranges.

Table D-10. TL Depth and Range Sampling Parameters by Sonar Type

Sonar	Range Step	Maximum Range	Depth Sampling
MK-48	10 m	10 km	0 – 1 km in 5-m steps 1 km – Bottom in 10-m steps
AN/SQS-53C	10 m	200 km	0 – 1 km in 5-m steps 1 km – Bottom in 10-m steps
AN/AQS-22	10 m	10 km	0 – 1 km in 5-m steps 1 km – Bottom in 10-m steps
AN/ASQ-62	5 m	5 km	0 – 1 km in 5-m steps 1 km – Bottom in 10-m steps
AN/SQS-56	10 m	50 km	0 – 1 km in 5-m steps 1 km – Bottom in 10-m steps

In a few cases, most notably the AN/SQS-53C for thresholds below approximately 180 dB, TL data may be required by the energy summation algorithm at ranges greater than covered by the pre-computed GRAB data. In these cases, TL is extrapolated to the required range using a simple cylindrical spreading loss law in addition to the appropriate absorption loss. This extrapolation leads to a conservative (or under) estimate of TL at the greater ranges.

Although GRAB provides the option of including the effect of source directivity in its eigenray output, this capability is not exercised. By preserving data at the eigenray level, this allows source directivity to be applied later in the process and results in fewer TL calculations.

The other important feature that storing eigenray data supports is the ability to model the effects of surface-image interference that persist over range. However, this is primarily important at frequencies lower than those associated with the sonars considered in this subsection. A detailed description of the modeling of surface-image interference is presented in the subsection on explosive sources.

D.4.1.2 Energy Summation

The summation of EFD over multiple pings in a range-independent environment is a trivial exercise for the most part. A volumetric grid that covers the waters in and around the area of sonar operation is initialized. The source then begins its set of pings. For the first ping, the TL from the source to each grid point is determined (summing the appropriate eigenrays after they have been modified by the vertical beam pattern), the “effective” energy source level is reduced by that TL, and the result is added to the accumulated EFD at that grid point. After each grid point has been updated, the accumulated energy at grid points in each depth layer is compared to the specified threshold. If the accumulated energy exceeds that threshold, then the incremental volume represented by that grid point is added to the impact volume for that depth layer. Once all grid points have been processed, the resulting sum of the incremental volumes represents the impact volume for one ping.

The source is then moved along one of the axes in the horizontal plane by the specified ping separation range and the second ping is processed in a similar fashion. Again, once all grid points have been processed, the resulting sum of the incremental volumes represents the impact volume for two pings. This procedure continues until the maximum number of pings specified has been reached.

Defining the volumetric grid over which energy is accumulated is the trickiest aspect of this procedure. The volume must be large enough to contain all volumetric cells for which the accumulated energy is likely to exceed the threshold but not so large as to make the energy accumulation computationally unmanageable.

Determining the size of the volumetric grid begins with an iterative process to determine the lateral extent to be considered. Unless otherwise noted, throughout this process the source is treated as omnidirectional and the only animal depth that is considered is the TL target depth that is closest to the source depth (placing source and receiver at the same depth is generally an optimal TL geometry).

The first step is to determine the impact range (Rmax) for a single ping. The impact range in this case is the maximum range at which the effective energy source level reduced by the TL is greater than the threshold. Next, the source is moved along a straight-line track and EFD is accumulated at a point that has a closest point of approach (CPA) range of RMAX at the mid-point of the source track. That total EFD summed over all pings is then compared to the prescribed threshold. If it is greater than the threshold (which, for the first R_{max}, it must be) then R_{max} is increased by 10 percent, the accumulation process is repeated, and the total energy is again compared to the threshold. This continues until R_{max} grows large enough to ensure that the accumulated EFD at that lateral range is less than the threshold. The lateral range dimension of the volumetric grid is then set at twice R_{max}, with the grid centered along the source track. In the direction of advance for the source, the volumetric grid extends on the interval from [$-R_{max}$, 3 R_{max}] with the first source position located at zero in this dimension. Note that the source motion in this direction is limited to the interval [0, 2 R_{max}]. Once the source reaches 2 R_{max} in this direction, the incremental volume contributions have approximately reached their asymptotic limit and further pings add essentially the same amount. This geometry is demonstrated in Figure D-4.

If the source is directive in the horizontal plane, then the lateral dimension of the grid may be reduced and the position of the source track adjusted accordingly. For example, if the main lobe of the horizontal source beam is limited to the starboard side of the source platform, then the port side of the track is reduced substantially as demonstrated in Figure D-5.

Once the extent of the grid is established, the grid sampling can be defined. In both dimensions of the horizontal plane the sampling rate is approximately R_{max}/100. The round-off error associated with this sampling rate is roughly equivalent to the error in a numerical integration to determine the area of a circle with a radius of R_{max} with a partitioning rate of R_{max}/100 (approximately 1 percent). The depth-sampling rate of the grid is comparable to the sampling rates in the horizontal plane but discretized to match an actual TL sampling depth. The depth-sampling rate is also limited to no more than 10 meters to ensure that significant TL variability over depth is captured.

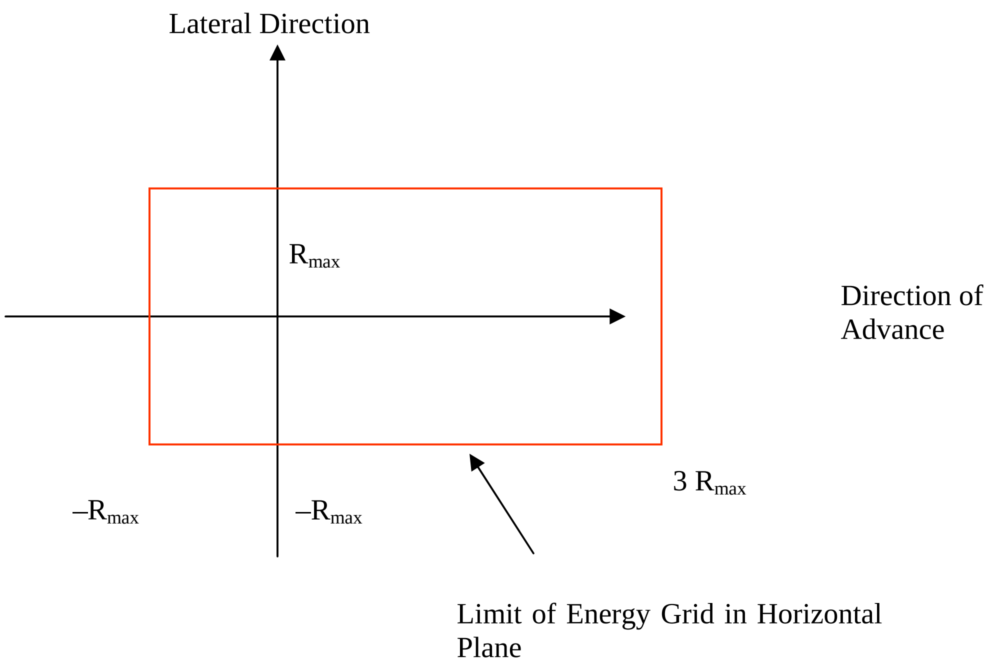


Figure D-4. Horizontal Plane of Volumetric Grid for Omni Directional Source

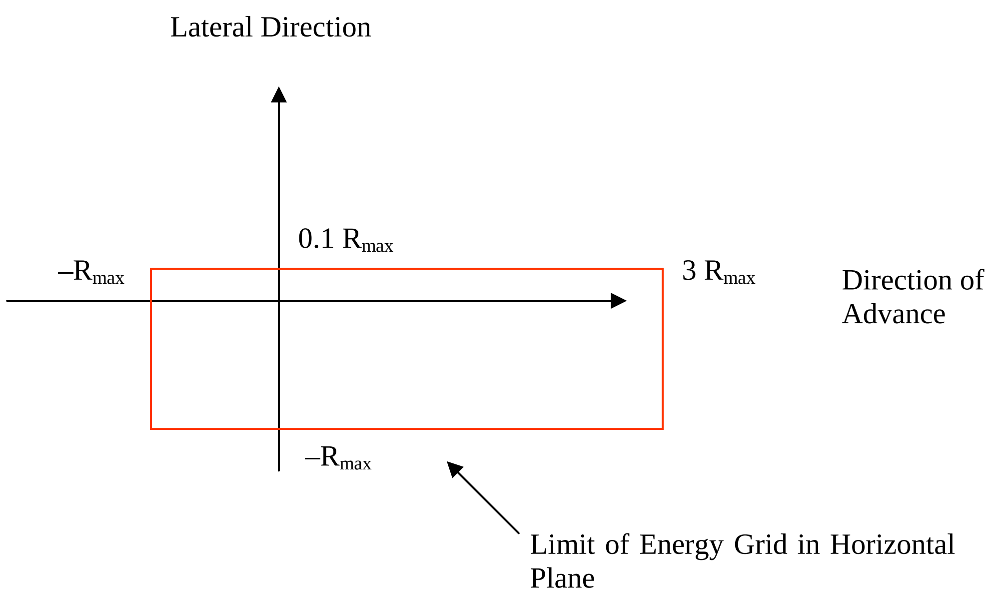


Figure D-5. Horizontal Plane of Volumetric Grid for Starboard Beam Source

D.4.1.3 Impact Volume per Hour of Sonar Operation

The impact volume for a sonar moving relative to the animal population increases with each additional ping. The rate at which the impact volume increases varies with a number of parameters but eventually approaches some asymptotic limit. Beyond that point the increase in impact volume becomes essentially linear as depicted in Figure D-6.

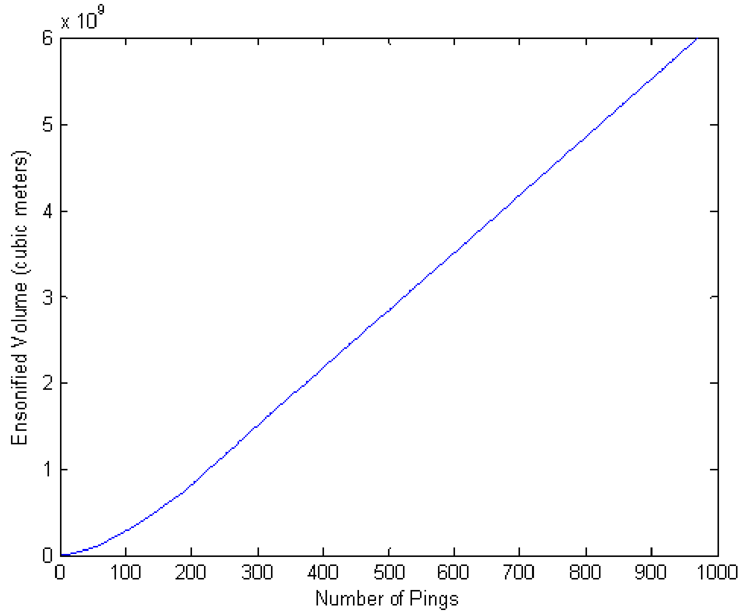


Figure D-6. 53C Impact Volume by Ping

The slope of the asymptotic limit of the impact volume at a given depth is the impact volume added per ping. This number multiplied by the number of pings in an hour gives the hourly impact volume for the given depth increment. Completing this calculation for all depths in a province, for a given source, gives the hourly impact volume vector, v_n, which contains the hourly impact volumes by depth for province n. Figure D-7 provides an example of an hourly impact volume vector for a particular environment.

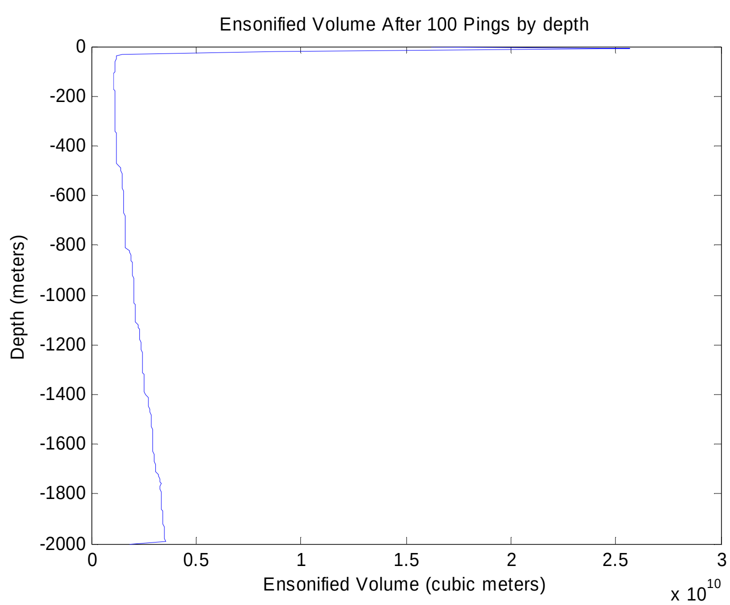


Figure D-7. Example of an Impact Volume Vector

D.4.2 Computing Impact Volumes for Explosive Sources

This section provides the details of the modeling of the explosive sources. This energy summation algorithm is similar to that used for sonars, only differing in details such as the sampling rates and source parameters. These differences are summarized in the following subsections. A more significant difference is that the explosive sources require the modeling of additional pressure metrics: (1) peak pressure, and (2) “modified” positive impulse. The modeling of each of these metrics is described in detail in the subsections of D.4.2.3.

D.4.2.1 Transmission Loss Calculations

Modeling impact volumes for explosive sources span requires the same type of TL data as needed for active sonars. However, unlike active sonars, explosive ordnances and the EER source are broadband, contributing significant energy from tens of hertz to tens of kilohertz. To accommodate the broadband nature of these sources, TL data are sampled at seven frequencies from 10 Hz to 40 kHz, spaced every two octaves.

An important propagation consideration at low frequencies is the effect of surface-image interference. As either source or target approach the surface, pairs of paths that differ by a single surface reflection set up an interference pattern that ultimately causes the two paths to cancel each other when the source or target is at the surface. A fully coherent summation of the eigenrays produces such a result but also introduces extreme fluctuations that would have to be highly sampled in range and depth, and then smoothed to give meaningful results. An alternative approach is to implement what is sometimes called a semi-coherent summation. A semi-coherent sum attempts to capture significant effects of surface-image interference (namely the reduction of the field due to destructive interference of reflected paths as the source or target approach the surface) without having to deal with the more rapid fluctuations associated with a fully coherent sum. The semi-coherent sum is formed by a random phase addition of paths that have already been multiplied by the expression:

$$\sin^2 [\, 4 \pi f z_s z_a / (c^2 t) \,]$$

where f is the frequency, z_s is the source depth, z_a is the animal depth, c is the sound speed and t is the travel time from source to animal along the propagation path. For small arguments of the sine function this expression varies directly as the frequency and the two depths. It is this relationship that causes the propagation field to go to zero as the depths approach the surface or the frequency approaches zero.

This surface-image interference must be applied across the entire bandwidth of the explosive source. The TL field is sampled at several representative frequencies. However, the image-interference correction given above varies substantially over that frequency spacing. To avoid possible under sampling, the image-interference correction is averaged over each frequency interval.

D.4.2.2 Source Parameters

Unlike active sonars, explosive sources are defined by only two parameters: (1) net explosive weight, and (2) source detonation depth. Values for these source parameters are defined earlier in subsection D.2.2.

The effective energy source level, which is treated as a de facto input for the other sonars, is instead modeled directly for EER and munitions. For both, the energy source level is comparable to the model used for other explosives (Arons [1954], Weston [1960], McGrath [1971], Urick [1983], Christian and Gaspin [1974]). The energy source level over a one-third octave band with a center frequency of f for a source with a net explosive weight of w pounds is given by:

$$\text{ESL} = 10 \log_{10} (0.26\, f) + 10 \log_{10} (2\, p_{max}^2 / [1/\theta^2 + 4 \pi f^2]) + 197 \text{ dB}$$

where the peak pressure for the shock wave at 1 meter is defined as

$$p_{max} = 21600\, (w^{1/3} / 3.28)^{1.13} \text{ psi} \qquad \text{(E-1)}$$

and the time constant is defined as:

$$\theta = [(0.058)\, (w^{1/3})\, (3.28 / w^{1/3})^{0.22}] / 1{,}000 \text{ msec} \qquad \text{(E-2)}$$

In contrast to munitions that are modeled as omnidirectional sources, the EER source is a continuous line array that produces a directed source. The EER array consists of two explosive strips that are fired simultaneously from the center of the array. Each strip generates a beam pattern with the steer direction of the main lobe determined by the burn rate. The resulting response of the entire array is a bifurcated beam for frequencies above 200 Hz, while at lower frequencies the two beams tend to merge into one.

Since very short ranges are under consideration, the loss of directivity of the array needs to be accounted for in the near field of the array. This is accomplished by modeling the sound pressure level across the field as the coherent sum of contributions of infinitesimal sources along the array that are delayed according to the burn rate. For example, for frequency f the complex pressure contribution at a depth z and horizontal range x from an infinitesimal source located at a distance z' above the center of the array is

$$p(r,z) = e^{i\phi}$$

where

$$\phi = kr' + \alpha z', \text{ and}$$

$$\alpha = 2 \pi f / c_b$$

with k the acoustic wave number, c_b the burn rate of the explosive ribbon, and r' the slant range from the infinitesimal source to the field point (x,z).

Beam patterns as function of vertical angle are then sampled at various ranges out to a maximum range that is approximately L^2 / λ where L is the array length and λ is the wavelength. This maximum range is a rule-of-thumb estimate for the end of the near field (Bartberger, 1965). Finally, commensurate with the resolution of the TL samples, these beam patterns are averaged over octave bands.

A couple of sample beam patterns are provided in Figure D-8 and Figure D-9. In both cases, the beam response is sampled at various ranges from the source array to demonstrate the variability across the near field. The 80-Hz family of beam patterns presented in Figure D-8 shows the rise of a single main lobe as range increases.

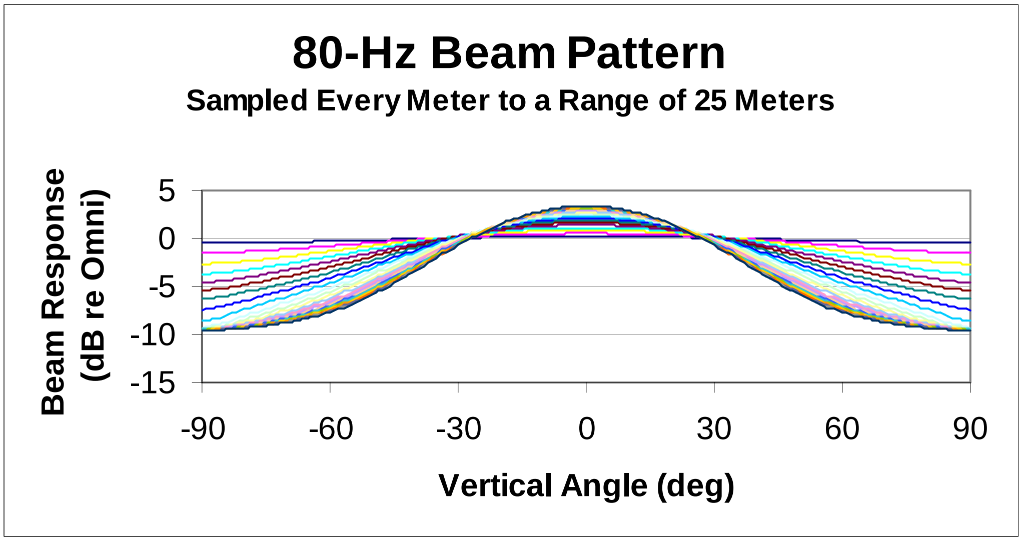


Figure D-8. 80-Hz Beam Patterns across Near Field of EER Source

On the other hand, the 1,250-Hz family of beam patterns depicted in Figure D-9 demonstrates the typical high-frequency bifurcated beam.

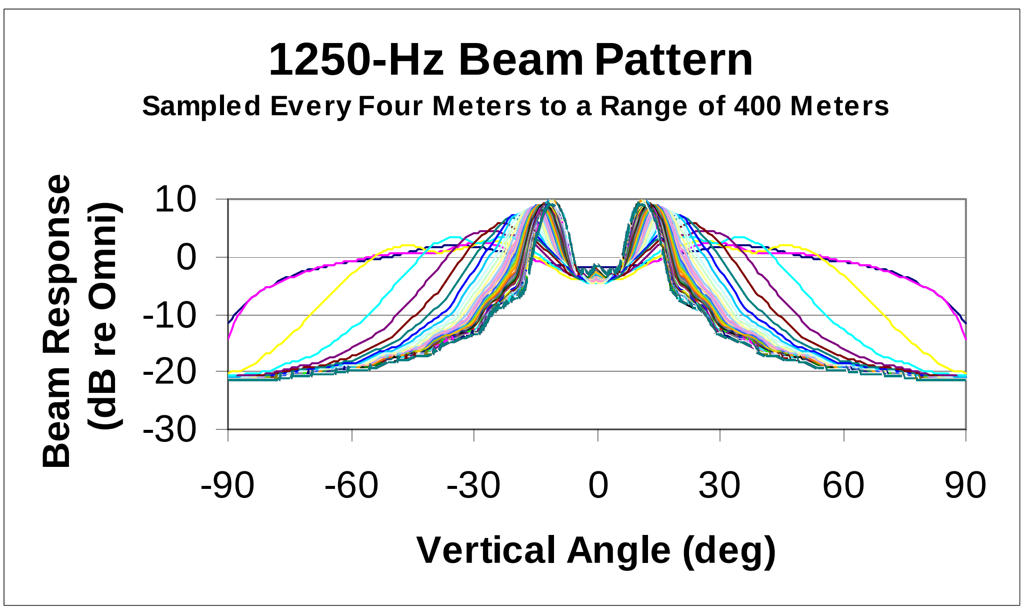


Figure D-9. 1250-Hz Beam Patterns across Near Field of EER Source

D.4.2.3 Impact Volumes for Various Metrics

The impact of explosive sources on marine wildlife is measured by three different metrics, each with its own thresholds. The energy metric, peak one-third octave, is treated in similar fashion as the energy metric used for the active sonars, including the summation of energy if there are multiple source emissions. The other two, peak pressure and positive impulse, are not accumulated but rather the maximum levels are taken.

Peak One-Third Octave Energy Metric

The computation of impact volumes for the energy metric closely follows the approach taken to model the energy metric for the active sonars. The only significant difference is that EFD is sampled at several frequencies in one-third-octave bands and only the peak one-third-octave level is accumulated over time.

Peak Pressure Metric

The peak pressure metric is a simple, straightforward calculation at each range/animal depth combination. First, the transmission ratio, modified by the source level in a one-octave band and the vertical beam pattern, is averaged across frequency on an eigenray-by-eigenray basis. This averaged transmission ratio (normalized by the total broadband source level) is then compared across all eigenrays with the maximum designated as the peak arrival. Peak pressure at that range/animal depth combination is then simply the product of:

- The square root of the averaged transmission ratio of the peak arrival,
- The peak pressure at a range of 1 meter (given by equation E-1), and
- The similitude correction (given by r –0.13, where r is the slant range along the eigenray estimated as tc with t the travel time along the dominant eigenray and c the nominal speed of sound).

If the peak pressure for a given grid point is greater than the specified threshold, then the incremental volume for the grid point is added to the impact volume for that depth layer.

"Modified" Positive Impulse Metric

The modeling of positive impulse follows the work of Goertner (Goertner, 1982). The Goertner model defines a "partial" impulse as

$$\int_0^{T_{min}} p(t)\, dt$$

where $p(t)$ is the pressure wave from the explosive as a function of time t, defined so that $p(t) = 0$ for $t < 0$. This pressure wave is modeled as

$$p(t) = p_{max}\, e^{-t/\theta}$$

where p_{max} is the peak pressure at 1 meter (see, equation B-1), and θ is the time constant defined as

$$\theta = 0.058\, w^{1/3}\, (r/w^{1/3})^{0.22} \text{ seconds}$$

with w the net explosive weight (pounds), and r the slant range between source and animal.

The upper limit of the "partial" impulse integral is

$$T_{min} = \min\{T_{cut}, T_{osc}\}$$

where T_{cut} is the time to cutoff and T_{osc} is a function of the animal lung oscillation period. When the upper limit is T_{cut}, the integral is the definition of positive impulse. When the upper limit is defined by T_{osc}, the integral is smaller than the positive impulse and thus is just a "partial" impulse. Switching the integral limit from T_{cut} to T_{osc} accounts for the diminished impact of the positive impulse upon the animals lungs that compress with increasing depth and leads to what is sometimes call a "modified" positive impulse metric.

The time to cutoff is modeled as the difference in travel time between the direct path and the surface-*reflected* path in an isospeed environment. At a range of *r*, the time to cutoff for a source depth z_s and an animal depth z_a is

$$T_{cut} = 1/c \; \{ \; [r^2 + (z_a + z_s)^2]^{1/2} - [r^2 + (z_a - z_s)^2]^{1/2} \; \}$$

where *c* is the speed of sound.

The *animal* lung oscillation period is a function of animal mass *M* and depth z_a and is modeled as

$$T_{osc} = 1.17 \; M^{1/3} \; (1 + z_a/33)^{-5/6}$$

where *M* is the animal mass (in kg) and z_a is the animal depth (in feet).

The modified positive impulse threshold is unique among the various injury and harassment metrics in that it is a function of depth and the animal weight. So instead of the user specifying the threshold, it is computed as $K\ (M/42)^{1/3}\ (1 + z_a/33)^{1/2}$. The coefficient *K* depends upon the level of exposure. For the onset of slight lung injury, *K* is 19.7; for the onset of extensive lung hemorrhaging (1% mortality), *K* is 47.

Although the thresholds are a function of depth and animal weight, sometimes they are summarized as their value at the sea surface for a typical dolphin calf (with an average mass of 12.2 kg). For the onset of slight lung injury, the threshold at the surface is approximately 13 psi-msec; for the onset of extensive lung hemorrhaging (1% mortality), the threshold at the surface is approximately 31 psi-msec.

As with peak pressure, the "modified" positive impulse at each grid point is compared to the derived threshold. If the impulse is greater than that threshold, then the incremental volume for the grid point is added to the impact volume for that depth layer.

D.4.2.4 Impact Volume per Explosive Detonation

The detonations of explosive sources are generally widely spaced in time and/or space. This implies that the impact volume for multiple firings can be easily derived by scaling the impact volume for a single detonation. Thus the typical impact volume vector for an explosive source is presented on a per-detonation basis.

D.4.3 Impact Volume by Region

The NWTRC is described by 16 environmental provinces. The hourly impact volume vector for operations involving any particular source is a linear combination of the 16 impact volume vectors with the weighting determined by the distribution of those 16 environmental provinces within the range. Unique hourly impact volume vectors for winter and summer are calculated for each type of source and each metric/threshold combination.

D.5 RISK FUNCTION: THEORETICAL AND PRACTICAL IMPLEMENTATION

This section discusses the recent addition of a risk function "threshold" to acoustic effects analysis procedure. This approach includes two parts, a new metric, and a function to map exposure level under the new metric to probability of harassment. What these two parts mean, how they affect exposure calculations, and how they are implemented are the objects of discussion.

D.5.1 Thresholds and Metrics

The term "thresholds" is broadly used to refer to both thresholds and metrics. The difference, and the distinct roles of each in effects analyses, will be the foundation for understanding the risk function approach, putting it in perspective, and showing that, conceptually, it is similar to past approaches.

Sound is a pressure wave, so at a certain point in space, sound is simply rapidly changing pressure. Pressure at a point is a function of time. Define $p(t)$ as pressure (in micro Pascals) at a given point at time t (in seconds); this function is called a "time series." Figure D-10 gives the time series of the first "hallelujah" in Handel's Hallelujah Chorus.

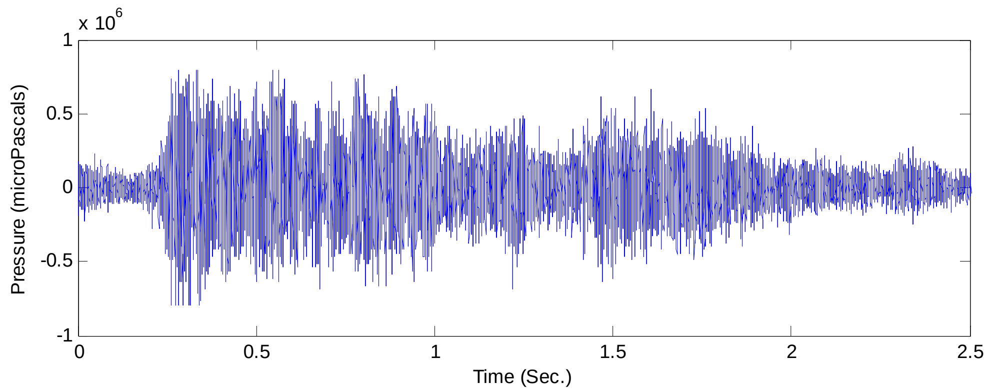


Figure D-10. Time Series

The time-series of a source can be different at different places. Therefore, sound, or pressure, is not only a function of time, but also of location. Let the function $p(t)$, then be expanded to $p(t;x,y,z)$ and denote the time series at point (x,y,z) in space. Thus, the series in Figure D-10 $p(t)$ is for a given point (x,y,z). At a different point in space, it would be different.

Assume that the location of the source is (0,0,0) and this series is recorded at (0,10,-4). The time series above would be p(t;0,10,-4) for 0<t<2.5.

As in Figure D-10, pressure can be positive or negative, but acoustic power, which is proportional to the square of the pressure, is always positive, this makes integration meaningful. Figure D-11 is $p^2(t;0,10,-4)$.

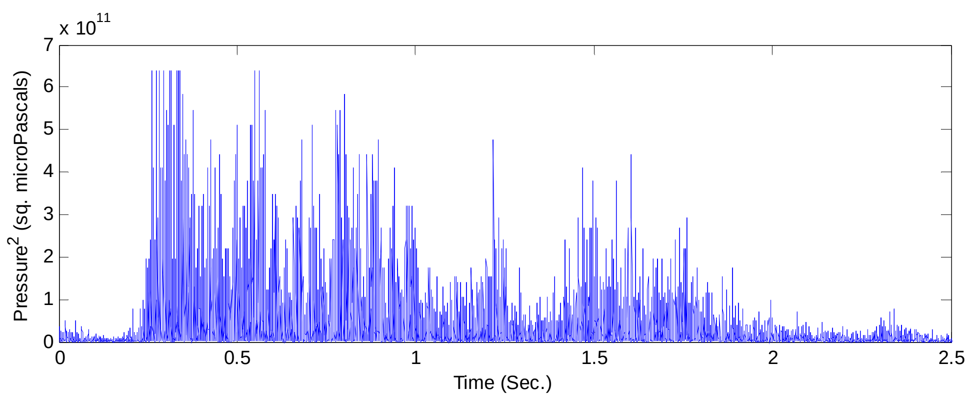


Figure D-11. Time Series Squared

The metric chosen to evaluate the sound field at the end of this first "hallelujah" determines how the time series is summarized from thousands of points, as in Figure D-10, to a single value for each point (*x*,*y*,*z*) in the space. The metric essentially "boils down" the four dimensional *p*(*t*,*x*,*y*,*z*) into a three dimensional function *m*(*x*,*y*,*z*) by dealing with time. There is more than one way to summarize the time component, so there is more than one metric.

D.5.2 Maximum Sound Pressure Level

Because of the large dynamic range of the acoustic power, it is generally represented on a logarithmic scale using sound pressure levels (SPLs). SPL is actually the ratio of acoustic power and density (power/unit area = $\frac{p^2}{Z}$ where Z = ρc is the acoustic impedance). This ratio is presented on a logarithmic scale relative to a reference pressure level, and is defined as:

$$SPL = 10\log_{10}\left(\frac{p^2}{p_{ref}^2}\right) = 20\log_{10}\left(abs\left(\frac{p}{p_{ref}}\right)\right)$$

(Note that SPL is defined in dB re a reference pressure, even though it comes from a ratio of powers.)

One way to characterize the power of the time series $p(t;x,y,z)$ with a single number over the 2.5 seconds is to only report the maximum SPL value of the function over time or,

$SPL_{\max} = \max\{10\log_{10}\left(p^2(t,x,y,z)\right)\}$ (relative to a reference pressure of 1 μPa) for 0<*t*<2.5

The $SPL_{\max}$ for this snippet of the Hallelujah Chorus is $10\log_{10}\left(6.4\times10^{11}\,\mu Pa^2/1\mu Pa^2\right) = 118\,dB$ re 1 μPa and occurs at 0.2606 seconds, as shown in Figure D-12.

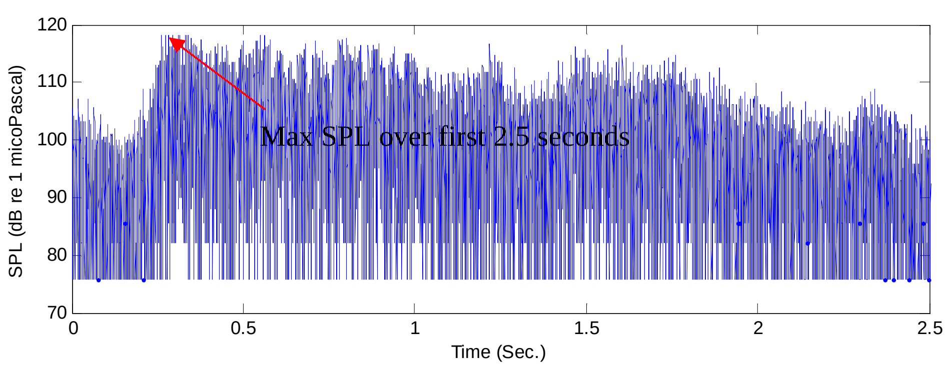


Figure D-12. Max SPL of Time Series Squared

D.5.3 Integration

$SPL_{\max}$ is not necessarily influenced by the duration of the sound (2.5 seconds in this case). Integrating the function over time gives the EFD, which accounts for this duration. A simple integration of $p^2(t;x,y,z)$ over t is common and is proportional to the EFD at (*x*,*y*,*z*). Because we will again be dealing in levels (logarithms of ratios), we neglect the impedance and simply measure the square of the pressure:

$Energy = \int_0^T p^2(t,x,y,z)dt$, where T is the maximum time of interest in this case 2.5.

The energy for this snippet of the Hallelujah Chorus is $8.47 \times 10^{10}\ \mu Pa^2 \cdot s$. This would more commonly be reported as an energy level (EL):

$$EL = 10\log_{10}\left(\frac{\int_0^T p^2(t,x,y,z)dt}{1.0\mu Pa^2 s}\right) = \text{ 109.3 dB re 1μPa}^2\text{s}$$

Energy is sometimes called "equal energy" because if *p*(*t*) is a constant function and the duration is doubled, the effect is the same as doubling the signal amplitude (*y* value). Thus, the duration and the signal have an "equal" influence on the energy metric.

Mathematically,

$$\int_0^{2T} p(t)^2\,dt = 2\int_0^T p(t)^2\,dt = \int_0^T 2\,p(t)^2\,dt$$

or a doubling in duration equals a doubling in energy equals a doubling in signal.

Sometimes, the integration metrics are referred to as having a "3 dB exchange rate" because if the duration is doubled, this integral increases by a factor of two, or 10log10(2)=3.01 dB. Thus, equal energy has "a 3 dB exchange rate."

After p(t) is determined (i.e., when the stimulus is over), propagation models can be used to determine p(t;x,y,z) for every point in the vicinity and for a given metric. Define

$$m_a(x,y,z,T) = \text{value of metric "}a\text{" at point }(x,y,z)\text{ after time }T$$

So,

$$m_{energy}(x,y,z;T) = \int_0^T p(t)^2\,dt$$

$$m_{\max SPL}(x,y,z;T) = \max 10\log_{10}\left(p^2(t)\right) over\ [0,T]$$

Since modeling is concerned with the effects of an entire event, T is usually implicitly defined: a number that captures the duration of the event. This means that $m_a(x,y,z)$ is assumed to be measured over the duration of the received signal.

D.5.3.1 Three Dimensions versus Two Dimensions

To further reduce the calculation burden, it is possible to reduce the domain of $m_a(x,y,z)$ to two dimensions by defining $m_a(x,y) = \max\{m_a(x,y,z)\}$ over all z. This reduction is not used for this analysis, which is exclusively three-dimensional.

D.5.4 Threshold

For a given metric, a threshold is a function that gives the probability of exposure at every value of m_a. This threshold function will be defined as

$$D(m_a(x,y,z)) = P(effect\ at\ m_a(x,y,z))$$

The domain of D is the range of $m_a(x,y,z)$, and its range is the proportion of thresholds.

An example of threshold functions is the heavyside (or unit step) function, currently used to determine PTS and TTS in cetaceans. For PTS, the metric is $m_{energy}(x,y,z)$, defined above, and the threshold function is a heavyside function with a discontinuity at 215 dB, shown in Figure D13.

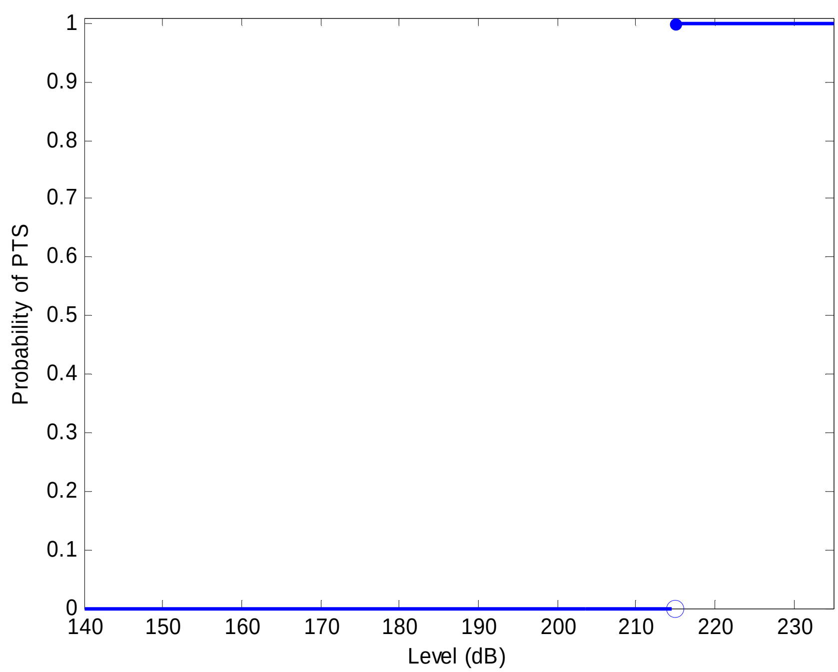


Figure D-13. PTS Heavyside Threshold Function

Mathematically, this D is defined as:

$$D(m_{energy}) = \begin{cases} 0 \ \ for\ m_{energy} < 215 \\ 1 \ \ for\ m_{energy} \geq 215 \end{cases}$$

Any function can be used for D, as long as its range is in [0,1]. The risk function uses normal Feller risk functions (defined below) instead of heavyside functions, and use the max SPL metric instead of the energy metric. While a heavyside function is specified by a single parameter, the discontinuity, a Feller function requires three parameters: the basement cutoff value, the level above the basement for 50% effect, and a steepness parameter. Mathematically, these Feller, "risk" functions, D, are defined as

$$D(m_{\max SPL}) = \begin{cases} \dfrac{1}{1+\left(\dfrac{K}{m_{\max SPL}-B}\right)^{A}} & for\ m_{\max SPL} \geq B \\ 0 & for\ m_{\max SPL} < B \end{cases}$$

where B=cutoff (or basement), K=the difference in level (dB) between the basement and the median (50% effect) harassment level, and A = the steepness factor. The dose function for odontocetes and pinnipeds uses the parameters:

B = 120 dB,

K = 45 dB, and

A = 10.

The dose function for mysticetes uses:

B = 120 dB,

K = 45 dB, and

A = 8.

Harbor porpoises are a special case. Though the metric for their behavioral harassment is also SPL, their risk function is a heavyside step function with a harassment threshold discontinuity (0 % to 100 %) at 120 dB. All other species use the continuous Feller CDF function for evaluating expected harassment.

D.5.5 Multiple Metrics and Thresholds

It is possible to have more than one metric, and more than one threshold in a given metric. For example, in this document, humpback whales have two metrics (energy and max SPL), and three thresholds (two for energy, one for max SPL). The energy thresholds are heavyside functions, as described above, with discontinuities at 215 and 195 for PTS and TTS respectively. The max SPL effect is calculated from the Feller risk function for odontocetes defined in the previous section.

D.5.6 Calculation of Expected Exposures

Determining the number of expected exposures for disturbance is the object of this analysis.

$$\text{Expected exposures in volume V} = \int_V \rho(V) D(m_a(V))dV$$

For this analysis, $m_a = m_{\max SPL}$, so

$$\int_V \rho(V) D\big(m_a(V)\big) dV = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \rho(x,y,z) D(m_{\max SPL}(x,y,z))\, dx\, dy\, dz$$

In this analysis, the densities are constant over the *xy*-plane, and the *z* dimension is always negative, so this reduces to

$$\int_{-\infty}^{0} \rho(z) \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z))\, dx\, dy\, dz$$

D.5.7 Numeric Implementation

Numeric integration of $\int_{-\infty}^{0} \rho(z) \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z))\, dx\, dy\, dz$ can be involved because, although the bounds are infinite, D is non-negative out to 141 dB, which, depending on the environmental specifics, can drive propagation loss calculations and their numerical integration out to more than 100 km.

The first step in the solution is to separate out the *xy*-plane portion of the integral:

$$\text{Define } f(z) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z))\, dx\, dy\,.$$

Calculation of this integral is the most involved and time consuming part of the calculation. Once it is complete,

$$\int_{-\infty}^{0} \rho(z) \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z))\, dx\, dy\, dz = \int_{-\infty}^{0} \rho(z) f(z) dz\,,$$

which, when numerically integrated, is a simple dot product of two vectors.

Thus, the calculation of f(z) requires the majority of the computation resources for the numerical integration. The rest of this section presents a brief outline of the steps to calculate f(z) and preserve the results efficiently.

The concept of numerical integration is, instead of integrating over continuous functions, to sample the functions at small intervals and sum the samples to approximate the integral. Smaller sized intervals yield closer approximations with longer calculation time, so a balance between accuracy and time is determined in the decision of step size. For this analysis, z is sampled in 5-meter steps to 1,000 meters in depth and 10-meter steps to 2,000 meters, which is the limit of animal depth in this analysis. The step size for x is 5 meters, and y is sampled with an interval that increases as the distance from the source increases. Mathematically,

$$z \in Z = \{0,5,...1000,1010,...,2000\}$$
$$x \in X = \{0,\pm5,...,\pm5k\}$$
$$y \in Y = \left\{0,\pm5*(1.005)^0, \pm5*\left[(1.005)^0 + (1.005)^1\right],...,\pm5*\left[\sum_{i=0}^{j}(1.005)^i\right]\right\}$$

for integers *k*, *j*, which depend on the propagation distance for the source. For this analysis, *k* = 20,000 and *j* = 600.

With these steps, $f(z_0) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z_0))dxdy$ is approximated as

$$\sum_{z \in Y}\sum_{x \in X} D(m_{\max SPL}(x,y,z_0))\Delta x \Delta y$$

where *X*,*Y* are defined as above.

This calculation must be repeated for each $z_0 \in Z$, to build the discrete function *f*(*z*).

With the calculation of *f*(*z*) complete, the integral of its product with $\rho(z)$ must be calculated to complete evaluation of

$$\int_{-\infty}^{\infty}\rho(z)\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x,y,z))dxdydz = \int_{-\infty}^{0}\rho(z)f(z)dz$$

Since *f*(*z*) is discrete, and $\rho(z)$ can be readily made discrete, $\int_{-\infty}^{0}\rho(z)f(z)dz$ is approximated numerically as $\sum_{z \in Z}\rho(z)f(z)$, a dot product.

D.5.8 Preserving Calculations for Future Use

Calculating *f*(*z*) is the most time-consuming part of the numerical integration, but the most time-consuming portion of the entire process is calculating $m_{\max SPL}(x,y,z)$ over the area range required for the minimum cutoff value (141 dB). The calculations usually require propagation estimates out to over 100 km, and those estimates, with the beam pattern, are used to construct a sound field that extends 200 km x 200 km—40,000 sq km, with a calculation at the steps for every value of *X* and *Y*, defined above. This is repeated for each depth, to a maximum of 2,000 meters.

Saving the entire $m_{\max SPL}$ for each *z* is unrealistic, requiring great amounts of time and disk space. Instead, the different levels in the range of $m_{\max SPL}$ are sorted into 0.5 dB wide bins; the volume of water at each bin level is taken from $m_{\max SPL}$, and associated with its bin. Saving this, the amount of water ensonified at each level, at a 0.5 dB resolution, preserves the ensonification information without using the space and time required to save $m_{\max SPL}$ itself. Practically, this is a histogram of occurrence of level at each depth, with 0.5 dB bins. Mathematically, this is simply defining the discrete functions $V_z(L)$, where $L = \{.5a\}$ for every positive integer *a*, and for all $z \in Z$. These functions, or histograms, are saved for future work. The information lost by saving only the histograms is *where* in space the different levels occur, although *how often* they occur is saved. But the thresholds (dose response curves) are purely a function of level, not location, so this information is sufficient to calculate *f*(*z*).

Applying the dose function to the histograms is a dot product:

$$\sum_{\ell \in L_1} D(\ell) V_{z_0}(\ell) \approx \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x, y, z_0))dxdy$$

So, once the histograms are saved, neither $m_{\max SPL}(x, y, z)$ nor *f*(*z*) must be recalculated to generate $\int_{-\infty}^{0} \rho(z) \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} D(m_{\max SPL}(x, y, z))dxdydz$ for a new threshold function.

For the interested reader, the following section includes an in-depth discussion of the method, software, and other details of the *f*(*z*) calculation.

D.5.9 Software Detail

The risk function metric uses the cumulative normal probability distribution to determine the probability that an animal is affected by a given SPL. The probability distribution is defined by a low cutoff level (below which the species is not affected), a 50 percent effect level, and a steepness factor. The acoustic quantity of interest is the maximum SPL experienced over multiple pings in a range-independent environment. The procedure for calculating the impact volume at a given depth is relatively simple. In brief, given the SPL of the source and the transmission loss (TL) curve, the received SPL is calculated on a volumetric grid. For a given depth, volume associated with each SPL interval is calculated. Then, this volume is multiplied by the probability that an animal will be affected by that SPL. This gives the impact volume for that depth, which can be multiplied by the animal densities at that depth, to obtain the number of animals affected at that depth. The process repeats for each depth to construct the impact volume as a function of depth.

The case of a single emission of sonar energy, one ping, illustrates the computational process in more detail. First, the SPLs are segregated into a sequence of bins that cover the range encountered in the area. The SPL are used to define a volumetric grid of the local sound field. The impact volume for each depth is calculated as follows: for each depth in the volumetric grid, the SPL at each *xy*-plane grid point is calculated using the SPL of the source, the TL curve, the horizontal beam pattern of the source, and the vertical beam patterns of the source. The SPLs in this grid become the bins in the volume histogram. Figure D-14 shows a volume histogram for a low-power sonar. Level bins are 0.5 dB in width and the depth is 50 meters in an environment with water depth of 100 meters. The oscillatory structure at very low levels is due the flattening of the TL curve at long distances from the source, which magnifies the fluctuations of the TL as a function of range. The “expected” impact volume for a given level at a given depth is calculated by multiplying the volume in each level bin by the dose response probability function at that level. Total expected impact volume for a given depth is the sum of these “expected” volumes. Figure D-5 is an example of the impact volume as a function of depth at a water depth of 100 meters.

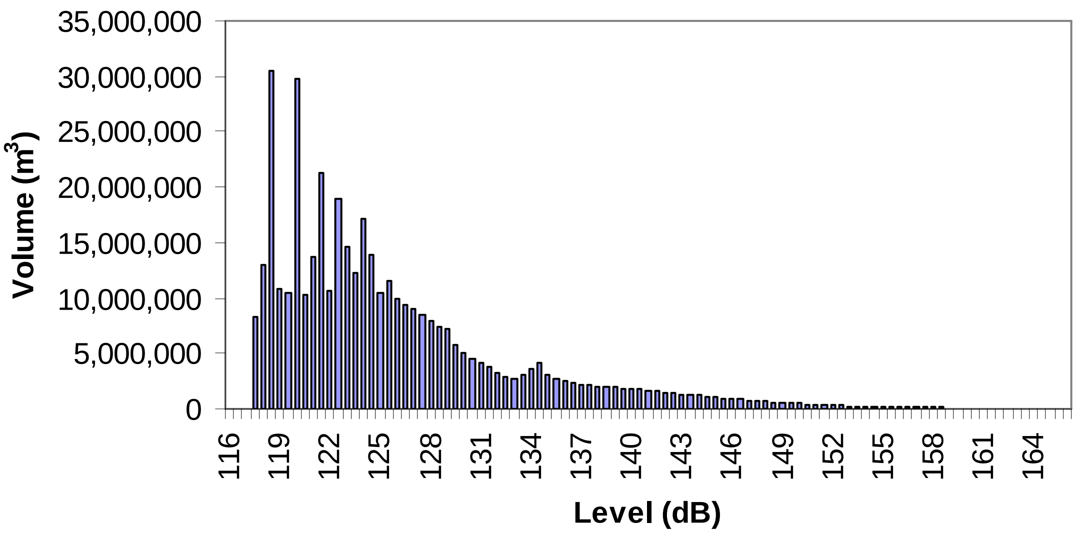


Figure D-14. Example of a Volume Histogram

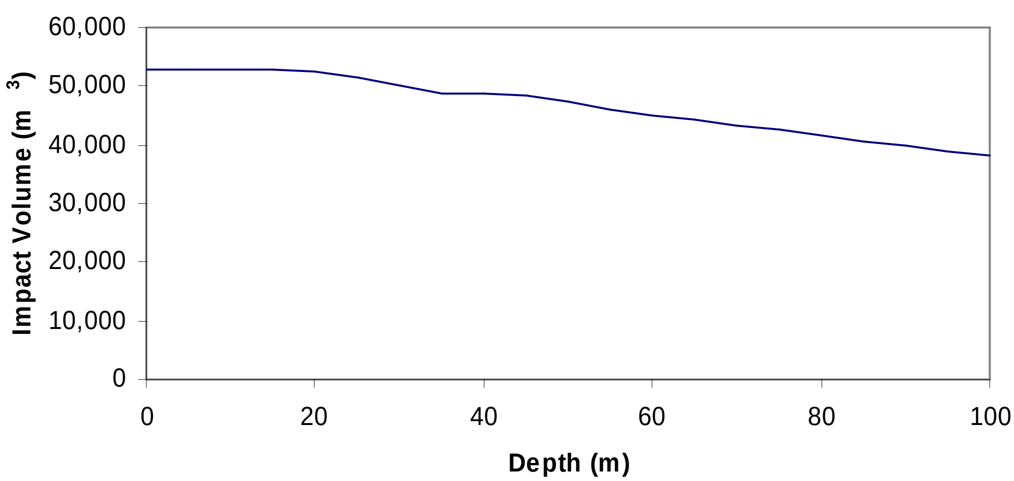


Figure D-15. Example of the Dependence of Impact Volume on Depth

The volumetric grid covers the waters in and around the area of sonar operation. The grid for this analysis has a uniform spacing of 5 meters in the x-coordinate and a slowly expanding spacing in the y-coordinate that starts with 5 meters spacing at the origin. The growth of the grid size along the y-axis is a geometric series where each successive grid size is obtained from the previous by multiplying it by 1 + *Ry*, where *Ry* is the *y*-axis growth factor. The n^{th} grid size is related to the first grid size by multiplying by $(1 + Ry)^{(n-1)}$. For an initial grid size of 5 meters and a growth factor of 0.005, the 100^{th} grid increment is 8.19 meters. The constant spacing in the *x*-coordinate allows greater accuracy as the source moves along the *x*-axis. The slowly increasing spacing in *y* reduces computation time, while maintaining accuracy, by taking advantage of the fact that TL changes more slowly at longer distances from the source. The *x*-and *y*-coordinates extend from $-R_{max}$ to $+R_{max}$, where R_{max} is the maximum range used in the TL calculations. The z direction uses a uniform spacing of 5 meters down to 1,000 meters and 10 meters from 1,000 to 2,000 meters. This is the same depth mesh used for the effective energy metric as described above. The depth mesh does not extend below 2,000 meters, on the assumption that animals of interest are not found below this depth.

The next three figures indicate how the accuracy of the calculation of impact volume depends on the parameters used to generate the mesh in the horizontal plane. Figure D-16 shows the relative change of impact volume for one ping as a function of the grid size used for the *x*-axis. The *y*-axis grid size is fixed at 5 meters and the *y*-axis growth factor is 0, i.e., uniform spacing. The impact volume for a 5-meter grid size is the reference. For grid sizes between 2.5 and 7.5 meters, the change is less than 0.1%. A grid size of 5 meters for the *x*-axis is used in the calculations. Figure D-17 shows the relative change of impact volume for one ping as a function of the grid size used for the *y*-axis. The *x*-axis grid size is fixed at 5 meters and the *y*-axis growth factor is 0. The impact volume for a 5 meters grid size is the reference. This figure is very similar to that for the *x*-axis grid size. For grid sizes between 2.5 and 7.5 meters, the change is less than 0.1%. A grid size of 5 meters is used for the y-axis in our calculations. Figure D-18 shows the relative change of impact volume for one ping as a function of the y-axis growth factor. The *x*-axis grid size is fixed at 5 meters and the initial *y*-axis grid size is 5 meters. The impact volume for a growth factor of 0 is the reference. For growth factors from 0 to 0.01, the change is less than 0.1%. A growth factor of 0.005 is used in the calculations.

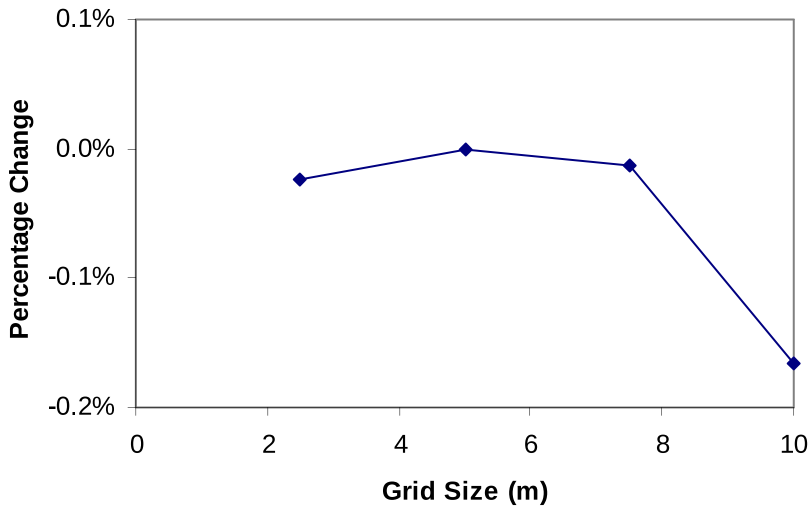


Figure D-16. Change of Impact Volume as a Function of *x*-axis Grid Size

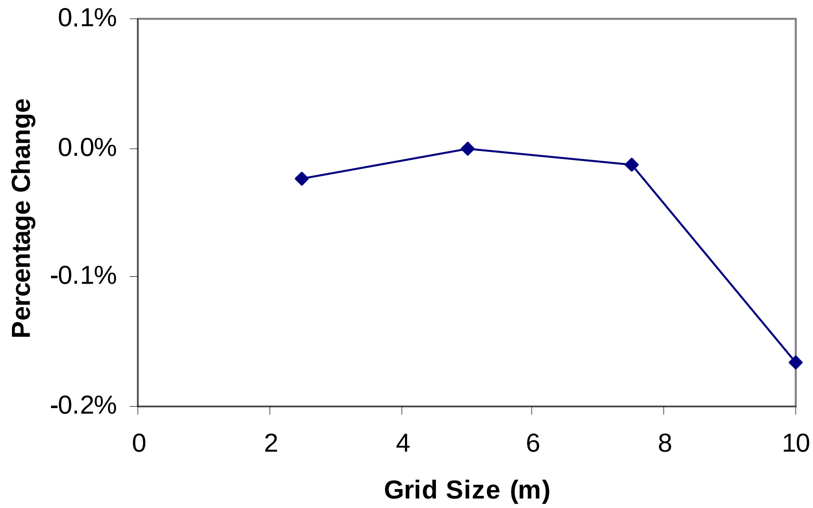


Figure D-17. Change of Impact Volume as a Function of y-axis Grid Size

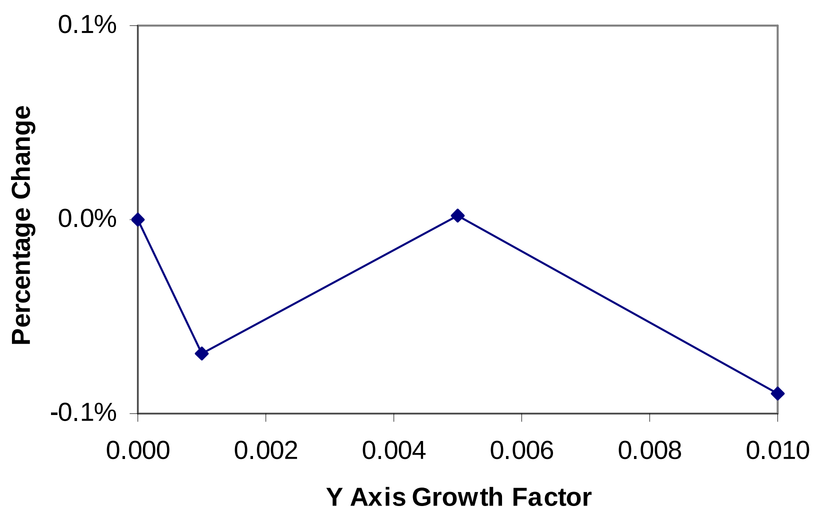


Figure D-18. Change of Impact Volume as a Function of y-axis Growth Factor

Another factor influencing the accuracy of the calculation of impact volumes is the size of the bins used for SPL. The SPL bins extend from 100 dB (far lower than required) up to 300 dB (much higher than that expected for any sonar system). Figure D-19 shows the relative change of impact volume for one ping as a function of the bin width. The *x*-axis grid size is fixed at 5 meters the initial *y*-axis grid size is 5 meters, and the *y*-axis growth factor is 0.005. The impact volume for a bin size of 0.5 dB is the reference. For bin widths from 0.25 dB to 1.00 dB, the change is about 0.1%. A bin width of 0.5 is used in our calculations.

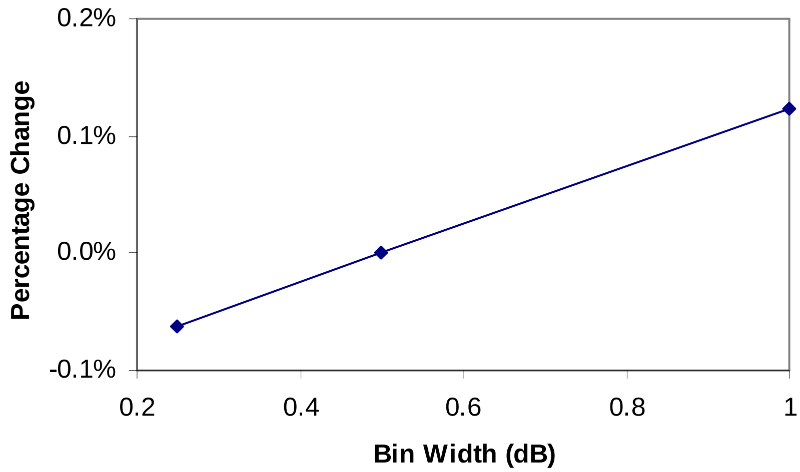


Figure D-19. Change of Impact Volume as a Function of Bin Width

Two other issues for discussion are the maximum range (R_{max}) and the spacing in range and depth used for calculating TL. The TL generated for the energy accumulation metric is used for risk function analysis. The same sampling in range and depth is adequate for this metric because it requires a less demanding computation (i.e., maximum value instead of accumulated energy). Using the same value of R_{max} needs some discussion since it is not clear that the same value can be used for both metrics. R_{max} was set so that the TL at R_{max} is more than needed to reach the energy accumulation threshold of 173 dB for 1,000 pings. Since energy is accumulated, the same TL can be used for one ping with the source level increased by 30 dB (10 $\log_{10}$(1000)). Reducing the source level by 30 dB, to get back to its original value, permits the handling of an SPL threshold down to 143 dB, comparable to the minimum required. Hence, the TL calculated to support energy accumulation for 1,000 pings will also support calculation of impact volumes for the risk function metric.

The process of obtaining the maximum SPL at each grid point in the volumetric grid is straightforward. The active sonar starts at the origin and moves at constant speed along the positive *x*-axis emitting a burst of energy, a ping, at regularly spaced intervals. For each ping, the distance and horizontal angle connecting the sonar to each grid point is computed. Calculating the TL from the source to a grid point has several steps. The TL is made up of the sum of many eigenrays connecting the source to the grid point. The beam pattern of the source is applied to the eigenrays based on the angle at which they leave the source. After summing the vertically beamformed eigenrays on the range mesh used for the TL calculation, the vertically beamformed TL for the distance from the sonar to the grid point is derived by interpolation. Next, the horizontal beam pattern of the source is applied using the horizontal angle connecting the sonar to the grid point. To avoid problems in extrapolating TL, only grid points with distances less than R_{max} are used. To obtain the SPL at a grid point, the SPL of the source is reduced by that TL. For the first ping, the volumetric grid is populated by the calculated SPL at each grid point. For the second ping and subsequent pings, the source location increments along the x-axis by the spacing between pings and the SPL for each grid point is again calculated for the new source location. Since the risk function metric uses the maximum of the SPLs at each grid point, the newly calculated SPL at each grid point is compared to the SPL stored in the grid. If the new level is larger than the stored level, the value at that grid point is replaced by the new SPL.

For each bin, a volume is determined by summing the ensonified volumes with a maximum SPL in the bin's interval. This forms the volume histogram shown in Figure D-14. Multiplying by the risk function probability function for the level at the center of a bin gives the impact volume for that bin. The result can be seen in Figure D-15, which is an example of the impact volume as a function of depth.

The impact volume for a sonar moving relative to the animal population increases with each additional ping. The rate at which the impact volume increases for the dose response metric is essentially linear with the number of pings. Figure D-20 shows the dependence of impact volume on the number of pings. The slope of the line at a given depth is the impact volume added per ping. This number multiplied by the number of pings in an hour gives the hourly impact volume for the given depth increment. Completing this calculation for all depths in a province, for a given source, gives the hourly impact volume vector which contains the hourly impact volumes by depth for a province. Figure D-21 provides an example of an hourly impact volume vector for a particular environment. Given the speed of the sonar platform, the hourly impact volume vector could be displayed as the impact volume vector per kilometer of track.

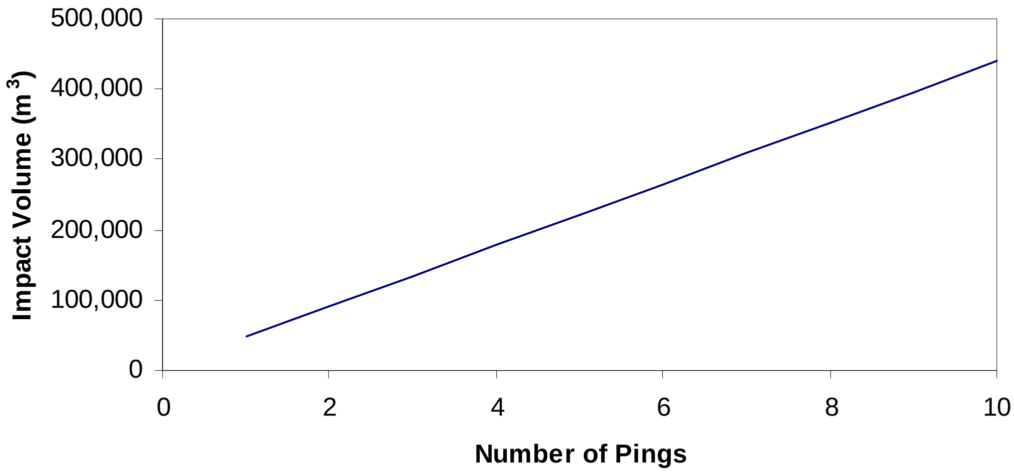


Figure D-20. Dependence of Impact Volume on the Number of Pings

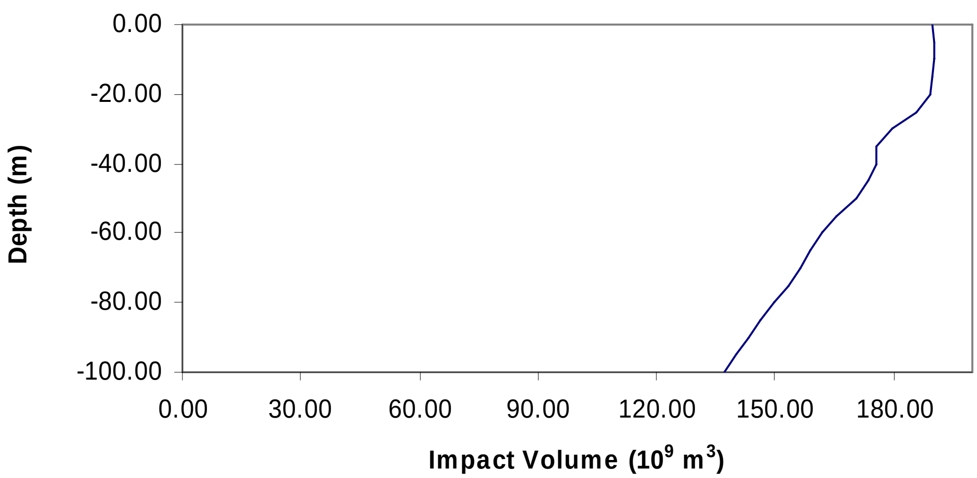


Figure D-21. Example of an Hourly Impact Volume Vector

D.6 EXPOSURE ESTIMATES

Densities are usually reported by marine biologists as animals per square kilometer (km^2), which is an area metric. This gives an estimate of the number of animals below the surface in a certain area, but does not provide any information about their distribution in depth. The impact volume vector (see subsection

D.4.3) specifies the volume of water ensonified above the specified threshold in each depth interval. A corresponding animal density for each of those depth intervals is required to compute the expected value of the number of exposures. The two-dimensional area densities do not contain this information, so three-dimensional densities must be constructed by using animal depth distributions to extrapolate the density at each depth. The required depth distributions are presented in the biology subsection.

The following sperm whale example demonstrates the methodology used to create a three-dimensional density by merging the area densities with the depth distributions. The sperm whale surface density is 0.0117 whales per km^2. From the depth distribution report, "depth distribution for sperm whales based on information in the Amano paper is: 31% in 0-10 m, 8% in 10-200 m, 9% in 201-400 m, 9% in 401-600 m, 9% in 601-800 m and 34% in >800 m." So the sperm whale density at 0-10 m is 0.0117*0.31/0.01 = 0.3627 per cubic km, at 10-200 m is 0.0117*0.08/0.19 = 0.004926 per cubic km, and so forth.

In general, the impact volume vector samples depth in finer detail than given by the depth distribution data. When this is the case, the densities are apportioned uniformly over the appropriate intervals. For example, suppose the impact volume vector provides volumes for the intervals 0-10 meters, 10-50 meters, and 50-200 meters. Then for the depth-distributed densities discussed in the preceding paragraph,

- 0.3627 whales per cubic km is used for 0-10 meters,
- 0.004926 whales per cubic km is used for 10-50 meters, and
- 0.004926 whales per cubic km is used for 50-200 meters.

Once depth-varying, three-dimensional densities are specified for each species type, with the same depth intervals and the ensonified volume vector, the density calculations are finished. The expected number of ensonified animals within each depth interval is the ensonified volume at that interval multiplied by the volume density at that interval and this can be obtained as the dot product of the ensonified volume and animal density vectors.

Since the ensonified volume vector is the ensonified volume per unit operation (i.e., per hour, per sonobuoy, etc.), the final exposure count for each species is the unit operation exposure count multiplied by the number of units (hours, sonobuoys, etc).

D.7 POST ACOUSTIC MODELING ANALYSIS

The acoustic modeling results include additional analysis to account for land mass, multiple ships, and number of animals that could be exposed. Specifically, post modeling analysis is designed to consider:

Acoustic footprints for sonar sources must account for land masses.

Acoustic modeling should account for the maximum number of individuals of a species that could potentially be exposed to sonar within the course of 1 day or a discreet continuous sonar event if less than 24 hours.

When modeling the effect of sound projectors in the water, the ideal task presents modelers with complete *a priori* knowledge of the location of the source(s) and transmission patterns during the times of interest. In these cases, calculation inputs include the details of source path, proximity of shoreline, high-resolution density estimates, and other details of the scenario. However, in the NWTRC, there are sound-producing events for which the source locations and transmission patterns are unknown, but still require analysis to predict effects. For these cases, a more general modeling approach is required: "We will be operating somewhere in this large area for X minutes. What are the potential effects on average?"

Modeling these general scenarios requires a statistical approach to incorporate the scenario nuances into harassment calculations. For example, one may ask: "If an animal receives 130 dB SPL when the source passes at CPA on Tuesday morning, how do we know it does not receive a higher level on Tuesday afternoon?" This question cannot be answered without knowing the path of the source (and several other facts). Because the path of the source is unknown, the number of an individual's re-exposures cannot be calculated directly. But it can, on average, be accounted for by making appropriate assumptions.

Table D-11 lists unknowns created by uncertainty about the specifics of a future proposed action, the portion of the calculation to which they are relevant, and the assumption that allows the effect to be computed without the detailed information:

Table D-11. Unknowns and Assumptions

Unknowns	Relevance	Assumption
Path of source(esp. with respect to animals)	Ambiguity of multiple exposures, Local population: upper bound of harassments	Most conservative case: sources can be anywhere within range
Source locations	Ambiguity of multiple exposures, land shadow	Equal distribution of action in each range
Direction of sonar transmission	Land shadow	Equal probability of pointing any direction

The following sections discuss two topics that require action details, and describe how the modeling calculations used the general knowledge and assumptions to overcome the future-action uncertainty with respect to re-exposure of animals, and land shadow.

D.7.1 Multiple Exposures in General Modeling Scenario

Consider the following hypothetical scenario. A box is painted on the surface of a well-studied ocean environment with well-known propagation. A sonar-source and 100 whales are inserted into that box and a curtain is drawn. What will happen? The details of what will happen behind the curtain are unknown, but the existing knowledge, and general assumptions, can allow for a calculation of average affects.

For the first period of time, the source is traveling in a straight line and pinging at a given rate. In this time, it is known how many animals, on average, receive their max SPLs from each ping. As long as the source travels in a straight line, this calculation is valid. However, after an undetermined amount of time, the source will change course to a new and unknown heading.

If the source changes direction 180 degrees and travels back through the same swath of water, all the animals the source passes at CPA before the next course change have already been exposed to what will be their maximum SPL, so the population is not "fresh." If the direction does not change, only new animals will receive what will be their maximum SPL from that source (though most have received sound from it), so the population is completely "fresh." Most source headings lead to a population of a mixed "freshness," varying by course direction. Since the route and position of the source over time are unknown, the freshness of the population at CPA with the source is unknown. This ambiguity continues through the remainder of the exercise.

What is known? The source and, in general, the animals remain in the vicinity of the range. Thus, if the farthest range to a possible effect from the source is X km, no animals farther than X km outside of the operating area (OPAREA) can be harassed. The intersection of this area with a given animal's habitat multiplied by the density of that animal in its habitat represents the maximum number of animals that can be harassed by activity in that OPAREA, which shall be defined as "the local population." Two details:

first, this maximum should be adjusted down if a risk function is being used, because not 100% of animals within X km of the OPAREA border will be harassed. Second, it should be adjusted up to account for animal motion in and out of the area.

The ambiguity of population freshness throughout the exercise means that multiple exposures cannot be calculated for any individual animal. It must be dealt with generally at the population level.

D.7.1.1 Solution to Ambiguity of Multiple Exposures in the General Modeling Scenario

At any given time, each member of the population has received a maximum SPL (possibly zero) that indicates the probability of harassment in the exercise. This probability indicates the contribution of that individual to the expected value of the number of harassments. For example, if an animal receives a level that indicates 50% probability of harassment, it contributes 0.5 to the sum of the expected number of harassments. If it is passed later with a higher level that indicates a 70% chance of harassment, its contribution increases to 0.7. If two animals receive a level that indicates 50% probability of harassment, they together contribute 1 to the sum of the expected number of harassments. That is, we statistically expect exactly one of them to be harassed. Let the expected value of harassments at a given time be defined as “the harassed population” and the difference between the local population (as defined above) and the harassed population be defined as “the unharassed population.” As the exercise progresses, the harassed population will never decrease and the unharassed population will never increase.

The unharassed population represents the number of animals statistically “available” for harassment. Since we do not know where the source is, or where these animals are, we assume an average (uniform) distribution of the unharassed population over the area of interest. The densities of unharassed animals are lower than the total population density because some animals in the local population are in the harassed population.

Density relates linearly to expected harassments. If action A in an area with a density of 2 animals per km2 produces 100 expected harassments, then action A in an area with 1 animal per km2 produces 50 expected harassments. The modeling produces the number of expected harassments per ping starting with 100% of the population unharassed. The next ping will produce slightly fewer harassments because the pool of unharassed animals is slightly less.

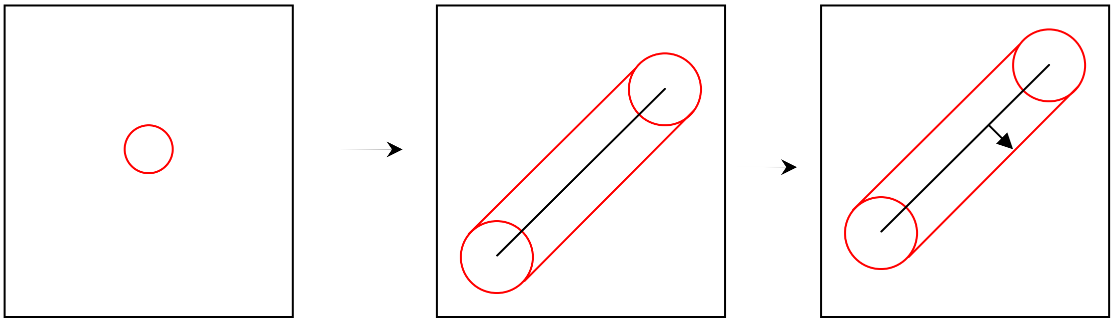
For example, consider the case where 1 animal is harassed per ping when the local population is 100, 100% of which are initially unharassed. After the first ping, 99 animals are unharassed, so the number of animals harassed during the second ping are

$$1\left(\frac{99}{100}\right) = 1(.99) = 0.99 \text{ animals}$$

and so on for the subsequent pings.

A closed form function for this process can be derived as follows.

Define $H =$ number of animals harassed per ping with 100% unharassed population. H is calculated by determining the expected harassments for a source moving in a straight line for the duration of the exercise and dividing by the number of pings in the exercise (Figure D-22).



$$H = \int\int\int \rho(z) D(L(x,y,z)) dxdydz / N_{pings}$$

Figure D-22. Process of Calculating H

The total unharassed population is then calculated by iteration. Each ping affects the un-harassed population left after all previous pings:

Define P_n = unharassed population after ping *n*

$$P_0 = \text{local population}$$

$$P_1 = P_0 - H$$

$$P_2 = P_1 - H\left(\frac{P_1}{P_0}\right)$$

$$\ldots$$

$$P_n = P_{n-1} - H\left(\frac{P_{n-1}}{P_0}\right)$$

Therefore,

$$P_n = P_{n-1}\left(1-\left(\frac{H}{P_0}\right)\right) = P_{n-2}\left(1-\left(\frac{H}{P_0}\right)\right)^2 = \ldots = P_0\left(1-\left(\frac{H}{P_0}\right)\right)^n$$

Thus, the total number of harassments depends on the per-ping harassment rate in an un-harassed population, the local population size, and the number of operation hours.

D.7.1.2 Local Population: Upper Bound on Harassments

As discussed above, Navy planners have confined periods of sonar use to training areas. The size of the harassed population of animals for an action depends on animal re-exposure, so uncertainty about the precise source path creates variability in the "harassable" population. Confinement of sonar use to a sonar training area allows modelers to compute an upper bound, or worst case, for the number of harassments with respect to location uncertainty. This is done by assuming that every animal which enters the training area at any time in the exercise (and also many outside) is "harassable" and creates an upper bound on the number of harassments for the exercise. Since this is equivalent to assuming that there are sonars transmitting simultaneously from each point in the confined area throughout the action length, this greatly overestimates the harassments from an exercise.

NMFS has defined a 24-hour "refresh rate," or amount of time in which an individual can be harassed no more than once. The Navy has determined that, in a 24-hour period, all sonar activities in the NWTRC transmit for no longer than 2 hours.

The most conservative assumption for a single ping is that it harasses the entire population within the range (a gross over-estimate). However, the total harassable population for multiple pings will be even greater since animal motion over the period in the above table can bring animals into range that otherwise would be out of the harassable population.

D.7.1.3 Animal Motion Expansion

Though animals often change course to swim in different directions, straight-line animal motion would bring the more animals into the harassment area than a "random walk" motion model. Since precise and accurate animal motion models exist more as speculation than documented fact and because the modeling requires an undisputable upper bound, calculation of the upper bound for NWTRC modeling areas uses a straight-line animal motion assumption. This is a conservative assumption.

For a circular area, the straight-line motion in any direction produces the same increase in harassable population. However, since the ranges are non-circular polygons, choosing the initial fixed direction as perpendicular to the longest diagonal produces greater results than any other direction. Thus, the product of the longest diagonal and the distance the animals move in the period of interest gives an overestimate of the expansion in range modeling areas due to animal motion. The NWTRC expansions use this estimate as an absolute upper bound on animal-motion expansion.

Figure D-23 illustrates an example of the overestimation, which occurs during the second arrow:

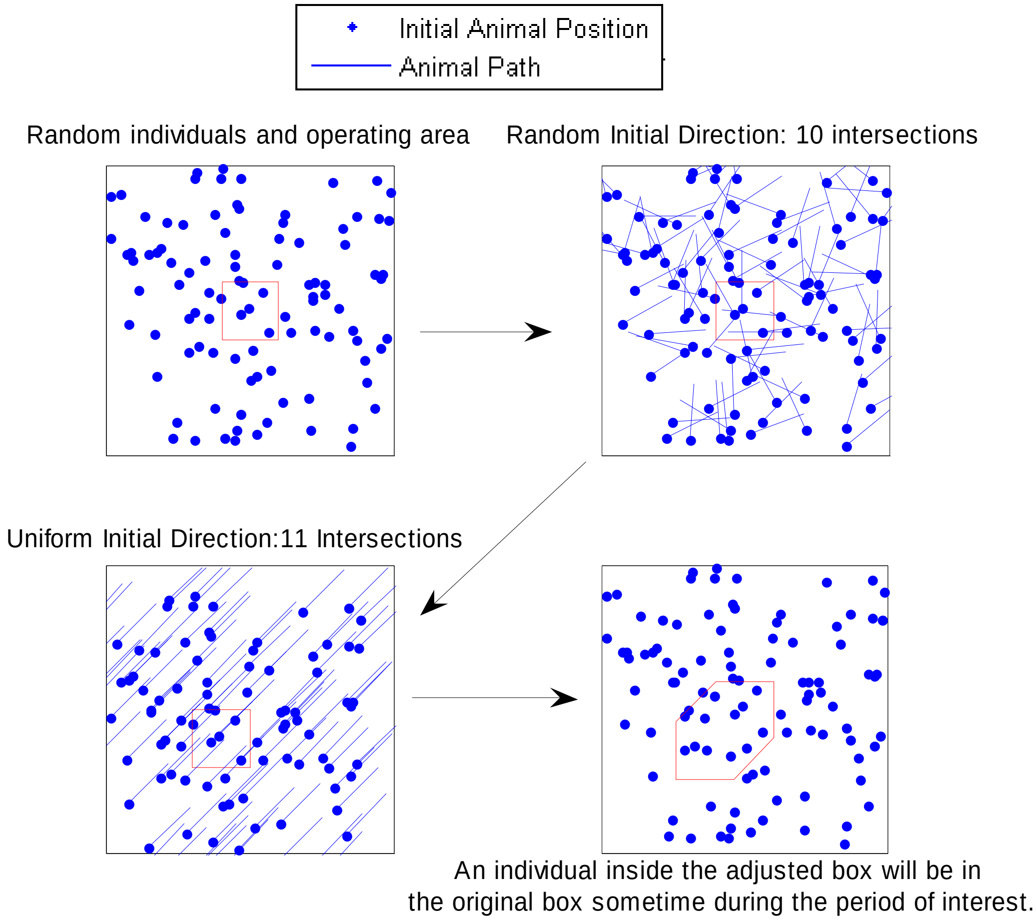


Figure D-23. Process of Setting an Upper Bound on Individuals Present in Area

It is important to recognize that the area used to calculate the harassable population, shown in Figure D-23 will, in general, be much larger than the area that will be within the ZOI of a ship for the duration of its broadcasts. For a ship moving faster than the speed of the marine animals, a better (and much smaller) estimate of the harassable population would be that within the straight line ZOI cylinder shown in Figure D-22. Using this smaller population would lead to a greater dilution of the unharassed population per ping and would greatly reduce the estimated harassments.

D.7.1.4 Risk Function Expansion

The expanded area contains the number of animals that will enter the range over the period of interest. However, an upper bound on harassments must also include animals outside the area that would be affected by a source transmitting from the area's edge. A gross overestimation could simply assume pinging at every point on the range border throughout the exercise and would include all area with levels from a source on the closest border point greater than the risk function basement. In the case of NWTRC, this would include all area within approximately 150 km from the edge of the adjusted box. This basic method would give a crude and exaggerated upper bound, since only a tiny fraction of this out-of-range area can be ensonified above threshold for a given ping. A more refined upper bound on harassments can be found by maintaining the assumption that a sonar is transmitting from each point in the adjusted box and calculating the expected ensonified area, which would give all animals inside the area a 100% probability of harassment, and those outside the area a varying probability, based on the risk function.

$$\int_{0}^{L^{-1}(120\,dB)} D(L(r))dr\ ,$$

Where *L* is the SPL function with domain in range and range in level,

r is the range from the sonar operating area,

L^{-1}(120 dB) is the range at which the received level drops to 120 dB, and

D is the risk function function (probability of harassment vs. Level).

At the corners of the polygon, additional area can be expressed as

$$\frac{[\pi - \theta] \displaystyle\int_{0}^{L^{-1}(120\,dB)} D(L(r))rdr}{2\pi}$$

with *D*, *L*, and *r* as above, and

θ the inner angle of the polygon corner, in radians.

For the risk function and transmission loss of the NWTRC, this method adds an area equivalent by expanding the boundaries of the adjusted box by 4 km. The resulting shape, the adjusted box with a boundary expansion of 4 km, does not possess special meaning for the problem. But the number of individuals contained by that shape, is the harassable population and an absolute upper bound on possible harassments for that operation.

The following plots (Figure D-24) illustrate the growth of area for the sample case above. The shapes of the boxes are unimportant. The area after the final expansion, though, gives an upper bound on the "harassable," or initially unharassed population which could be affected by operations.

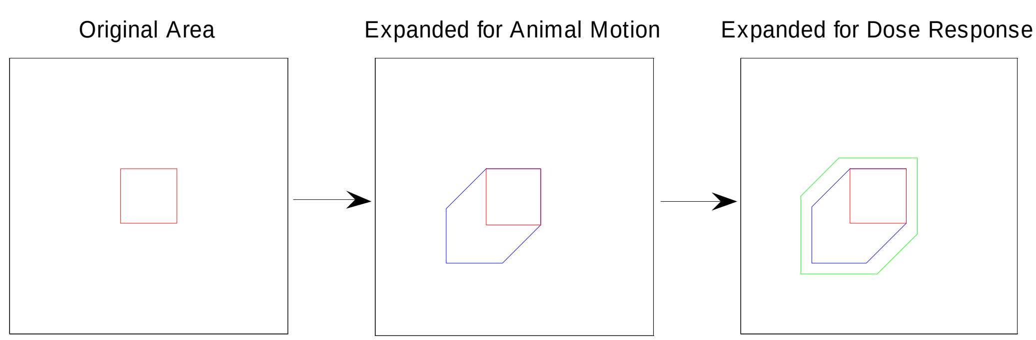


Figure D-24. Process of Expanding Area to Create Upper Bound of Harassments

D.7.1.5 Example Case

Consider a sample case from the NWTRC General Area. For the most powerful source, the 53C, the expected winter rate of harassment for short-finned pilot whales is approximately 0.00022128 harassments per ping. The exercise will transmit sonar pings for 2 hours in a 24-hour period as consistent with NWTRC planned use, with 120 pings per minute, a total of 120*2=240 pings in a 24-hour period.

The NWTRC General Area has an area of approximately 422,265 km^2 and a diagonal of 1,053 km. Adjusting this with straight-line (upper bound) animal motion of 5.5 km per hour for 2 hours, animal motion adds 1,053*5.5*2= 11,583 km^2 to the area. Using the risk function to calculate the expected range outside the SOA adds another 11,295 km^2, bringing the total upper-bound of the affected area to 445,143 km^2.

For this analysis, short-finned pilot whales have an average winter density of 0.00005 animals per km^2, so the upper bound number short-finned pilot whales that can be affected by 53C activity in the NWTRC during a 24-hour period is 445,143 *0.00005=22.3 whales.

In the first ping, 0.00022128 short-finned pilot whales will be harassed. With the second ping,

$0.00022128 \left(\frac{22.3-0.00022128}{22.3}\right) = 0.0002212778$ short-finned pilot whales will be harassed. Using the formula derived above, after 2 hours of continuous operation, the remaining **unharassed** population is $P_{240} = P_0\left(1-\left(\frac{h}{P_0}\right)\right)^{240} = 22.3\left(1-\left(\frac{.00022128}{22.3}\right)\right)^{240} \approx 22.25$

So the **harassed** population will be 22.3-22.25 = 0.05 animals.

Contrast this with linear accumulation of harassments without consideration of the local population and the dilution of the unharassed population:

Harassments = 0.00022128 * 240=0.053 animals

The difference in harassments is very small, as a percentage of total harassments, because the size of the NWTRC implies a large "harassable" population relative to the harassment per ping of the 53C. In cases where the harassable population is not as large, with respect to the per ping harassments, the difference in harassments between linear accumulation and density dilution is more pronounced.

D.7.2 Land Shadow

The risk function considers harassment possible if an animal receives 120 dB SPL, or above. In the open ocean of the NWTRC, this can occur as far away as 150 km, so over a large "effect" area, sonar sound could, but does not necessarily, harass an animal. The harassment calculations for a general modeling case must assume that this effect area covers only water fully populated with animals, but in some portions of the NWTRC, land partially encroaches on the area, obstructing sound propagation.

As discussed in the introduction of this section, Navy planners do not know the exact location and transmission direction of the sonars at future times. These factors however, completely determine the interference of the land with the sound, or "land shadow," so a general modeling approach does not have enough information to compute the land shadow effects directly. However, modelers can predict the reduction in harassments at any point due to land shadow for different pointing directions and use expected probability distribution of activity to calculate the average land shadow for operations in each range.

For each of the coastal points that are within 150 km of the grid, the azimuth and distance is computed. In the computation, only the minimum range at each azimuth is computed. The minimum range compared with azimuth for the sample point is shown in Figure D-25.

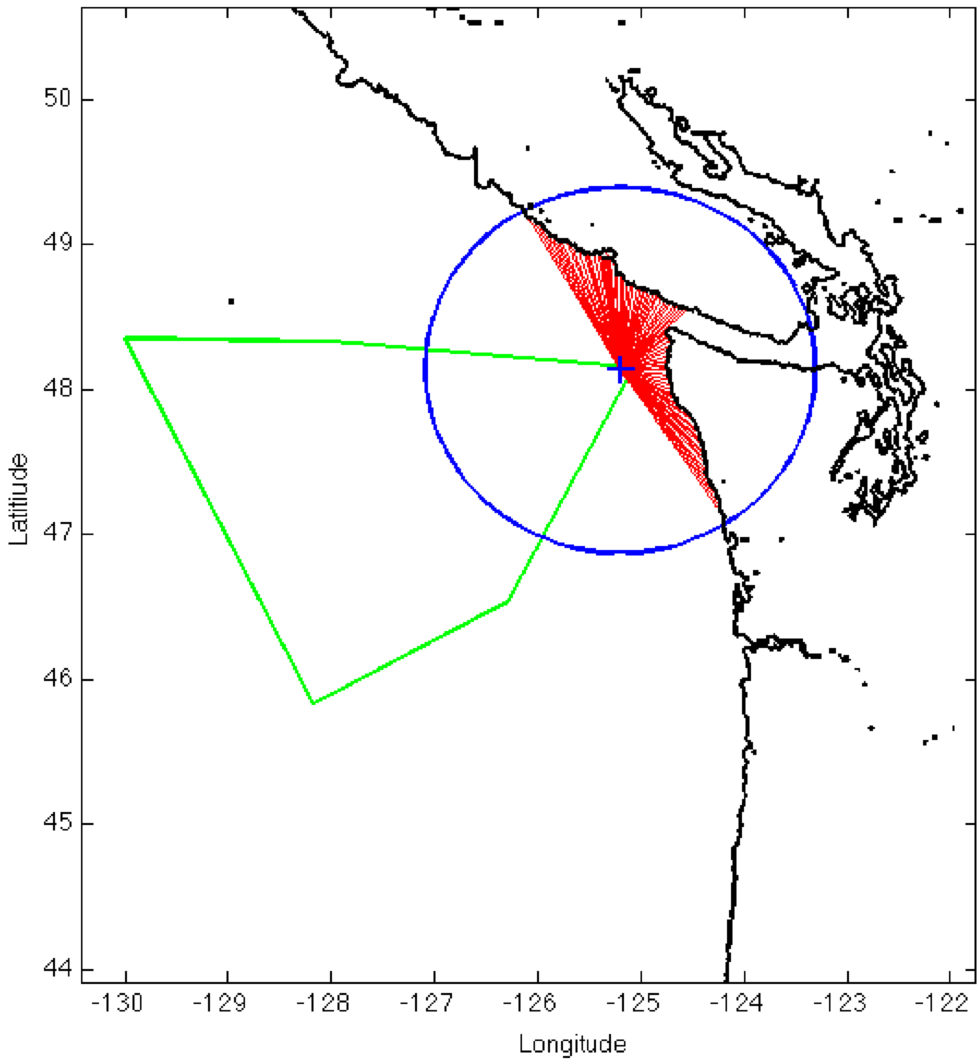


Figure D-25. The nearest point at each azimuth (with 1^o spacing) to a sample grid point (red circle) is shown by the green lines.

Now, the average of the distances to shore, along with the angular profile of land is computed (by summing the unique azimuths that intersect the coast) for each grid point. The values are then used to compute the land shadow for the grid points.

D.7.2.1 Computing the Land Shadow Effect at Each Grid Point

The effect of land shadow is computed by determining the levels, and thus the distances from the sources, that the harassments occur. Table D-12 and Figure D-26 give a mathematical extrapolation of the distances and levels at which harassments occur, with average propagation in the NWTRC.

Table D-12. Behavioral Harassments at each Received Level Band from 53C

Received Level (dB SPL)	Distance at which Levels Occur in NWTRC	Percent of Behavioral Harassments Occurring at Given Levels
Below 140	51 km - 130 km	< 1%
140<Level<150	25 km – 51 km	2%
150<Level<160	10 km – 25 km	18%
160<Level<170	3 km – 10 km	43%
170<Level<180	560 m – 3 km	28%
Above 180 dB	0 m – 560 m	< 9%

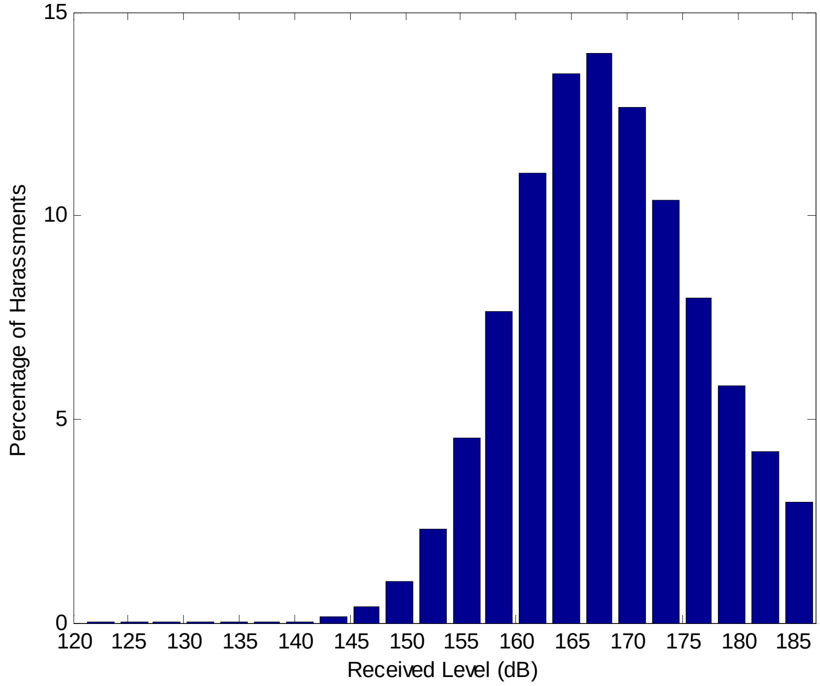


Figure D-26. Approximate Percentage of Behavioral Harassments for Every 5 Degree Band of Received Level from the 53C

With the data used to produce the previous figure, the average effect reduction across season for a sound path blocked by land can be calculated. For the 53C, since approximately 81% of harassments occur within 10 km of the source (Figure D-27), a sound path blocked by land at 10 km will, on average, cause approximately 81% of the effect of an unblocked path.

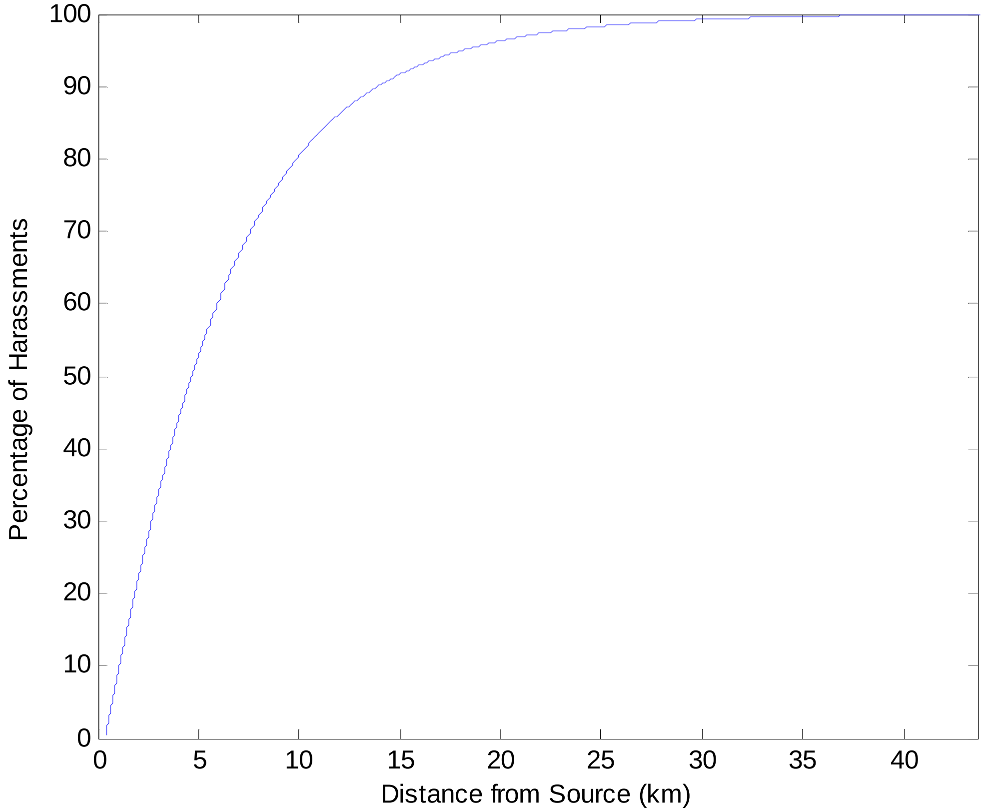


Figure D-27. Average Percentage of Harassments Occurring Within a Given Distance

As described above, the mapping process determines the angular profile of and distance to the coastline(s) from each grid point. The distance, then, determines the reduction due to land shadow when the sonar is pointed in that direction. The angular profile, then, determines the probability that the sonar is pointed at the coast.

Define θn = angular profile of coastline at point n in radians

Define rn = mean distance to shoreline

Define $A(r)$ = average effect adjustment factor for sound blocked at distance r

The land shadow at point n can be approximated by $A(r_n)\theta_n/(2\pi)$. For illustration, Figures D-28 and D-29 give the land shadow reduction factor at each point in each range area for the 53C. The white portions of these figures indicate the areas outside the range and the blue lines indicate the coastline. The color plots inside the ranges give the land shadow factor at each point. The average land shadow factor from the 53C for the NWTRC is 0.9992 and for the special case of harbor porpoises is 0.9116; the reduction in effect is 0.0008% for the former and 8.84% for the latter. For the other, lower-power sources, this reduction is negligible.

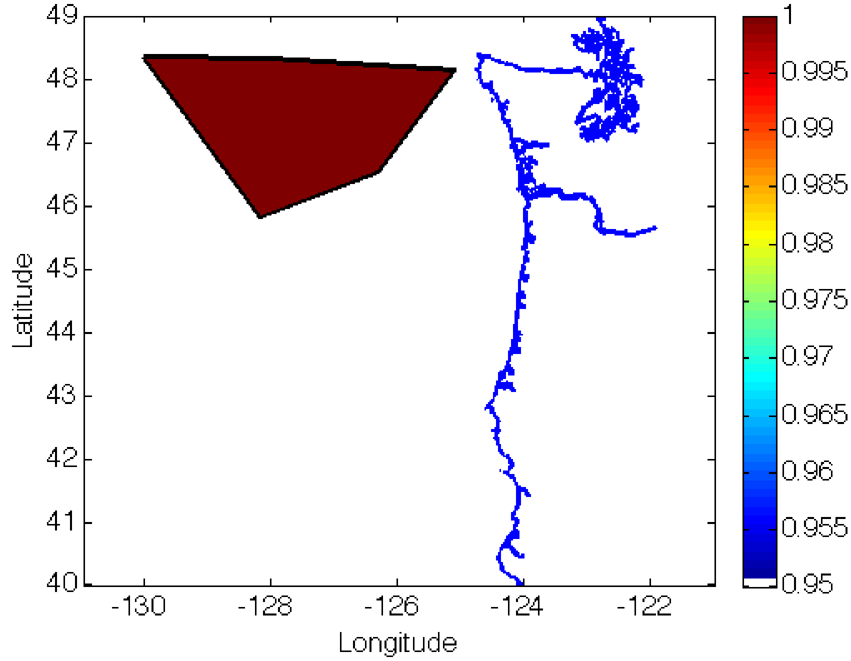


Figure D-28. Depiction of Land Shadow over Warning Area 237

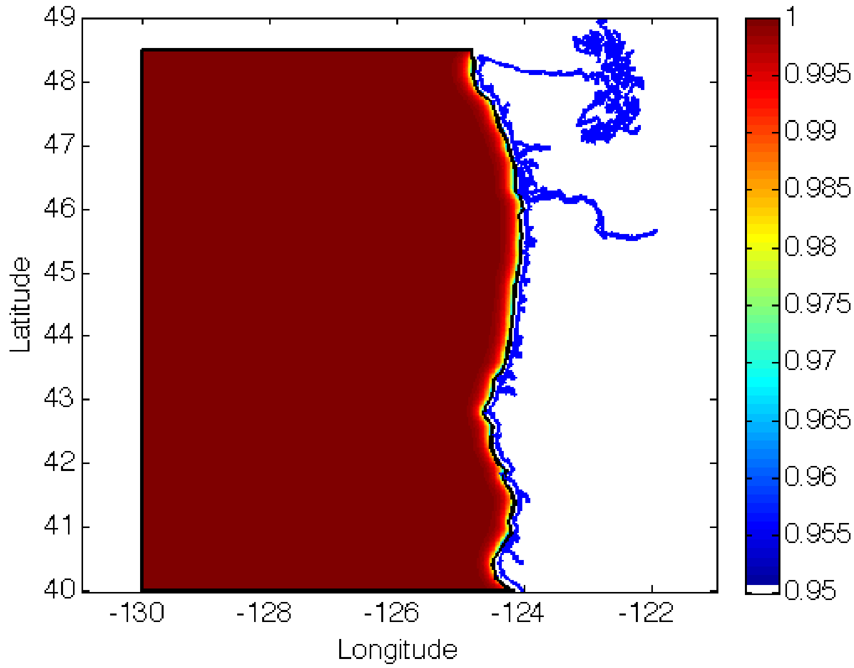


Figure D-29. Depiction of Land Shadow over NWTRC

D.8 REFERENCES

Arons, A.B. (1954). “Underwater Explosion Shock Wave Parameters at Large Distances from the Charge,” J. Acoust. Soc. Am. 26, 343.

Bartberger, C.L. (1965). “Lecture Notes on Underwater Acoustics,” NADC Report NADC=WR-6509, Naval Air Development Center Technical Report, Johnsville, PA, 17 May (AD 468 869) (UNCLASSIFIED).

Christian, E.A. and J.B. Gaspin, (1974). Swimmer Safe Standoffs from Underwater Explosions,” NSAP Project PHP-11-73, Naval Ordnance Laboratory, Report NOLX-89, 1 July (UNCLASSIFIED).

Department of the Navy (1998), “Final Environmental Impact Statement, Shock Testing the SEAWOLF Submarine,” U.S. Department of the Navy, Southern Division, Naval Facilities Engineering Command, North Charleston, SC, 637 p.

Department of the Navy (2001), “Final Environmental Impact Statement, Shock Trial of the WINSTON S. CHURCHILL (DDG 81),” U.S. Department of the Navy, NAVSEA, 597 p.

Goertner, J.F. (1982), “Prediction of Underwater Explosion Safe Ranges for Sea Mammals,” NSWC TR 82-188, Naval Surface Weapons Center, Dahlgren, VA.

Keenan, R.E., Denise Brown, Emily McCarthy, Henry Weinberg, and Frank Aidala (2000). “Software Design Description for the Comprehensive Acoustic System Simulation (CASS Version 3.0) with the Gaussian Ray Bundle Model (GRAB Version 2.0)”, NUWC-NPT Technical Document 11,231, Naval Undersea Warfare Center Division, Newport, RI, 1 June (UNCLASSIFIED).

McGrath, J.R. (1971). “Scaling Laws for Underwater Exploding Wires,” J. Acoust. Soc. Am. 50, 1030-1033 (UNCLASSIFIED).

Urick, R.J. (1983). Principles of Underwater Sound for Engineers, McGraw-Hill, NY (first edition: 1967, second edition: 1975) (UNCLASSIFIED).

Weston, D.E. (1960). “Underwater Explosions as Acoustic Sources,” Proc. Phys. Soc. 76, 233 (UNCLASSIFIED).

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Appendix E

Cetacean Stranding Report

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E CETACEAN STRANDING REPORT

E.1 CETACEAN STRANDINGS AND THREATS

Strandings can involve a single animal or several to hundreds of animals. An event where animals are found out of their normal habitat may be considered a stranding even though animals do not necessarily end up beaching (such as the July 2004 "Hanalei Mass Stranding Event"; Southall et al., 2006). Several hypotheses have been given for the mass strandings which include the impact of shallow beach slopes on odontocete echolocation, disease or parasites, geomagnetic anomalies that affect navigation, following a food source in close to shore, avoiding predators, social interactions that cause other cetaceans to come to the aid of stranded animals, and human actions. Generally, inshore species do not strand in large numbers, but generally just as individual animals. This may be due to their familiarity with the coastal area. By contrast, pelagic species that are unfamiliar with obstructions or sea bottom tend to strand more often in larger numbers (Woodings, 1995). The Navy has studied several stranding events in detail that may have occurred in association with Navy sonar activities. To better understand the causal factors in stranding events that may be associated with Navy sonar activities, the main factors - including bathymetry (i.e. steep drop-offs), narrow channels (less than 35 nm), environmental conditions (e.g. surface ducting) and multiple sonar ships (see Section on Stranding Events Associated with Navy Sonar) - were compared among the different stranding events.

E.1.1 What is a Stranded Marine Mammal?

When a live or dead marine mammal swims or floats onto shore and becomes "beached" or incapable of returning to sea, the event is termed a "stranding" (Geraci et al., 1999; Perrin and Geraci, 2002; Geraci and Lounsbury, 2005; NMFS, 2007). The legal definition for a stranding within the U.S. is that "a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance." (16 United States Code [U.S.C.] section 1421h).

The majority of animals that strand are dead or moribund (NMFS, 2007). For animals that strand alive, human intervention through medical aid and/or guidance seaward may be required for the animal to return to the sea. If unable to return to sea, rehabilitation at an appropriate facility may be determined as the best opportunity for animal survival. An event where animals are found out of their normal habitat may be considered a stranding depending on circumstances even though the animals do not necessarily end up beaching (Southhall, 2006).

Three general categories can be used to describe strandings: single, mass and unusual mortality events. The most frequent type of stranding involves only one animal (or a mother/calf pair) (NMFS, 2007).

Mass stranding involves two or more marine mammals of the same species other than a mother/calf pair (Wilkinson, 1991), and may span one or more days and range over several miles (Simmonds and Lopez-Jurado, 1991; Frantzis, 1998; Walsh et al., 2001; Freitas, 2004). In North America, only a few species typically strand in large groups of 15 or more and include sperm whales, pilot whales, false killer whales, Atlantic white-sided dolphins, white-beaked dolphins and rough-toothed dolphins (Odell 1987, Walsh et al., 2001). Some species, such as pilot whales, false-killer whales and melon-headed whales occasionally strand in groups of 50 to 150 or more (Geraci et al., 1999). All of these normally pelagic off-shore species are highly sociable and infrequently encountered in coastal waters. Species that commonly strand in smaller numbers include pygmy killer whales, common dolphins, bottlenose dolphins, Pacific white-sided dolphin Frasier's dolphins, gray whales and humpback whales (West Coast only), harbor porpoise, Cuvier's beaked whales, California sea lions and harbor seals (Mazzuca et al., 1999, Norman et al., 2004, Geraci and Lounsbury, 2005).

Unusual mortality events (UMEs) can be a series of single strandings or mass strandings, or unexpected mortalities (i.e., die-offs) that occur under unusual circumstances (Dierauf and Gulland, 2001; Harwood, 2002; Gulland, 2006; NMFS, 2007). These events may be interrelated: for instance, at-sea die-offs lead to increased stranding frequency over a short period of time, generally within one to two months. As published by the NMFS, revised criteria for defining a UME include (71 FR 75234, 2006):

(1) A marked increase in the magnitude or a marked change in the nature of morbidity, mortality or strandings when compared with prior records.

(2) A temporal change in morbidity, mortality or strandings is occurring.

(3) A spatial change in morbidity, mortality or strandings is occurring.

(4) The species, age, or sex composition of the affected animals is different than that of animals that are normally affected.

(5) Affected animals exhibit similar or unusual pathologic findings, behavior patterns, clinical signs or general physical condition (e.g., blubber thickness).

(6) Potentially significant morbidity, mortality or stranding is observed in species, stocks or populations that are particularly vulnerable (e.g., listed as depleted, threatened or endangered or declining). For example, stranding of three or four right whales may be cause for great concern whereas stranding of a similar number of fin whales may not.

(7) Morbidity is observed concurrent with or as part of an unexplained continual decline of a marine mammal population, stock or species.

UMEs are usually unexpected, infrequent and may involve a significant number of marine mammal mortalities. As discussed below, unusual environmental conditions are probably responsible for most UMEs and marine mammal die-offs (Vidal and Gallo-Reynoso, 1996; Geraci et al., 1999; Walsh et al., 2001; Gulland and Hall, 2005).

E.1.2 United States Stranding Response Organization

Stranding events provide scientists and resource managers information not available from limited at-sea surveys, and may be the only way to learn key biological information about certain species such as distribution, seasonal occurrence and health (Rankin, 1953; Moore et al., 2004; Geraci and Lounsbury, 2005). Necropsies are useful in attempting to determine a reason for the stranding, and are performed on stranded animals when the situation and resources allow.

In 1992, Congress amended the MMPA to establish the Marine Mammal Health and Stranding Response Program (MMHSRP) under authority of the NMFS. The MMHSRP was created out of concern started in the 1980s for marine mammal mortalities, to formalize the response process and to focus efforts being initiated by numerous local stranding organizations and as a result of public concern.

Major elements of the MMHSRP include (NMFS, 2007):

- National Marine Mammal Stranding Network
- Marine Mammal UME Program

- National Marine Mammal Tissue Bank (NMMTB) and Quality Assurance Program
- Marine Mammal Health Biomonitoring, Research and Development
- Marine Mammal Disentanglement Network
- John H. Prescott Marine Mammal Rescue Assistance Grant Program (a.k.a. the Prescott Grant Program)
- Information Management and Dissemination.

The United States has a well-organized network in coastal states to respond to marine mammal strandings. Overseen by the NMFS, the National Marine Mammal Stranding Network is comprised of smaller organizations manned by professionals and volunteers from nonprofit organizations, aquaria, universities and state and local governments trained in stranding response animal health and diseased investigation. Currently, 141 organizations are authorized by NMFS to respond to marine mammal strandings (National Marine Fisheries Service, 2007o). Through a National Coordinator and six regional coordinators, NMFS authorizes and oversees stranding response activities and provides specialized training for the network.

NMFS Regions and Associated States and Territories

NMFS Northeast Region- ME, NH, MA, RI, CT, NY, NJ, PA, DE, MD, VA

NMFS Southeast Region- NC, SC, GA, FL, AL, MS, LA, TX, PR, VI

NMFS Southwest Region- CA

NMFS Northwest Region- OR, WA

NMFS Alaska Region- AK

NMFS Pacific Islands Region- HI, Guam, American Samoa, Commonwealth of the Northern Mariana Islands (CNMI)

Stranding reporting and response efforts over time have been inconsistent, although effort and data quality within the U.S. have been improving within the last 20 years (NMFS, 2007). Given the historical inconsistency in response and reporting, however, interpretation of long-term trends in marine mammal stranding is difficult (NMFS, 2007). Nationwide, between 1995-2004, there were approximately 700-1500 cetacean strandings per year and between 2000-4600 pinniped strandings per year (NMFS, 2007). Detailed regional stranding information including most commonly stranded species can be found in Zimmerman (1991), Geraci and Lounsbury (2005), and NMFS (2007).

Stranding data is presented in Table E-1 and Figure E-1 below.

Table E-1. Cetacean And Pinniped Stranding Count By NMFS Region 2001-2004.

NMFS Region	# of Cetaceans	# of Pinnipeds
Northeast	1,620	4,050
Southeast	2,830	45
Southwest	12,900	45
Northwest	188	1,430
Alaska	269	348
Pacific Islands	59	10
Four Year Total	17,866	5,928

Source: NMFS 2007

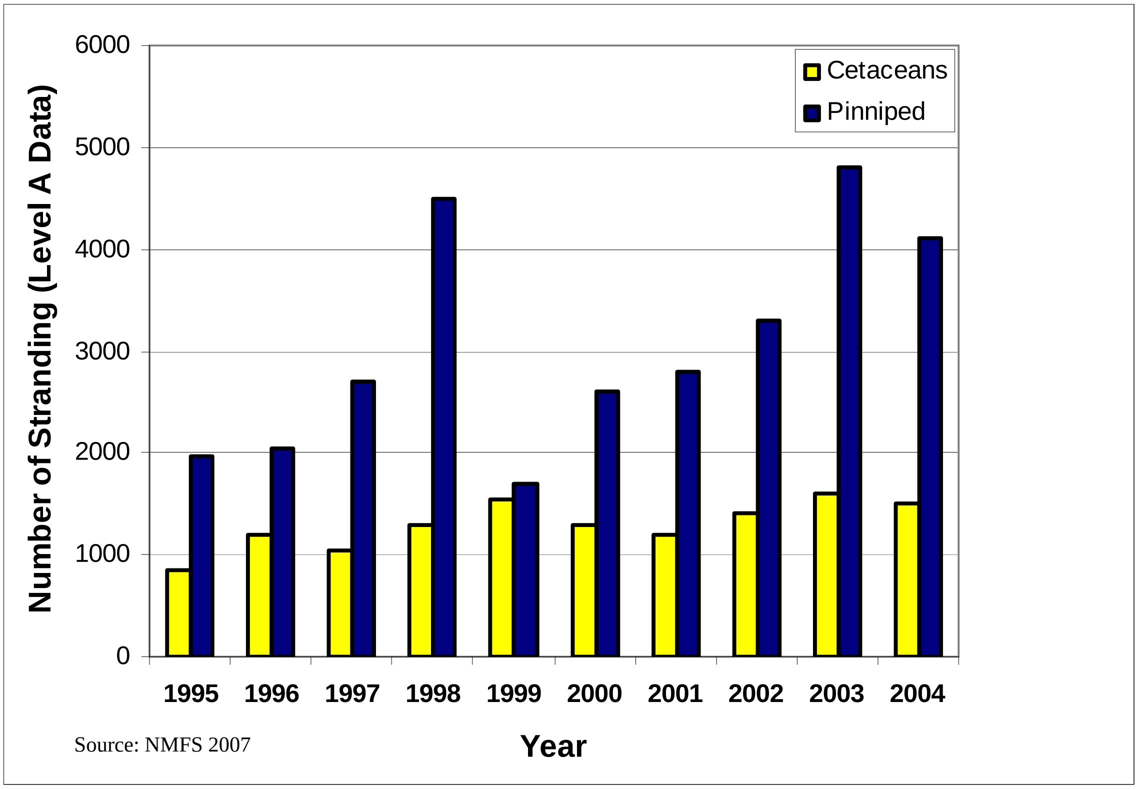


Figure E-1. United States Annual Cetacean And Pinniped Stranding From 1995-2004.

E.1.3 Unusual Mortality Events (UMEs)

From 1991 to the present, there have been 45 formally recognized UMEs in the U.S. The UMEs have either involved single or multiple species and dozens to hundreds of individual marine mammals per event (NOAA Fisheries, Office of Protected Resources 2008). Table E-2 contains a list of documented UMEs in and along the Pacific coast of the U.S.

E.1.4 Threats to Marine Mammals and Potential Causes for Stranding

Reports of marine mammal strandings can be traced back to ancient Greece (Walsh et al., 2001). Like any wildlife population, there are normal background mortality rates that influence marine mammal population dynamics, including starvation, predation, aging, reproductive success and disease (Geraci et al., 1999; Carretta et al., 2007). Strandings in and of themselves may be reflective of this natural cycle or, more recently, may be the result of anthropogenic sources (i.e., human impacts). Current science suggests that multiple factors, both natural and man-made, may be acting alone or in combination to cause a marine mammal to strand (Geraci et al., 1999; Culik, 2002; Perrin and Geraci, 2002; Hoelzel, 2003; Geraci and Lounsbury, 2005; NRC, 2006). While post-stranding data collection and necropsies of dead animals are attempted in an effort to find a possible cause for the stranding, it is often difficult to pinpoint exactly one factor that can be blamed for any given stranding. An animal suffering from one ailment becomes susceptible to various other influences because of its weakened condition, making it difficult to determine a primary cause. In many stranding cases, scientists never learn the exact reason for the stranding.

Table E-2. Documented UMEs within the United States.

Year	Composition	Determination
1993	Harbor seals, Steller sea lions, and California sea lions on the central Washington coast	Human Interaction
1993/1994	Bottlenose dolphins in the Gulf of Mexico	Morbillivirus
1994	Common dolphins in California	Cause not determined
1996	Right whales off Florida/Georgia coast	Evidence of human interactions
1996	Manatees on the west coast of Florida	Brevetoxin
1996	Bottlenose dolphins in Mississippi	Cause not determined
1997	Harbor seals in California	Unknown infectious respiratory disease
1997	Pinnipeds on the Pacific coast	El Niño
1998	California sea lions in central California	Harmful algal bloom; Domoic acid
1999	Harbor porpoises on the East Coast	Determined not to meet criteria for UME because of multiplicity of causes
1999/2000	Bottlenose dolphins in the Panhandle of Florida	Harmful algal bloom is suspected; still under investigation
1999/2000	Gray whales from Alaska to Mexico	Still under investigation
2004	Bottlenose dolphins along the Florida Panhandle	Uncertain, red tide is suspected
2005	Bottlenose dolphins, manatees, sea turtles, and seabirds in west central Florida	Unknown

Source: NMFS 2007

Specific potential stranding causes can include both natural and human influenced (anthropogenic) causes listed below and described in the following sections:

Natural Stranding Causes

- Disease
- Natural toxins
- Weather and climatic influences
- Navigation errors
- Social cohesion
- Predation

Human Influenced (Anthropogenic) Stranding Causes

- Fisheries interaction
- Vessel strike
- Pollution and ingestion
- Noise

E.1.4.1 Natural Stranding Causes

Significant natural causes of mortality, die-offs and stranding discussed below include disease and parasitism; marine neurotoxins from algae; navigation errors that lead to inadvertent stranding; and climatic influences that impact the distribution and abundance of potential food resources (i.e., starvation). Other natural mortality not discussed in detail includes predation by other species such as sharks (Cockcroft et al., 1989; Heithaus, 2001), killer whales (Constantine et al., 1998; Guinet et al., 2000; Pitman et al., 2001) and some species of pinniped (Hiruki et al., 1999; Robinson et al., 1999).

Disease

Like other mammals, marine mammals frequently suffer from a variety of diseases of viral, bacterial, parasitic and fungal origin (Visser et al., 1991; Dunn et al., 2001; Harwood, 2002). Gulland and Hall (2005) provide a more detailed summary of individual and population effects of marine mammal diseases.

Microparasites such as bacteria, viruses and other microorganisms are commonly found in marine mammal habitats and usually pose little threat to a healthy animal (Geraci et al., 1999). For example, long-finned pilot whales that inhabit the waters off the northeastern coast of the U.S. are carriers of the morbillivirus, yet have grown resistant to its usually lethal effects (Geraci et al., 1999). Since the 1980s, however, virus infections have been strongly associated with marine mammal die-offs (Domingo et al., 1992; Geraci and Lounsbury, 2005). Morbillivirus is the most significant marine mammal virus and suppresses a host's immune system, increasing risk of secondary infection (Harwood, 2002). A bottlenose dolphin UME in 1993 and 1994 was caused by infectious disease. Die-offs ranged from northwestern Florida to Texas, with an increased number of deaths as it spread (NMFS, 2007c). A 2004 UME in Florida was also associated with dolphin morbillivirus (NMFS, 2004). Influenza A was responsible for the first reported mass mortality in the U.S., occurring along the coast of New England in 1979-1980 (Geraci et al., 1999; Harwood, 2002). Canine distemper virus (a type of morbillivirus) has been responsible for large scale pinniped mortalities and die-offs (Grachev et al., 1989; Kennedy et al., 2000; Gulland and Hall, 2005), while a bacteria, *Leptospira pomona*, is responsible for periodic die-offs in California sea lions about every four years (Gulland et al., 1996; Gulland and Hall, 2005). It is difficult to determine whether microparasites commonly act as a primary pathogen, or whether they show up as a secondary infection in an already weakened animal (Geraci et al., 1999). Most marine mammal die-offs from infectious disease in the last 25 years, however, have had viruses associated with them (Simmonds and Mayer, 1997; Geraci et al., 1999; Harwood, 2002).

Macroparasites are usually large parasitic organisms and include lungworms, trematodes (parasitic flatworms), and protozoans (Geraci and St. Aubin, 1987; Geraci et al., 1999). Marine mammals can carry many different types and have shown a robust tolerance for sizeable infestation unless compromised by illness, injury or starvation (Morimitsu et al., 1987; Dailey et al., 1991; Geraci et al., 1999). Nasitrema, a usually benign trematode found in the head sinuses of cetaceans (Geraci et al., 1999), can cause brain damage if it migrates (Ridgway and Dailey, 1972). As a result, this worm is one of the few directly linked to stranding in the cetaceans (Dailey and Walker, 1978; Geraci et al., 1999).

Non-infectious disease, such as congenital bone pathology of the vertebral column (osteomyelitis, spondylosis deformans, and ankylosing spondylitis [AS]), has been described in several species of cetacean (Paterson, 1984; Alexander et al., 1989; Kompanje, 1995; Sweeny et al., 2005). In humans, bone pathology such as AS, can impair mobility and increase vulnerability to further spinal trauma (Resnick and Niwayama, 2002). Bone pathology has been found in cases of single strandings (Paterson, 1984; Kompanje, 1995), and also in cetaceans prone to mass stranding (Sweeny et al., 2005), possibly acting as a contributing or causal influence in both types of events.

Naturally Occurring Marine Neurotoxins

Some single-cell marine algae common in coastal waters, such as dinoflagellates and diatoms, produce toxic compounds that can accumulate (termed bioaccumulation) in the flesh and organs of fish and invertebrates (Geraci et al., 1999; Harwood, 2002). Marine mammals become exposed to these compounds when they eat prey contaminated by these naturally produced toxins although exposure can also occur through inhalation and skin contact (Van Dolah, 2005). Figure E-2 shows U.S. animal mortalities from 1997-2006 resulting from toxins produced during harmful algal blooms.

In the Gulf of Mexico and mid- to southern Atlantic states, "red tides," a form of harmful algal bloom, are created by a dinoflagellate (*Karenia brevis*). *K. brevis* is found throughout the Gulf of Mexico and sometimes along the Atlantic coast (Van Dolah 2005; NMFS 2007). It produces a neurotoxin known as brevetoxin. Brevetoxin has been associated with several marine mammal UMEs within this area (Geraci, 1989; Van Dolah et al., 2003; NMFS, 2004; Flewelling et al., 2005; Van Dolah, 2005; NMFS, 2007). On the U.S. West Coast and in the northeast Atlantic, several species of diatoms produce a toxin called domoic acid which has also been linked to marine mammal strandings (Geraci et al., 1999; Van Dolah et al., 2003; Greig et al., 2005; Van Dolah, 2005; Brodie et al., 2006; NMFS, 2007; Bargu et al., 2008; Goldstein et al., 2008). Other algal toxins associated with marine mammal strandings include saxitoxins and ciguatoxins and are summarized by Van Dolah (2005).

Weather events and climate influences

Severe storms, hurricanes, typhoons and prolonged temperature extremes may lead to localized marine mammal strandings (Geraci et al., 1999; Walsh et al., 2001). Hurricanes may have been responsible for mass strandings of pygmy killer whales in the British Virgin Islands and Gervais' beaked whales in North Carolina (Mignucci-Giannoni et al., 2000; Norman and Mead, 2001). Storms in 1982-1983 along the California coast led to deaths of 2,000 northern elephant seal pups (Le Boeuf and Reiter, 1991). Ice movement along southern Newfoundland has forced groups of blue whales and white-beaked dolphins ashore (Sergeant, 1982). Seasonal oceanographic conditions in terms of weather, frontal systems and local currents may also play a role in stranding (Walker et al., 2005).

The effect of large-scale climatic changes to the world's oceans and how these changes impact marine mammals and influence strandings is difficult to quantify given the broad spatial and temporal scales involved and the cryptic movement patterns of marine mammals (Moore, 2005; Learmonth et al., 2006). The most immediate, although indirect, effect is decreased prey availability during unusual conditions. This, in turn, results in increased search effort required by marine mammals (Crocker et al., 2006), potential starvation if not successful and corresponding stranding due directly to starvation or succumbing to disease or predation while in a more weakened, stressed state (Selzer and Payne, 1988; Geraci et al., 1999; Moore, 2005; Learmonth et al., 2006; Weise et al., 2006).

Two recent papers examined potential influences of climate fluctuation on stranding events in southern Australia, including Tasmania, an area with a history of more than 20 mass stranding since the 1920s (Evans et al., 2005; Bradshaw et al., 2006). These authors note that patterns in animal migration, survival, fecundity, population size and strandings will revolve around the availability and distribution of food resources. In southern Australia, movement of nutrient-rich waters pushed closer to shore by periodic meridinal winds (occurring about every 12 to 14 years) may be responsible for bringing marine mammals closer to land, thus increasing the probability of stranding (Bradshaw et al., 2006). The papers conclude, however, that while an overarching model can be helpful for providing insight into the prediction of strandings, the particular reasons for each one are likely to be quite varied.

Source: Woods Hole Oceanographic Institute (WHO) http://www.whoi.edu/redtide/HABdistribution/HABmap.html

Figure E-2. Animal Mortalities from Harmful Algal Blooms within the U.S., 1997-2006.

Navigation Error

Geomagnetism – It has been hypothesized that, like some land animals, marine mammals may be able to orient to the Earth's magnetic field as a navigational cue, and that areas of local magnetic anomalies may influence strandings (Bauer et al., 1985; Klinowska, 1985; Kirschvink et al., 1986; Klinowska, 1986; Walker et al., 1992; Wartzok and Ketten, 1999). In a plot of live stranding positions in Great Britain with magnetic field maps, Klinowska (1985; 1986) observed an association between live stranding positions and magnetic field levels. In all cases, live strandings occurred at locations where magnetic minima, or lows in the magnetic fields, intersect the coastline. Kirschvink et al. (1986) plotted stranding locations on a map of magnetic data for the East Coast of the U.S., and were able to develop associations between stranding sites and locations where magnetic minima intersected the coast. The authors concluded that there were highly significant tendencies for cetaceans to beach themselves near these magnetic minima and coastal intersections. The results supported the hypothesis that cetaceans may have a magnetic sensory system similar to other migratory animals, and that marine magnetic topography and patterns may influence long-distance movements (Kirschvink et al., 1986). Walker et al. (1992) examined fin whale swim patterns off the northeastern U.S. continental shelf, and reported that migrating animals aligned with lows in the geometric gradient or intensity. While a similar pattern between magnetic features and marine mammal strandings at New Zealand stranding sites was not seen (Brabyn and Frew, 1994), mass strandings in Hawaii typically were found to occur within a narrow range of magnetic anomalies (Mazzuca et al., 1999).

Echolocation Disruption in Shallow Water - Some researchers believe stranding may result from reductions in the effectiveness of echolocation within shallow water, especially with the pelagic species of odontocetes that may be less familiar with coastline (Dudok van Heel, 1966; Chambers and James, 2005). For an odontocete, echoes from echolocation signals contain important information on the location and identity of underwater objects and the shoreline. The authors postulate that the gradual slope of a beach may present difficulties to the navigational systems of some cetaceans, since it is common for live strandings to occur along beaches with shallow, sandy gradients (Brabyn and McLean, 1992; Mazzuca et al., 1999; Maldini et al., 2005; Walker et al., 2005). A contributing factor to echolocation interference in turbulent, shallow water is the presence of microbubbles from the interaction of wind, breaking waves and currents. Additionally, ocean water near the shoreline can have an increased turbidity (e.g., floating sand or silt, particulate plant matter, etc.) due to the run-off of fresh water into the ocean, either from rainfall or from freshwater outflows (e.g., rivers and creeks). Collectively, these factors can reduce and scatter the sound energy within echolocation signals and reduce the perceptibility of returning echoes of interest.

Social cohesion

Many pelagic species such as sperm whale, pilot whales, melon-head whales and false killer whales and some dolphins occur in large groups with strong social bonds between individuals. When one or more animals strand due to any number of causative events, then the entire pod may follow suit out of social cohesion (Geraci et al., 1999; Conner ,2000; Perrin and Geraci, 2002; NMFS, 2007).

E.1.4.2 Anthropogenic Stranding Causes and Potential Risks

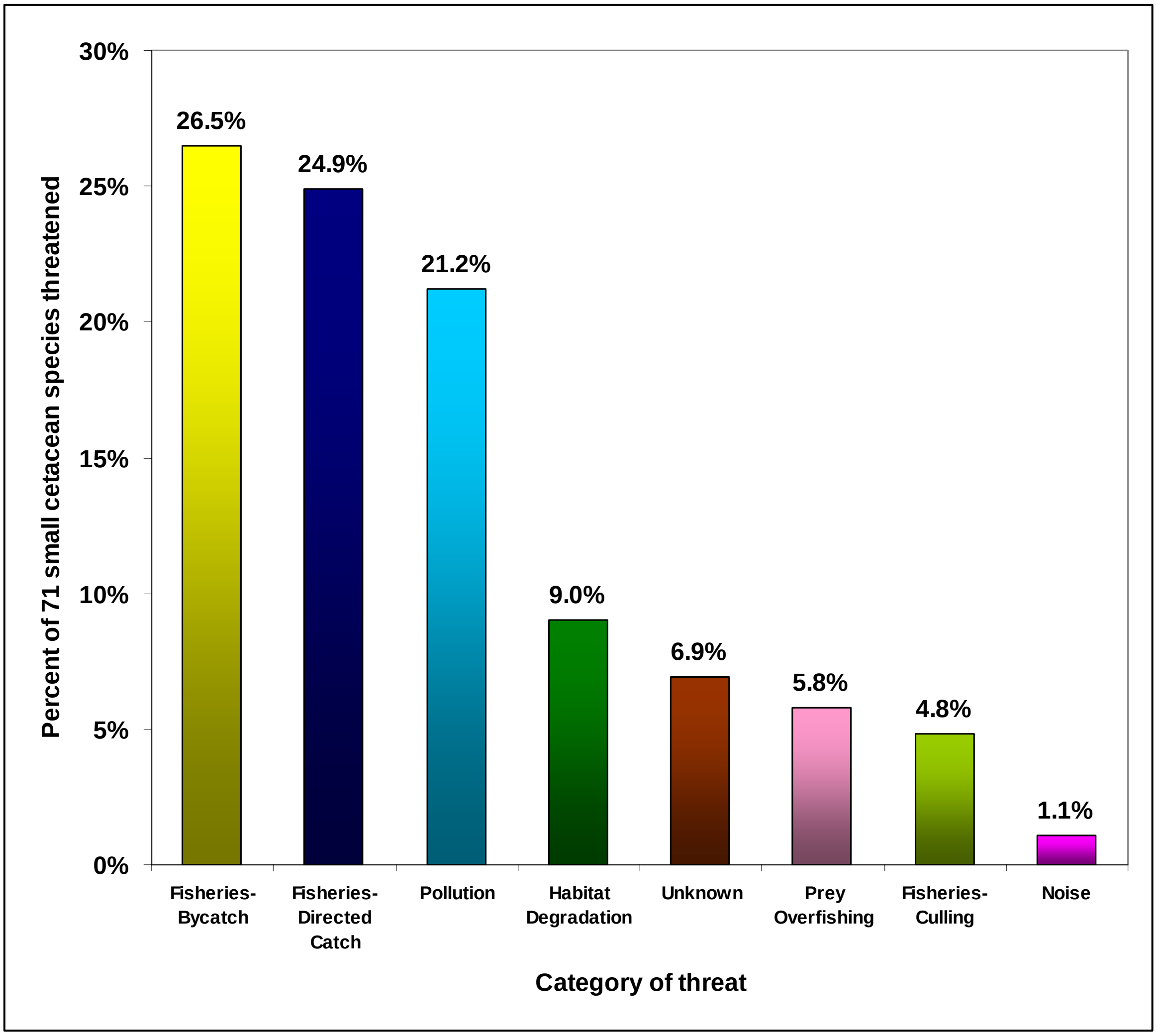
With the exception of historic whaling in the 19th and early part of the 20th century, over the past few decades there has been an increase in marine mammal mortalities associated with a variety of human activities (Geraci et al., 1999; NMFS, 2007). These include fisheries interactions (bycatch and directed catch), pollution (marine debris, toxic compounds), habitat modification (degradation, prey reduction), direct trauma (vessel strikes, gunshots) and noise. Figure E-3 show potential worldwide risk to small toothed cetaceans by source.

Fisheries Interaction: By-Catch, Directed Catch, and Entanglement

The incidental catch of marine mammals in commercial fisheries is a significant threat to the survival and recovery of many populations of marine mammals (Geraci et al., 1999; Baird, 2002; Culik, 2002; Carretta et al., 2004; Geraci and Lounsbury, 2005; NMFS, 2007). Interactions with fisheries and entanglement in discarded or lost gear continue to be a major factor in marine mammal deaths worldwide (Geraci et al., 1999; Nieri et al., 1999; Geraci and Lounsbury, 2005; Read et al., 2006; Zeeber et al., 2006). For instance, baleen whales and pinnipeds have been found entangled in nets, ropes, monofilament line and other fishing gear that had been discarded out at sea (Geraci et al., 1999; Campagna et al., 2007).

Bycatch - Bycatch is the catching of non-target species within a given fishing operation and can include non-commercially used invertebrates, fish, sea turtles, birds and marine mammals (NRC 2006). Read et al. (2006) attempted to estimate the magnitude of marine mammal bycatch in U.S. and global fisheries. Data on marine mammal bycatch within the United States was obtained from fisheries observer programs, reports of entangled stranded animals and fishery logbooks, and was then extrapolated to estimate global bycatch by using the ratio of U.S. fishing vessels to the total number of vessels within the world's fleet (Read et al., 2006). Within U.S. fisheries, between 1990 and 1999 the mean annual bycatch of marine mammals was 6,215 animals, with a standard error of +/- 448 (Read et al., 2006). Eighty-four percent of cetacean bycatch occurred in gill-net fisheries, with dolphins and porpoises constituting most of the cetacean bycatch (Read et al., 2006). Over the decade there was a 40 percent decline in marine mammal bycatch, which was significantly lower from 1995-1999 than it was from 1990-1994 (Read et al., 2006). Read et al. (2006) suggests that this is primarily due to effective conservation measures that were implemented during this period.

Read et al. (2006) then extrapolated this data for the same time period and calculated an annual estimate of 653,365 of marine mammals globally, with most of the world's bycatch occurring in gill-net fisheries. With global marine mammal bycatch likely to be in the hundreds of thousands every year, bycatch in fisheries is the single greatest threat to many marine mammal populations around the world (Read et al., 2006).



(Source: Culik 2002)

Figure E-3. Human Threats to World Wide Small Cetacean Populations

Entanglement - Entanglement in active fishing gear is a major cause of death or severe injury among the endangered whales in the action area. Entangled marine mammals may die as a result of drowning, escape with pieces of gear still attached to their bodies, manage to be set free either of their own accord, or are set free by fishermen. Many large whales carry off gear after becoming entangled (Read et al., 2006). Many times when a marine mammal swims off with gear attached, the end result can be fatal. The gear may be become too cumbersome for the animal or it can be wrapped around a crucial body part and tighten over time. Stranded marine mammals frequently exhibit signs of previous fishery interaction, such as scarring or gear attached to their bodies, and the cause of death for many stranded marine mammals is often attributed to such interactions (Baird and Gorgone, 2005). Because marine mammals that die or are injured in fisheries may not wash ashore and because not all animals that do wash ashore exhibit clear signs of interactions, stranding data probably underestimate fishery-related mortality and serious injury (NMFS, 2005a).

From 1993 through 2003, 1,105 harbor porpoises were reported stranded from Maine to North Carolina, many of which had cuts and body damage suggestive of net entanglement (NMFS, 2005e). In 1999 it was possible to determine that the cause of death for 38 of the stranded porpoises was fishery interactions, with one additional animal having been mutilated (right flipper and fluke cut off) (NMFS, 2005e). In 2000, one stranded porpoise was found with monofilament line wrapped around its body (NMFS, 2005e). In 2003, nine stranded harbor porpoises were attributed to fishery interactions, with an additional three mutilated animals (NMFS, 2005e). An estimated 78 baleen whales were killed annually in the offshore Southern California/Oregon drift gillnet fishery during the 1980s (Heyning and Lewis, 1990). From 1998-2005, based on observer records, five fin whales (CA/OR/WA stock), 12 humpback whales (ENP stock), and six sperm whales (CA/OR/WA stock) were either seriously injured or killed in fisheries off the mainland West Coast of the U.S. (California Marine Mammal Stranding Network Database, 2006).

Ship Strike

Vessel strikes to marine mammals are another cause of mortality and stranding (Laist et al., 2001; Geraci and Lounsbury, 2005; de Stephanis and Urquiola, 2006). An animal at the surface could be struck directly by a vessel, a surfacing animal could hit the bottom of a vessel, or an animal just below the surface could be cut by a vessel's propeller. The severity of injuries typically depends on the size and speed of the vessel (Knowlton and Kraus, 2001; Laist et al., 2001; Vanderlaan and Taggart, 2007).

An examination of all known ship strikes from all shipping sources (civilian and military) indicates vessel speed is a principal factor in whether a vessel strike results in death (Knowlton and Kraus, 2001; Laist et al., 2001, Jensen and Silber, 2003; Vanderlaan and Taggart, 2007). In assessing records in which vessel speed was known, Laist et al. (2001) found a direct relationship between the occurrence of a whale strike and the speed of the vessel involved in the collision. The authors concluded that most deaths occurred when a vessel was traveling in excess of 13 knots, although most vessels do travel greater than 15 knots. Jensen and Silber (2003) detailed 292 records of known or probable ship strikes of all large whale species from 1975 to 2002. Of these, vessel speed at the time of collision was reported for 58 cases. Of these cases, 39 (or 67 percent) resulted in serious injury or death (19 or 33 percent resulted in serious injury as determined by blood in the water, propeller gashes or severed tailstock, and fractured skull, jaw, vertebrae, hemorrhaging, massive bruising or other injuries noted during necropsy and 20 or 35 percent resulted in death). Operating speeds of vessels that struck various species of large whales ranged from 2 to 51 knots. The majority (79 percent) of these strikes occurred at speeds of 13 knots or greater. The average speed that resulted in serious injury or death was 18.6 knots. Pace and Silber (2005) found that the probability of death or serious injury increased rapidly with increasing vessel speed. Specifically, the predicted probability of serious injury or death increased from 45 percent to 75 percent as vessel speed increased from 10 to 14 knots, and exceeded 90 percent at 17 knots. Higher speeds during collisions result in greater force of impact, but higher speeds also appear to increase the chance of severe injuries or death by pulling whales toward the vessel. Computer simulation modeling showed that hydrodynamic forces pulling whales toward the vessel hull increase with increasing speed (Clyne, 1999; Knowlton et al., 1995).

The growth in civilian commercial ports and associated commercial vessel traffic is a result in the globalization of trade. The Final Report of the NOAA International Symposium on "Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology" stated that the worldwide commercial fleet has grown from approximately 30,000 vessels in 1950 to more than 85,000 vessels in 1998 (NRC, 2003; Southall, 2005). Between 1950 and 1998, the U.S.-flagged fleet declined from approximately 25,000 to fewer than 15,000 and currently represents only a small portion of the world fleet. From 1985 to 1999, world seaborne trade doubled to 5 billion tons and currently includes 90 percent of the total world trade, with container shipping movements representing the largest volume of seaborne trade. It is unknown how international shipping volumes and densities will continue to grow. However, current statistics support the prediction that the international shipping fleet will continue to grow at the current rate or at greater rates in the future. Shipping densities in specific areas and trends in routing and vessel design are as, or more, significant than the total number of vessels. Densities along existing coastal routes are expected to increase both domestically and internationally. New routes are also expected to develop as new ports are opened and existing ports are expanded. Vessel propulsion systems are also advancing toward faster ships operating in higher sea states for lower operating costs; and container ships are expected to become larger along certain routes (Southall, 2005).

While there are reports and statistics of whales struck by vessels in U.S. waters, the magnitude of the risks of commercial ship traffic poses to marine mammal populations is difficult to quantify or estimate. In addition, there is limited information on vessel strike interactions between ships and marine mammals outside of U.S. waters (de Stephanis and Urquiola, 2006). Laist et al. (2001) concluded that ship collisions may have a negligible effect on most marine mammal populations in general, except for regional-based small populations where the significance of low numbers of collisions would be greater given smaller populations or populations segments.

U.S. Navy vessel traffic is a small fraction of the overall U.S. commercial and fishing vessel traffic. While U.S. Navy vessel movements may contribute to the ship strike threat, given the lookout and mitigation measures adopted by the U.S. Navy, probability of vessel strikes is greatly reduced. Furthermore, actions to avoid close interaction of U.S. Navy ships and marine mammals and sea turtles, such as maneuvering to keep away from any observed marine mammal and sea turtle are part of existing at-sea protocols and standard operating procedures. Navy ships have up to three or more dedicated and trained lookouts as well as two to three bridge watchstanders during at-sea movements who would be searching for any whales, sea turtles or other obstacles on the water surface. Such lookouts are expected to further reduce the chances of a collision.

Commercial and Private Marine Mammal Viewing

In addition to vessel operations, private and commercial vessels engaged in marine mammal watching also have the potential to impact marine mammals in Southern California. NMFS has promulgated regulations at 50 CFR 224.103, which provide specific prohibitions regarding wildlife viewing activities. In addition, NMFS launched an education and outreach campaign to provide commercial operators and the general public with responsible marine mammal viewing guidelines. In January 2002, NMFS also published an official policy on human interactions with wild marine mammals which states: “NOAA Fisheries cannot support, condone, approve or authorize activities that involve closely approaching, interacting or attempting to interact with whales, dolphins, porpoises, seals or sea lions in the wild. This includes attempting to swim, pet, touch or elicit a reaction from the animals.”

Although considered by many to be a non-consumptive use of marine mammals with economic, recreational, educational and scientific benefits, marine mammal watching is not without potential negative impacts. One concern is that animals become more vulnerable to vessel strikes once they habituate to vessel traffic (Swingle et al., 1993; Wiley et al., 1995). Another concern is that preferred habitats may be abandoned if disturbance levels are too high. A whale’s behavioral response to whale watching vessels depends on the distance of the vessel from the whale, vessel speed, vessel direction, vessel noise and the number of vessels (Amaral and Carlson, 2005; Au and Green, 2000; Cockeron, 1995; Erbe, 2002; Felix, 2001; Magalhaes et al., 2002; Richter et al., 2003; Schedat et al., 2004; Simmonds, 2005; Watkins, 1986; Williams et al., 2002). The whale’s responses changed with these different variables and, in some circumstances, the whales did not respond to the vessels, but in other circumstances, whales changed their vocalizations surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior and social interactions. In addition to the information on whale watching, there is also direct evidence of pinniped haul out site (Pacific harbor seals) abandonment because of human disturbance at Strawberry Spit in San Francisco Bay (Allen, 1991).

Ingestion of Plastic Objects and Other Marine Debris and Toxic Pollution Exposure

For many marine mammals, debris in the marine environment is a great hazard and can be harmful to wildlife. Not only is debris a hazard because of possible entanglement, animals may mistake plastics and other debris for food (NMFS, 2007g). U.S. Navy vessels have a zero-plastic discharge policy and return all plastic waste to appropriate disposition on shore.

There are certain species of cetaceans, along with Florida manatees, that are more likely to eat trash, especially plastics, which is usually fatal for the animal (Geraci et al., 1999). From 1990 through October 1998, 215 pygmy sperm whales stranded along the U.S. Atlantic Coast from New York through the Florida Keys (NMFS, 2005a). Remains of plastic bags and other debris were found in the stomachs of 13 of these animals (NMFS, 2005a). During the same period, 46 dwarf sperm whale strandings occurred along the U.S. Atlantic coastline between Massachusetts and the Florida Keys (NMFS, 2005d). In 1987 a pair of latex examination gloves was retrieved from the stomach of a stranded dwarf sperm whale (NMFS, 2005d). One hundred twenty-five pygmy sperm whales were reported stranded from 1999 to 2003 between Maine and Puerto Rico; in one pygmy sperm whale found stranded in 2002, red plastic debris was found in the stomach along with squid beaks (NMFS, 2005a).

Sperm whales have been known to ingest plastic debris, such as plastic bags (Evans et al., 2003; Whitehead, 2003). While this has led to mortality, the scale to which this is affecting sperm whale populations is unknown, but Whitehead (2003) suspects it is not substantial at this time.

High concentrations of potentially toxic substances within marine mammals along with an increase in new diseases have been documented in recent years. Scientists have begun to consider the possibility of a link between pollutants and marine mammal mortality events. NMFS takes part in a marine mammal bio-monitoring program not only to help assess the health and contaminant loads of marine mammals, but also to assist in determining anthropogenic impacts on marine mammals, marine food chains and marine ecosystem health. Using strandings and bycatch animals, the program provides tissue/serum archiving, samples for analyses, disease monitoring and reporting and additional response during disease investigations (NMFS, 2007).

The impacts of these activities are difficult to measure. However, some researchers have correlated contaminant exposure to possible adverse health effects in marine mammals. Contaminants such as organochlorines do not tend to accumulate in significant amounts in invertebrates, but do accumulate in fish and fish-eating animals. Thus, contaminant levels in planktivorous mysticetes have been reported to be one to two orders of magnitude lower compared to piscivorous odontocetes (Borell, 1993; O'Shea and Brownell, 1994; O'Hara and Rice, 1996; O'Hara et al., 1999).

The manmade chemical PCB (polychlorinated biphenyl), and the pesticide DDT (dichlorodiphyenyltrichloroethane), are both considered persistent organic pollutants that are currently banned in the United States for their harmful effects in wildlife and humans (NMFS, 2007c). Despite having been banned for decades, the levels of these compounds are still high in marine mammal tissue samples taken along U.S. coasts (NMFS, 2007c). Both compounds are long-lasting, reside in marine mammal fat tissues (especially in the blubber), and can be toxic, causing effects such as reproductive impairment and immunosuppression (NMFS, 2007c).

Both long-finned and short-finned pilot whales have a tendency to mass strand throughout their range. Short-finned pilot whales have been reported as stranded as far north as Rhode Island, and long-finned pilot whales as far south as South Carolina (NMFS, 2005b). For U.S. East Coast stranding records, both species are lumped together and there is rarely a distinction between the two because of uncertainty in species identification (NMFS ,2005b). Since 1980 within the Northeast region alone, between 2 and 120 pilot whales have stranded annually either individually or in groups (NMFS, 2005b). Between 1999 and 2003 from Maine to Florida, 126 pilot whales were reported stranded, including a mass stranding of 11 animals in 2000 and another mass stranding of 57 animals in 2002, both along the Massachusetts coast (NMFS, 2005b).

It is unclear how much of a role human activities play in these pilot whale strandings, and toxic poisoning may be a potential human-caused source of mortality for pilot whales (NMFS, 2005b). Moderate levels of PCBs and chlorinated pesticides (such as DDT, DDE and dieldrin) have been found in pilot whale blubber (NMFS, 2005b). Bioaccumulation levels have been found to be more similar in whales from the same stranding event than from animals of the same age or sex (NMFS, 2005b). Numerous studies have measured high levels of toxic metals (mercury, lead and cadmium), selenium and PCBs in pilot whales in the Faroe Islands (NMFS, 2005b). Population effects resulting from such high contamination levels are currently unknown (NMFS, 2005b).

Habitat contamination and degradation may also play a role in marine mammal mortality and strandings. Some events caused by man have direct and obvious effects on marine mammals, such as oil spills (Geraci et al., 1999). But in most cases, effects of contamination will more than likely be indirect in nature, such as effects on prey species availability or by increasing disease susceptibility (Geraci et al., 1999).

U.S. Navy vessel operation between ports and exercise locations has the potential for release of small amounts of pollutant discharges into the water column. U.S. Navy vessels are not a typical source, however, of either pathogens or other contaminants with bioaccumulation potential such as pesticides and PCBs. Furthermore, any vessel discharges such as bilge water and deck runoff associated with the vessels would be in accordance with international and U.S. requirements for eliminating or minimizing discharges of oil, garbage and other substances, and not likely to contribute significant changes to ocean water quality.

Deep Water Ambient Noise

Urick (1983) provided a discussion of the ambient noise spectrum expected in the deep ocean. Shipping, seismic activity and weather, are the primary causes of deep-water ambient noise. The ambient noise frequency spectrum can be predicted fairly accurately for most deep-water areas based primarily on known shipping traffic density and wind state (wind speed, Beaufort wind force or sea state) (Urick, 1983). For example, for frequencies between 100 and 500 Hz, Urick (1983) estimated the average deep water ambient noise spectra to be 73 to 80 dB for areas of heavy shipping traffic and high sea states, and 46 to 58 dB for light shipping and calm seas.

Shallow Water Ambient Noise

In contrast to deep water, ambient noise levels in shallow waters (i.e., coastal areas, bays, harbors, etc.) are subject to wide variations in level and frequency depending on time and location. The primary sources of noise include distant shipping and industrial activities, wind and waves, marine animals (Urick, 1983). At any give time and place, the ambient noise is a mixture of all of these noise variables. In addition, sound propagation is also affected by the variable shallow water conditions, including the depth, bottom slope and type of bottom. Where the bottom is reflective, the sound levels tend to be higher, than when the bottom is absorptive.

Noise from Aircraft and Vessel Movement

Surface shipping is the most widespread source of anthropogenic, low frequency (0 to 1,000 Hz) noise in the oceans and may contribute to over 75 percent of all human sound in the sea (Simmonds and Hutchinson, 1996, ICES, 2005b). Ross (1976) has estimated that between 1950 and 1975, shipping had caused a rise in ambient noise levels of 10 dB. He predicted that this would increase by another 5 dB by the beginning of the 21st century. The National Resource Council (1997) estimated that the background ocean noise level at 100 Hz has been increasing by about 1.5 dB per decade since the advent of propeller-driven ships. Michel et al. (2001) suggested an association between long-term exposure to low-frequency sounds from shipping and an increased incidence of marine mammal mortalities caused by collisions with ships.

Sound from a low-flying helicopter or airplane may be heard by marine mammals and turtles while at the surface or underwater. Due to the transient nature of sounds from aircraft involved in at-sea operations, such sounds would not likely cause physical effects but have the potential to affect behaviors. Responses by mammals and turtles could include hasty dives or turns or decreased foraging (Soto et al., 2006). Whales may also slap the water with flukes or flippers or swim away from the aircraft track.

Sound emitted from large vessels, particularly in the course of transit, is the principal source of noise in the ocean today, primarily due to the properties of sound emitted by civilian cargo vessels (Richardson et al., 1995; Arveson and Vendittis, 2000). Ship propulsion and electricity generation engines, engine gearing, compressors, bilge and ballast pumps, as well as hydrodynamic flow surrounding a ship's hull and any hull protrusions contribute to a large vessel's noise emission into the marine environment. Propellor-driven vessels also generate noise through cavitation, which accounts for much of the noise emitted by a large vessel depending on its travel speed. Military vessels underway or involved in naval operations or exercises also introduce anthropogenic noise into the marine environment. Noise emitted by large vessels can be characterized as low-frequency, continuous and tonal. The sound pressure levels at the vessel will vary according to speed, burden, capacity and length (Richardson et al., 1995; Arveson and Vendittis, 2000). Vessels ranging from 135 to 337 meters generate peak source sound levels from 169 to 200 dB between 8 Hz and 430 Hz, although Arveson and Vendittis (2000) documented components of higher frequencies (10-30 kHz) as a function of newer merchant ship engines and faster transit speeds.

Whales have variable responses to vessel presence or approaches, ranging from apparent tolerance to diving away. Unfortunately, it is not always possible to determine whether the whales are responding to the vessel itself or the noise generated by the engine and cavitation around the propeller. Apart from some disruption of behavior, an animal may be unable to hear other sounds in the environment due to masking by the noise from the vessel. Any masking of environmental sounds or conspecific sounds is expected to be temporary, as noise dissipates with a vessel transit through an area.

Vessel noise primarily raises concerns for masking of environmental and conspecific cues. However, exposure to vessel noise of sufficient intensity and/or duration can also result in temporary or permanent loss of sensitivity at a given frequency range, referred to as temporary or permanent threshold shifts (TTS or PTS). Threshold shifts are assumed to be possible in marine mammal species as a result of prolonged exposure to large vessel traffic noise due to its intensity, broad geographic range of effectiveness and constancy.

Collectively, significant cumulative exposure to individuals, groups, or populations can occur if they exhibit site fidelity to a particular area; for example, whales that seasonally travel to a regular area to forage or breed may be more vulnerable to noise from large vessels compared to transiting whales. Any permanent threshold shift in a marine animal's hearing capability, especially at particular frequencies for which it can normally hear best, can impair its ability to perceive threats, including ships. Whales have variable responses to vessel presence or approaches, ranging from apparent tolerance to diving away from a vessel. It is not possible to determine whether the whales are responding to the vessel itself or the noise generated by the engine and cavitation around the propeller. Apart from some disruption of behavior, an animal may be unable to hear other sounds in the environment due to masking by the noise from the vessel.

Most observations of behavioral responses of marine mammals to human-generated sounds have been limited to short-term behavioral responses, which included the cessation of feeding, resting, or social interactions. Nowacek et al. (2007) provide a detailed summary of cetacean response to underwater noise.

Given the sound propagation of low-frequency sounds, a large vessel in this sound range can be heard 139 to 463 kilometers away (Ross, 1976 in Polefka, 2004). U.S. Navy vessels, however, have incorporated significant underwater ship quieting technology to reduce their acoustic signatures (compared to a similarly sized vessel) in order to reduce their vulnerability to detection by enemy passive acoustics (Southall, 2005). Therefore, the potential for TTS or PTS from U.S. Navy vessel and aircraft movement is extremely low given, that the exercises and training events are transitory in time, with vessels moving over large areas of the ocean. A marine mammal or sea turtle is unlikely to be exposed long enough at high levels for TTS or PTS to occur. Any masking of environmental sounds or conspecific sounds is expected to be temporary, as noise dissipates with a U.S. Navy vessel transiting through an area. If behavioral disruptions result from the presence of aircraft or vessels, it is expected to be temporary. Animals are expected to resume their migration, feeding, or other behaviors without any threat to their survival or reproduction. However, if an animal is aware of a vessel and dives or swims away, it may successfully avoid being struck.

E.1.5 Stranding Events Associated with Navy Sonar

There are two classes of sonars employed by the U.S. Navy: active sonars and passive sonars. Most active military sonars operate in a limited number of areas, and are most likely not a significant contributor to a comprehensive global ocean noise budget (ICES, 2005b).

The effects of mid-frequency active naval sonar on marine wildlife have not been studied as extensively as the effects of air-guns used in seismic surveys (Madsen et al., 2006; Stone and Tasker, 2006; Wilson et al., 2006; Palka and Johnson, 2007; Parente et al., 2007). Maybaum (1989, 1993) observed changes in behavior of humpbacks during playback tapes of the M-1002 system (using 203 dB re 1 µPa-m for study); specifically, a decrease in respiration, submergence and aerial behavior rates; and an increase in speed of travel and track linearity. Direct comparison of Maybaum's results, however, with U.S Navy mid-frequency active sonar are difficult to make. Maybaum's signal source, the commercial M-1002, operated differently from naval mid-frequency sonar. In addition, behavioral responses were observed during playbacks of a control tape, (i.e. a tape with no sound signal) so interpretation of Maybaum's results are inconclusive.

Research by Nowacek, et al. (2004) on North Atlantic right whales using a whale alerting signal designed to alert whales to human presence suggests that received sound levels of only 133 to 148 pressure level (decibel [dB] re 1 microPascals [µPa]) for the duration of the sound exposure may disrupt feeding behavior. The authors did note, however, that within minutes of cessation of the source, a return to normal behavior would be expected. Direct comparison of the Nowacek et al. (2004) sound source to MFA sonar, however, is not possible given the radically different nature of the two sources. Nowacek et al.'s source was a series of non-sonar-like sounds designed to purposely alert the whale, lasting several minutes, and covering a broad frequency band. Direct differences between Nowacek et al. (2004) and MFA sonar is summarized below from Nowacek et al. (2004) and Nowacek et al. (2007):

(1) Signal duration: Time difference between the two signals is significant, 18-minute signal used by Nowacek et al. versus < 1 sec for MFA sonar.

(2) Frequency modulation: Nowacek et al. contained three distinct signals containing frequency modulated sounds:

1st - alternating 1-sec pure tone at 500 and 850 Hz

2nd - 2-sec logarithmic down-sweep from 4500 to 500 Hz

3rd - pair of low-high (1500 and 2000 Hz) sine wave tones amplitude modulated at 120 Hz

(3) Signal-to-noise ratio: Nowacek et al.'s signal maximized signal-to-noise ratio so that it would be distinct from ambient noise and resist masking.

(4) Signal acoustic characteristics: Nowacek et al.'s signal comprised of disharmonic signals spanning northern right whales' estimated hearing range.

Given these differences, therefore, the exact cause of apparent right whale behavior noted by the authors cannot be attributed to any one component, since the source was such a mix of signal types.

The effects of naval sonar on marine wildlife have not been studied as extensively as have the effects of airguns used in seismic surveys (Nowacek et al., 2007). In the Caribbean, sperm whales were observed to interrupt their activities by stopping echolocation and leaving the area in the presence of underwater sounds surmised to have originated from submarine sonar signals (Watkins and Schevill, 1975; Watkins et al., 1985). The authors did not report receive levels from these exposures, and also got a similar reaction from artificial noise they generated by banging on their boat hull. It was unclear if the sperm whales were reacting to the sonar signal itself or to a potentially new unknown sound in general. Madsen et al. (2006) tagged and monitored eight sperm whales in the Gulf of Mexico exposed to seismic airgun surveys. Sound sources were from approximately 2 to 7 nm (4 to 13 km) away from the whales and based on multipath propagation, RLs were as high as 162 dB re 1 uPa with energy content greatest between 0.3 and 3.0 kHz. Sperm whales engaged in foraging dives continued the foraging dives throughout exposure to these seismic pulses. In the Caribbean Sea, sperm whales avoided exposure to mid-frequency submarine sonar pulses, in the range 1000 Hz to 10,000 Hz (IWC 2005). Sperm whales have also moved out of areas after the start of airgun seismic testing (Davis et al., 1995). In contrast, during playback experiments off the Canary Islands, André et al. (1997) reported that foraging sperm whales exposed to a 10 kHz pulsed signal did not exhibit any general avoidance reactions.

The Navy sponsored tests of the effects of low-frequency active (LFA) sonar source, between 100 Hz and 1,000 Hz, on blue, fin and humpback whales. The tests demonstrated that whales exposed to sound levels up to 155 dB did not exhibit significant disturbance reactions, though there was evidence that humpback whales altered their vocalization patterns in reaction to the noise. Given that the source level of the Navy's LFA is reported to be in excess of 215 dB, the possibility exists that animals in the wild may be exposed to sound levels much higher than 155 dB.

Acoustic exposures have been demonstrated to kill marine mammals and result in physical trauma and injury (Ketten, 2005). Animals in or near an intense noise source can die from profound injuries related to shock wave or blast effects. Acoustic exposures can also result in noise-induced hearing loss that is a function of the interactions of three factors: sensitivity, intensity and frequency. Loss of sensitivity is referred to as a threshold shift; the extent and duration of a threshold shift depends on a combination of several acoustic features and is specific to particular species (TTS or PTS, depending on how the frequency, intensity and duration of the exposure combine to produce damage). In addition to direct physiological effects, noise exposures can impair an animal's sensory abilities (masking) or result in behavioral responses such as aversion or attraction (see Section 3.19).

Acoustic exposures can also result in the death of an animal by impairing its foraging, ability to detect predators or communicate, or by increasing stress and disrupting important physiological events. Whales have moved away from their feeding and mating grounds (Bryant et al., 1984; Morton and Symnods, 2002; Weller et al., 2002), moved away from their migration route (Richardson et al., 1995), and have changed their calls due to noise (Miller et al., 2000). Acoustic exposures such as MFA sonar tend to be infrequent, temporary in nature, and therefore effects are likely indirect and to be short lived. In situations such as the alteration of gray whale migration routes in response to shipping and whale watching boats, those acoustic exposures were chronic over several years (Moore and Clarke, 2002). This was also true of the effect of seismic survey airguns (daily for 39 days) on the use of feeding areas by gray whales in the western North Pacific although whales began returning to the feeding area within one day of the end of the exposure (Weller et al., 2002).

Below are evaluations of the general information available on the variety of ways in which cetaceans and pinnipeds have been reported to respond to sound, generally, and mid-frequency sonar, in particular.

The Navy is very concerned and thoroughly investigates each marine mammal stranding potentially associated with Navy activities to better understand the events surrounding strandings (Norman, 2006). Strandings can involve a single animal or several to hundreds. An event where animals are found out of their normal habitat may be considered a stranding even though animals do not necessarily end up beaching (such as the July 2004 "Hanalei Mass Stranding Event"; Southall et al., 2006). Several hypotheses have been given for the mass strandings which include the impact of shallow beach slopes on odontocete sonar, disease or parasites, geomagnetic anomalies that affect navigation, following a food source in close to shore, avoiding predators, social interactions that cause other cetaceans to come to the aid of stranded animals, and human actions. Generally, inshore species do not strand in large numbers but generally just as a single animal. This may be due to their familiarity with the coastal area whereas pelagic species that are unfamiliar with obstructions or sea bottom tend to strand more often in larger numbers (Woodings, 1995). The Navy has studied several stranding events in detail that may have occurred in association with Navy sonar activities. To better understand the causal factors in stranding events that may be associated with Navy sonar activities, the main factors, including bathymetry (i.e., steep drop offs), narrow channels (less than 35 nm), environmental conditions (e.g., surface ducting), and multiple sonar ships were compared between the different stranding events.

When a marine mammal swims or floats onto shore and becomes "beached" or stuck in shallow water, it is considered a "stranding" (MMPA section 410 (16 USC section 1421g; NMFS, 2007a). NMFS explains that "a cetacean is considered stranded when it is on the beach, dead or alive, or in need of medical attention while free-swimming in U.S. waters. A pinniped is considered to be stranded either when dead or when in distress on the beach and not displaying normal haul-out behavior" (NMFS, 2007b).

Over the past three decades, several "mass stranding" events [strandings involving two or more individuals of the same species (excluding a single cow-calf pair) and at times, individuals from different species] that have occurred have been associated with naval operations, seismic surveys, and other anthropogenic activities that introduce sound into the marine environment (Canary Islands, Greece, Vieques, U.S. Virgin Islands, Madeira Islands, Haro Strait, Washington State, Alaska, Hawaii, North Carolina).

Information was collected on mass stranding events (events in which two or more cetaceans stranded) that have occurred and for which reports are available, from the past 40 years. Any causal agents that have been associated with those stranding events were also identified (Table 2-5). Major range events undergo name changes over the years, however, the equivalent of COMPTUEX and JTFEX have been conducted in Southern California since 1934. Training involving sonar has been conducted since World War II and sonar systems described in the SOCAL EIS/OEIS since the 1970s (Jane's 2005).

E.1.6 Stranding Analysis

Over the past two decades, several mass stranding events involving beaked whales have been documented. While beaked whale strandings have been reported since the 1800s (Geraci and Lounsbury, 1993; Cox et al., 2006; Podesta et al., 2006), several mass strandings since have been associated with naval operations that may have included mid-frequency sonar (Simmonds and Lopez-Jurado, 1991; Frantzis, 1998; Jepson et al., 2003; Cox et al., 2006). As Cox et al. (2006) concludes, the state of science cannot yet determine if a sound source such as mid-frequency sonar alone causes beaked whale strandings, or if other factors (acoustic, biological or environmental) must co-occur in conjunction with a sound source.

A review of historical data (mostly anecdotal) maintained by the Marine Mammal Program in the National Museum of Natural History, Smithsonian Institution, reports 49 beaked whale mass stranding events between 1838 and 1999. The largest beaked whale mass stranding occurred in the 1870s in New Zealand when 28 Gray's beaked whales (*Mesoplodon grayi*) stranded. Blainsville's beaked whale (*Mesoplodon densirostris*) strandings are rare, and records show that they were involved in one mass stranding in 1989 in the Canary Islands. Cuvier's beaked whales (*Ziphius cavirostris*) are the most frequently reported beaked whale to strand, with at least 19 stranding events from 1804 through 2000 (DoC and DoN, 2001; Smithsonian Institution, 2000).

The discussion below centers on those worldwide stranding events that may have some association with naval operations, and global strandings that the U.S. Navy feels are either inconclusive or cannot be associated with naval operations.

E.1.6.1 Naval Association

In the following sections, specific stranding events that have been putatively linked to potential sonar operations are discussed. Of note, these events represent a small number of animals over an 11-year period (40 animals), and not all worldwide beaked whale strandings can be linked to naval activity (ICES, 2005a; 2005b; Podesta et al., 2006). Four of the five events occurred during NATO exercises or events where U.S. Navy presence was limited (Greece, Portugal, Spain). One of the five events involved only U.S. Navy ships (Bahamas).

Beaked whale stranding events associated with potential naval operations.

1996 May	Greece (NATO)
2000 March	Bahamas (US)
2000 May	Portugal, Madeira Islands (NATO/US)
2002 September	Spain, Canary Islands (NATO/US)
2006 January	Spain, Mediterranean Sea coast (NATO/US)

<u>Case Studies of Stranding Events (coincidental with or implicated with naval sonar)</u>

1996 Greece Beaked Whale Mass Stranding (May 12–13, 1996)

<u>Description</u>: Twelve Cuvier's beaked whales (*Ziphius cavirostris*) stranded along a 38.2-kilometer strand of the coast of the Kyparissiakos Gulf on May 12 and 13, 1996 (Frantzis, 1998). From May 11 through May 15, the NATO research vessel Alliance was conducting sonar tests with signals of 600 Hz and 3 kHz and root-mean-squared (rms) sound pressure levels (SPL) of 228 and 226 dB re: 1µPa, respectively (D'Amico and Verboom, 1998; D'Spain et al., 2006). The timing and the location of the testing encompassed the time and location of the whale strandings (Frantzis, 1998).

<u>Findings</u>: Partial necropsies of eight of the animals were performed, including external assessments and the sampling of stomach contents. No abnormalities attributable to acoustic exposure were observed, but the stomach contents indicated that the whales were feeding on cephalopods soon before the stranding event. No unusual environmental events before or during the stranding event could be identified (Frantzis, 1998).

Conclusions: The timing and spatial characteristics of this stranding event were atypical of stranding in Cuvier's beaked whale, particularly in this region of the world. No natural phenomenon that might contribute to the stranding event coincided in time with the mass stranding. Because of the rarity of mass strandings in the Greek Ionian Sea, the probability that the sonar tests and stranding coincided in time and location, while being independent of each other, was estimated as being extremely low (Frantzis, 1998). However, because information for the necropsies was incomplete and inconclusive, the cause of the stranding cannot be precisely determined.

2000 Bahamas Marine Mammal Mass Stranding (March 15-16, 2000)

Description: Seventeen marine mammals - Cuvier's beaked whales, Blainville's beaked whales (*Mesoplodon densirostris*), minke whale (*Balaenoptera acutorostrata*), and one spotted dolphin (*Stenella frontalis*) - stranded along the Northeast and Northwest Providence Channels of the Bahamas Islands on March 15-16, 2000 (Evans and England, 2001). The strandings occurred over a 36-hour period and coincided with U.S. Navy use of mid-frequency active sonar within the channel. Navy ships were involved in tactical sonar exercises for approximately 16 hours on March 15. The ships, which operated the AN/SQS-53C and AN/SQS-56, moved through the channel while emitting sonar pings approximately every 24 seconds. The timing of pings was staggered between ships and average source levels of pings varied from a nominal 235 dB SPL (AN/SQS-53C) to 223 dB SPL (AN/SQS-56). The center frequency of pings was 3.3 kHz and 6.8 to 8.2 kHz, respectively.

Seven of the animals that stranded died, while ten animals were returned to the water alive. The animals known to have died included five Cuvier's beaked whales, one Blainville's beaked whale, and the single spotted dolphin. Six necropsies were performed and three of the six necropsied animals (one Cuvier's beaked whale, one Blainville's beaked whale, and the spotted dolphin) were fresh enough to permit identification of pathologies by computerized tomography (CT). Tissues from the remaining three animals were in a state of advanced decomposition at the time of inspection.

Findings: The spotted dolphin demonstrated poor body condition and evidence of a systemic debilitating disease. In addition, since the dolphin stranding site was isolated from the acoustic activities of Navy ships, it was determined that the dolphin stranding was unrelated to the presence of Navy active sonar.

All five necropsied beaked whales were in good body condition and did not show any signs of external trauma or disease. In the two best preserved whale specimens, hemorrhage was associated with the brain and hearing structures. Specifically, subarachnoid hemorrhage within the temporal region of the brain and intracochlear hemorrhages were noted. Similar findings of bloody effusions around the ears of two other moderately decomposed whales were consistent with the same observations in the freshest animals. In addition, three of the whales had small hemorrhages in their acoustic fats, which are fat bodies used in sound production and reception (i.e., fats of the lower jaw and the melon). The best-preserved whale demonstrated acute hemorrhage within the kidney, inflammation of the lung and lymph nodes and congestion and mild hemorrhage in multiple other organs. Other findings were consistent with stresses and injuries associated with the stranding process. These consisted of external scrapes, pulmonary edema and congestion.

Conclusions: The post-mortem analyses of stranded beaked whales lead to the conclusion that the immediate cause of death resulted from overheating, cardiovascular collapse and stresses associated with being stranded on land. However, subarachnoid and intracochlear hemorrhages were believed to have occurred prior to stranding and were hypothesized as being related to an acoustic event. Passive acoustic monitoring records demonstrated that no large-scale acoustic activity besides the Navy sonar exercise occurred in the times surrounding the stranding event. The mechanism by which sonar could have caused the observed traumas or caused the animals to strand was undetermined. The spotted dolphin was in overall poor condition for examination, but showed indications of long-term disease. No analysis of baleen whales (minke whale) was conducted. Baleen whale stranding events have not been associated with either low-frequency or mid-frequency sonar use (ICES 2005a, 2005b).

2000 Madeira Island, Portugal Beaked Whale Strandings (May 10–14, 2000)

Description: Three Cuvier's beaked whales stranded on two islands in the Madeira Archipelago, Portugal, from May 10 to 14, 2000 (Cox et al., 2006). A joint NATO amphibious training exercise, named "Linked Seas 2000," which involved participants from 17 countries, took place in Portugal during May 2 to 15, 2000. The timing and location of the exercises overlapped with that of the stranding incident.

Findings: Two of the three whales were necropsied. Two heads were taken to be examined. One head was intact and examined grossly and by CT; the other was only grossly examined because it was partially flensed and had been seared from an attempt to dispose of the whale by fire (Ketten, 2005).

No blunt trauma was observed in any of the whales. Consistent with prior CT scans of beaked whales stranded in the Bahamas 2000 incident, one whale demonstrated subarachnoid and peribullar hemorrhage and blood within one of the brain ventricles. Post-cranially, the freshest whale demonstrated renal congestion and hemorrhage, which was also consistent with findings in the freshest specimens in the Bahamas incident.

Conclusions: The pattern of injury to the brain and auditory system were similar to those observed in the Bahamas strandings, as were the kidney lesions and hemorrhage and congestion in the lungs (Ketten, 2005). The similarities in pathology and stranding patterns between these two events suggested a similar causative mechanism. Although the details about whether or how sonar was used during "Linked Seas 2000" is unknown, the presence of naval activity within the region at the time of the strandings suggested a possible relationship to Navy activity.

2002 Canary Islands Beaked Whale Mass Stranding (September 24, 2002)

Description: On September 24, 2002, 14 beaked whales stranded on Fuerteventura and Lanzaote Islands in the Canary Islands (Jepson et al., 2003). Seven of the 14 whales died on the beach and the other seven were returned to the ocean. Four beaked whales were found stranded dead over the next three days either on the coast or floating offshore (Fernández et al., 2005). At the time of the strandings, an international naval exercise (Neo-Tapon, 2002) that involved numerous surface warships and several submarines was being conducted off the coast of the Canary Islands. Tactical mid-frequency active sonar was utilized during the exercises, and strandings began within hours of the onset of the use of mid-frequency sonar (Fernández et al., 2005).

Findings: Eight Cuvier's beaked whales, one Blainville's beaked whale, and one Gervais' beaked whale were necropsied; six of them within 12 hours of stranding (Fernández et al., 2005). The stomachs of the whales contained fresh and undigested prey contents. No pathogenic bacteria were isolated from the whales, although parasites were found in the kidneys of all of the animals. The head and neck lymph nodes were congested and hemorrhages were noted in multiple tissues and organs, including the kidney, brain, ears and jaws. Widespread fat emboli were found throughout the carcasses, but no evidence of blunt trauma was observed in the whales. In addition, the parenchyma of several organs contained macroscopic intravascular bubbles and lesions, putatively associated with nitrogen off-gassing.

Conclusions: The association of NATO mid-frequency sonar use close in space and time to the beaked whale strandings and the similarity between this stranding event and previous beaked whale mass strandings coincident with sonar use suggest that a similar scenario and causative mechanism of stranding may be shared between the events. Beaked whales stranded in this event demonstrated brain and auditory system injuries, hemorrhages and congestion in multiple organs, similar to the pathological findings of the Bahamas and Madeira stranding events. In addition, the necropsy results of the Canary Islands stranding event lead to the hypothesis that the presence of disseminated and widespread gas bubbles and fat emboli were indicative of nitrogen bubble formation, similar to what might be expected in decompression sickness (Jepson et al., 2003; Fernández et al., 2005). Whereas gas emboli would develop from the nitrogen gas, fat emboli would enter the blood stream from ruptured fat cells (presumably where nitrogen bubble formation occurs) or through the coalescence of lipid bodies within the blood stream.

The possibility that the gas and fat emboli found by Fernández et al. (2005) was due to nitrogen bubble formation has been hypothesized to be related to either direct activation of the bubble by sonar signals or to a behavioral response in which the beaked whales flee to the surface following sonar exposure. The first hypothesis is related to rectified diffusion (Crum and Mao, 1996), the process of increasing the size of a bubble by exposing it to a sound field. This process is facilitated if the environment in which the ensonified bubbles exist is supersaturated with gas. Repetitive diving by marine mammals can cause the blood and some tissues to accumulate gas to a greater degree than is supported by the surrounding environmental pressure (Ridgway and Howard, 1979). Deeper and longer dives of some marine mammals, such as those conducted by beaked whales, are theoretically predicted to induce greater levels of supersaturation (Houser et al., 2001). If rectified diffusion were possible in marine mammals exposed to high-level sound, conditions of tissue supersaturation could theoretically speed the rate and increase the size of bubble growth. Subsequent effects due to tissue trauma and emboli would presumably mirror those observed in humans suffering from decompression sickness. It is unlikely that the brief duration of sonar pings would be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. However, an alternative but related hypothesis has also been suggested: stable bubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of the tissues. In such a scenario the marine mammal would need to be in a gas-supersaturated state long enough for bubbles to become of a problematic size. The second hypothesis speculates that rapid ascent to the surface following exposure to a startling sound might produce tissue gas saturation sufficient for the evolution of nitrogen bubbles (Jepson et al., 2003; Fernández et al., 2005). In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation. Tyack et al. (2006) showed that beaked whales often make rapid ascents from deep dives, suggesting that it is unlikely that beaked whales would suffer from decompression sickness. Zimmer and Tyack (2007) speculated that if repetitive shallow dives that are used by beaked whales to avoid a predator or a sound source, they could accumulate high levels of nitrogen because they would be above the depth of lung collapse (above about 210 feet) and could lead to decompression sickness. There is no evidence that beaked whales dive in this manner in response to predators or sound sources and other marine mammals such as Antarctic and Galapagos fur seals, and pantropical spotted dolphins make repetitive shallow dives with no apparent decompression sickness (Kooyman and Trillmich, 1984; Kooyman et al., 1984; Baird et al., 2001).

Although theoretical predictions suggest the possibility for acoustically mediated bubble growth, there is considerable disagreement among scientists as to its likelihood (Piantadosi and Thalmann, 2004). Sound exposure levels predicted to cause *in vivo* bubble formation within diving cetaceans have not been evaluated and are suspected as needing to be very high (Evans, 2002; Crum et al., 2005). Moore and Early (2004) reported that in analysis of sperm whale bones spanning 111 years, gas embolism symptoms were observed, indicating that sperm whales may be susceptible to decompression sickness due to natural diving behavior. Further, although it has been argued that traumas from recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Jepson et al., 2003), there is no conclusive evidence supporting this hypothesis and there is concern that at least some of the pathological findings (e.g., bubble emboli) are artifacts of the necropsy. Currently, stranding networks in the United States have agreed to adopt a set of necropsy guidelines to determine, in part, the possibility and frequency with which bubble emboli can be introduced into marine mammals during necropsy procedures (Arruda et al., 2007).

2006 Spain, Gulf of Vera Beaked Whale Mass Stranding (26-27 January 2006)

Description: The Spanish Cetacean Society reported an atypical mass stranding of four beaked whales that occurred January 26-28, 2006, on the southeast coast of Spain near Mojacar (Gulf of Vera) in the Western Mediterranean Sea. According to the report, two of the whales were discovered the evening of January 26 and were found to be still alive. Two other whales were discovered on January 27, but had already died. A following report stated that the first three animals were located near the town of Mojacar and were examined by a team from the University of Las Palmas de Gran Canarias, with the help of the stranding network of Ecologistas en Acción Almería-PROMAR and others from the Spanish Cetacean Society. The fourth animal was found dead on the afternoon of January 27, a few kilometers north of the first three animals.

From January 25-26, 2006, a NATO surface ship group (seven ships including one U.S. ship under NATO operational command) conducted active sonar training against a Spanish submarine within 50 nm of the stranding site.

Findings: Veterinary pathologists necropsied the two male and two female beaked whales (*Z. cavirostris*).

Conclusions: According to the pathologists, a likely cause of this type of beaked whale mass stranding event may have been anthropogenic acoustic activities. However, no detailed pathological results confirming this supposition have been published to date, and no positive acoustic link was established as a direct cause of the stranding.

Even though no causal link can be made between the stranding event and naval exercises, certain conditions may have existed in the exercise area that, in their aggregate, may have contributed to the marine mammal strandings (Freitas, 2004):

- Operations were conducted in areas of at least 1,000 meters in depth near a shoreline where there is a rapid change in bathymetry on the order of 1,000 to 6,000 meters occurring a cross a relatively short horizontal distance (Freitas, 2004).

- Multiple ships, in this instance, five MFA sonar equipped vessels, were operating in the same area over extended periods (20 hours) in close proximity.

- Exercises took place in an area surrounded by landmasses, or in an embayment. Operations involving multiple ships employing mid-frequency active sonar near land may produce sound directed towards a channel or embayment that may cut off the lines of egress for marine mammals (Freitas, 2004)

E.1.6.2 Other Global Stranding Discussions

In the following sections, stranding events that have been linked to U.S. Navy activity in popular press are presented. As detailed in the individual case study conclusions, the U.S. Navy believes there is enough evidence available to refute allegations of impacts from mid-frequency sonar, or at least indicate a substantial degree of uncertainty in time and space that precludes a meaningful scientific conclusion.

Case Studies of Stranding Events

2003 Washington State Harbor Porpoise Strandings (May 2 – June 2 2003)

Description: At 1040 hours on May 5, 2003, the USS SHOUP began the use of mid-frequency tactical active sonar as part of a naval exercise. At 1420, the USS SHOUP entered the Haro Strait and terminated active sonar use at 1438, thus limiting active sonar use within the strait to less than 20 minutes. Between May 2 and June 2, 2003, approximately 16 strandings involving 15 harbor porpoises (*Phocoena phocoena*) and one Dall's porpoise (*Phocoenoides dalli*) were reported to the Northwest Marine Mammal

Stranding Network. A comprehensive review of all strandings and the events involving USS SHOUP on May 5, 2003 were presented in U.S. Department of Navy (2004). Given that the USS SHOUP was known to have operated sonar in the strait on May 5, and that supposed behavioral reactions of killer whales (*Orcinus orca*) had been putatively linked to these sonar operations (NMFS Office of Protected Resources, 2005), NMFS undertook an analysis of whether sonar caused the strandings of the harbor porpoises.

Whole carcasses of ten harbor porpoises and the head of an additional porpoise were collected for analysis. Necropsies were performed on ten of the porpoises, and six whole carcasses and two heads were selected for CT imaging. Gross examination, histopathology, age determination, blubber analysis, and various other analyses were conducted on each of the carcasses (Norman et al., 2004).

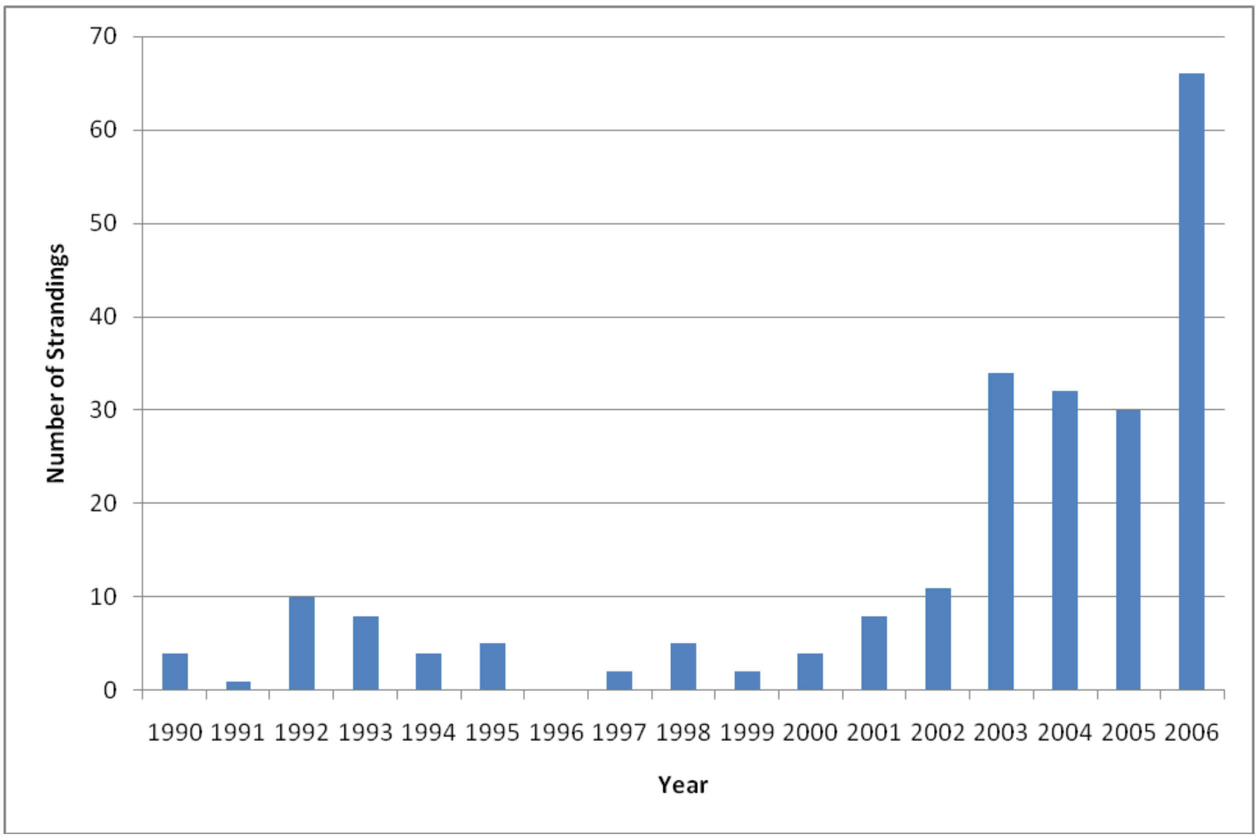
Findings: Post-mortem findings and analysis details are found in Norman et al. (2004). All of the carcasses suffered from some degree of freeze-thaw artifact that hampered gross and histological evaluations. At the time of necropsy, three of the porpoises were moderately fresh; the remainder of the carcasses were considered to have moderate to advanced decomposition. None of the 11 harbor porpoises demonstrated signs of acoustic trauma. In contrast, a putative cause of death was determined for five of the porpoises; two animals had blunt trauma injuries and three had indication of disease processes (fibrous peritonitis, salmonellosis and necrotizing pneumonia). A cause of death could not be determined in the remaining animals, which is consistent with expected percentage of marine mammal necropsies conducted within the Northwest region. It is important to note, however, that these determinations were based only on the evidence from the necropsy to avoid bias with regard to determinations of the potential presence or absence of acoustic trauma. The result was that other potential causal factors, such as one animal (Specimen 33NWR05005) found tangled in a fishing net, was unknown to the investigators in their determination regarding the likely cause of death.

Conclusions: NMFS concluded from a retrospective analysis of stranding events that the number of harbor porpoise stranding events in the approximate month surrounding the USS SHOUP use of sonar was higher than expected based on annual strandings of harbor porpoises (Norman et al., 2004). In this regard, it is important to note that the number of strandings in the May-June timeframe in 2003 was also higher for the outer coast, indicating a much wider phenomena than use of sonar by USS SHOUP in Puget Sound for one day in May. The conclusion by NMFS that the number of strandings in 2003 was higher is also different from that of The Whale Museum, which has documented and responded to harbor porpoise strandings since 1980 (Osborne, 2003). According to The Whale Museum, the number of strandings as of May 15, 2003, was consistent with what was expected based on historical stranding records and was less than that occurring in certain years. For example, since 1992 the San Juan Stranding Network has documented an average of 5.8 porpoise strandings per year. In 1997 there were 12 strandings in the San Juan Islands with more than 30 strandings throughout the general Puget Sound area. Disregarding the discrepancy in the historical rate of porpoise strandings and its relation to the USS SHOUP, NMFS acknowledged that the intense level of media attention focused on the strandings likely resulted in an increased reporting effort by the public over that which is normally observed (Norman et al., 2004). NMFS also noted in its report that the "sample size is too small and biased to infer a specific relationship with respect to sonar usage and subsequent strandings."

Seven of the porpoises collected and analyzed died prior to SHOUP departing to sea on May 5, 2003. Of these seven, one, discovered on May 5, 2003, was in a state of moderate decomposition, indicating it died before May 5; the cause of death was determined, most likely, to be salmonella septicemia. Another porpoise, discovered at Port Angeles on May 6, 2003, was in a state of moderate decomposition, indicating that this porpoise also died prior to May 5. One stranded harbor porpoise discovered fresh on May 6 is the only animal that could potentially be linked in time to the USS SHOUP's May 5 active sonar use. Necropsy results for this porpoise found no evidence of acoustic trauma. The remaining eight strandings were discovered one to three weeks after the USS SHOUP's May 5 transit of the Haro Strait, making it difficult to causally link the sonar activities of the USS SHOUP to the timing of the strandings. Two of the eight porpoises died from blunt trauma injury and a third suffered from parasitic infestation, which possibly contributed to its death (Norman et al., 2004). For the remaining five porpoises, NMFS was unable to identify the causes of death.

Additionally, it has become clear that the number of harbor porpoise strandings in the Northwest increased beginning in 2003 and through 2006. Figure A-3 shows the number of strandings documented in the Northwest for harbor porpoises. On November 3, 2006, a UME in the Pacific Northwest was declared. In 2006, a total of 66 harbor porpoise strandings were reported in the Outer Coast of Oregon and Washington and Inland waters of Washington (NOAA Fisheries, 2006; NOAA Fisheries, Northwest Region, 2006a).

Figure E-4. Northwest Region Harbor Porpoise Strandings 1990 - 2006



Source: NOAA Fishereis, Northwest Region, 2006b

The speculative association of the harbor porpoise strandings to the use of sonar by the USS SHOUP is inconsistent with prior stranding events linked to the use of mid-frequency sonar. Specifically, in prior events, the stranding of whales occurred over a short period of time (less than 36 hours), stranded individuals were spatially co-located, traumas in stranded animals were consistent between events, and active sonar was known or suspected to be in use. Although mid-frequency active sonar was used by the USS SHOUP, the distribution of harbor porpoise strandings by location and with respect to time surrounding the event do not support the suggestion that mid-frequency active sonar was a cause of harbor porpoise strandings. Rather, a complete lack of evidence of any acoustic trauma within the harbor porpoises and the identification of probable causes of stranding or death in several animals further support the conclusion that harbor porpoise strandings were unrelated to the sonar activities of the USS SHOUP.

Additional allegations regarding USS SHOUP use of sonar having caused behavioral effects to Dall's porpoise, orca and a minke whale also arose in association with this event (see U.S. Department of Navy 2004 for a complete discussion).

Dall's porpoise: Information regarding the observation of Dall's porpoise on May 5, 2003, came from the operator of a whale watch boat at an unspecified location. This operator reported the Dall's porpoise were seen "going north" when the SHOUP was estimated by him to be 10 miles away. Potential reasons for the Dall's movement include the pursuit of prey, the presence of harassing resident orca or predatory transient orca, vessel disturbance from one of many whale watch vessels or multiple other unknowable reasons, including the use of sonar by SHOUP. In short, there was nothing unusual in the observed behavior of the Dall's porpoise on May 5, 2003 and no way to assess if the otherwise normal behavior was in reaction to the use of sonar by SHOUP, any other potential causal factor or a combination of factors.

Orca: Observer opinions regarding orca J-Pod behaviors on May 5, 2003, were inconsistent, ranging from the orca being "at ease with the sound" or "resting" to their being "annoyed." One witness reported observing "low rates of surface active behavior" on behalf of the orca J-Pod, which is in conflict with that of another observer who reported variable surface activity, tail slapping and spyhopping. Witnesses also expressed the opinion that the behaviors displayed by the orca on May 5, 2003, were "extremely unusual," although those same behaviors are observed and reported regularly on the Orca Network Website, are behaviors listed in general references as being part of the normal repertoire of orca behaviors. Given the contradictory nature of the reports on the observed behavior of the J-Pod orca, there is no way to assess if any unusual behaviors were present or if present they were in reaction to vessel disturbance from one of many nearby whale watch vessels, use of sonar by SHOUP, any other potential causal factor or a combination of factors.

Minke whale: A minke whale was reported porpoising in Haro Strait on May 5, 2003, which is a rarely observed behavior. The cause of this behavior is indeterminate given multiple potential causal factors including but not limited to the presence of predatory transient orca, possible interaction with whale watch boats, other vessel or SHOUP's use of sonar. Given the existing information, there is no way to be certain if the unusual behavior observed was in reaction to the use of sonar by SHOUP, any other potential causal factor or a combination of factors.

2004 Alaska Beaked Whale Strandings (Northern Edge Exercise, 7-16 June 2004)

Description: Between 27 June and 19 July 2004, five beaked whales were discovered at various locations along 1,600 miles of the Alaskan coastline and one was found floating (dead) at sea. These whales included three Baird's beaked whales and two Cuvier's beaked whales. Questions and comments posed on previous Navy environmental documents have alleged that sonar use may have been the cause of these strandings in association with the Navy Alaska Shield/Northern Edge exercise, which occurred June 7 to June 16, 2004 (within the approximate timeframe of these strandings).

Findings: Information regarding the strandings is incomplete as the whales had been dead for some time before they were discovered. The stranded beaked whales were in moderate to advanced states of decomposition and necropsies were not performed. Additionally, prior to the Navy conducting the Alaska Shield/Northern Edge exercise, two Cuvier's beaked whales were discovered stranded at two separate locations along the Alaskan coastline (February 26 at Yakutat and June 1 at Nuka Bay).

Zimmerman (1991) reported that between 1975 and 1987, 11 species of cetaceans were found stranded in Alaska seven or more times, including 29 Stejneger's beaked whales, 19 Cuvier's beaked whales, and 8 Baird's beaked whales . Cuvier's beaked whales have been found stranded from the eastern Gulf of Alaska to the western Aleutians. Baird's beaked whales were found stranded as far north as the area between Cape Pierce and Cape Newenham, east near Kodiak, and along the Aleutian Islands. (Zimmerman, 1991). In short, however, the stranding of beaked whales in Alaska is a relatively uncommon occurrence (as compared to other species).

Conclusions: The at-sea portion of the Alaska Shield/Northern Edge 2004 exercise consisted mainly surface ships and aircraft tracking a vessel of interest followed by a vessel boarding search and seizure event. There was no ASW component to the exercise, no use of mid-frequency sonar and no use of explosives in the water. There were no events in the Alaska Shield/Northern Edge exercise that could have caused or been related to any of the strandings over this 33-day period along 1,600 miles of coastline.

2004 Hawai'i Melon-Headed Whale Unusual Milling Event (July 3-4 2004)

Description: The majority of the following information is taken from the NMFS report (which referred to the event as a "mass stranding event"; (Southall et al., 2006) but includes additional and new information not presented in the NMFS report. On the morning of July 3, 2004, between 150 and 200 melon-headed whales (*Peponocephala electra*) entered Hanalei Bay, Kauai. Individuals attending a canoe blessing ceremony observed the animals entering the bay at approximately 7:00 a.m. The whales were reported entering the bay in a "wave as if they were chasing fish" (Braun 2006). At 6:45 a.m. on July 3, 2004, approximately 25 nm north of Hanalei Bay, active sonar was tested briefly prior to the start of an anti-submarine warfare exercise.

The whales stopped in the southwest portion of the bay, grouping tightly, and displayed spy-hopping and tail-slapping behavior. As people went into the water among the whales, the pod separated into as many as four groups, with individual animals moving among the clusters. This continued through most of the day, with the animals slowly moving south and then southeast within the bay. By about 3 p.m., police arrived and kept people from interacting with the animals. The Navy believes that the abnormal behavior by the whales during this time is likely the result of people and boats in the water with the whales rather than the result of sonar activities taking place 25 or more miles off the coast. At 4:45 p.m. on July 3, 2004, the RIMPAC Battle Watch Captain received a call from a National Marine Fisheries representative in Honolulu, Hawaii, reporting the sighting of as many as 200 melon-headed whales in Hanalei Bay. At 4:47 p.m. the Battle Watch Captain directed all ships in the area to cease active sonar transmissions.

At 7:20 p.m. on July 3, 2004, the whales were observed in a tight single pod 75 yards from the southeast side of the bay. The pod was circling in a group and displayed frequent tail slapping and whistle vocalizations and some spyhopping. No predators were observed in the bay and no animals were reported having fresh injuries. The pod stayed in the bay through the night of July 3, 2004. On the morning of July 4, 2004, the whales were observed to still be in the bay and collected in a tight group. A decision was made at that time to attempt to herd the animals out of the bay. A 700-to-800-foot rope was constructed by weaving together beach morning glory vines. This vine rope was tied between two canoes and with the assistance of 30 to 40 kayaks, was used to herd the animals out of the bay. By approximately 11:30 a.m. on July 4, 2004, the pod was coaxed out of the bay.

A single neonate melon-headed whale was observed in the bay on the afternoon of July 4, after the whale pod had left the bay. The following morning on July 5, 2004, the neonate was found stranded on Lumahai Beach. It was pushed back into the water but was found stranded dead between 9 and 10 a.m. near the Hanalei pier. NMFS collected the carcass and had it shipped to California for necropsy, tissue collection and diagnostic imaging.

Following the unusual milling event, NMFS undertook an investigation of possible causative factors of the event. This analysis included available information on environmental factors, biological factors and an analysis of the potential for sonar involvement. The latter analysis included vessels that utilized mid-frequency active sonar on the afternoon and evening of July 2. These vessels were to the southeast of Kauai, on the opposite side of the island from Hanalei Bay.

Findings: NMFS concluded from the acoustic analysis that the melon-headed whales would have had to have been on the southeast side of Kauai on July 2 to have been exposed to sonar from naval vessels on that day (Southall et al., 2006). There was no indication whether the animals were in that region or whether they were elsewhere on July 2. NMFS concluded that the animals would have had to swim from 1.4 to 4.0 m/s for 6.5 to 17.5 hours after sonar transmissions ceased to reach Hanalei Bay by 7 a.m. on July 3. Sound transmissions by ships to the north of Hanalei Bay on July 3 were produced as part of exercises between 6:45 a.m. and 4:47 p.m. Propagation analysis conducted by the 3rd Fleet estimated that the level of sound from these transmissions at the mouth of Hanalei Bay could have ranged from 138-149 dB re: 1 μPa.

NMFS was unable to determine any environmental factors (e.g., harmful algal blooms, weather conditions) that may have contributed to the stranding. However, additional analysis by Navy investigators found that a full moon occurred the evening before the stranding and was coupled with a squid run (Mobley, 2007). One of the first observations of the whales entering the bay reported the pod came into the bay in a line “as if chasing fish” (Braun, 2005). In addition, a group of 500 to 700 melon-headed whales were observed to come close to shore and interact with humans in Sasanhaya Bay, Rota, on the same morning as the whales entered Hanalei Bay (Jefferson et al., 2006). Previous records further indicated that, though the entrance of melon-headed whales into the shallows is rare, it is not unprecedented. A pod of melon-headed whales entered Hilo Bay in the 1870s in a manner similar to that which occurred at Hanalei Bay in 2004.

The necropsy of the melon-headed whale calf suggested that the animal died from a lack of nutrition, possibly following separation from its mother. The calf was estimated to be approximately one week old. Although the calf appeared not to have eaten for some time, it was not possible to determine whether the calf had ever nursed after it was born. The calf showed no signs of blunt trauma or viral disease and had no indications of acoustic injury.

Conclusions: Although it is not impossible, it is unlikely that the sound level from the sonar caused the melon-headed whales to enter Hanalei Bay. This conclusion is based on a number of factors:

1. The speculation that the whales may have been exposed to sonar the day before and then fled to the Hanalei Bay is not supported by reasonable expectation of animal behavior and swim speeds. The flight response of the animals would have had to persist for many hours following the cessation of sonar transmissions. Such responses have not been observed in marine mammals and no documentation exists that such persistent flight response after the cessation of a frightening stimulus has been observed in other mammals. The swim speeds, though feasible for the species, are highly unlikely to be maintained for the durations proposed, particularly since the pod was a mixed group containing both adults and neonates. Whereas adults may maintain a swim speed of 4.0 m/s for some time, it is improbable that a neonate could achieve the same for a period of many hours.

2. The area between the islands of Oahu and Kauai and the Pacific Missile Range Facility training range have been used in RIMPAC exercises for more than 30 years, and are used year-round for ASW training with mid-frequency active sonar. Melon-headed whales inhabiting the waters around Kauai are likely not naive to the sound of sonar and there has never been another stranding event associated in time with ASW training at Kauai. Similarly, the waters surrounding Hawaii contain an abundance of marine mammals, many of which would have been exposed to the same sonar operations that were speculated to have affected the melon-headed whales. No other strandings were reported coincident with the RIMPAC exercises. This leaves it uncertain as to why melon-headed whales, and no other species of marine mammal, would respond to the sonar exposure by stranding.

3. At the nominal swim speed for melon-headed whales, the whales had to be within 1.5 to 2 nm of Hanalei Bay before sonar was activated on July 3. The whales were not in their open ocean habitat but had to be close to shore at 6:45 a.m. when the sonar was activated to have been observed inside Hanalei Bay from the beach by 7 a.m (Hanalei Bay is very large area). This observation suggests that other potential factors could have caused the event (see below).

4. The simultaneous movement of 500 to 700 melon-headed whales and Risso's dolphins into Sasanhaya Bay, Rota, in the Northern Marianas Islands on the same morning as the 2004 Hanalei stranding (Jefferson et al., 2006) suggests that there may be a common factor which prompted the melon-headed whales to approach the shoreline. A full moon occurred the evening before the stranding and a run of squid was reported concomitant with the lunar activity (Mobley et al., 2007). Thus, it is possible that the melon-headed whales were capitalizing on a lunar event that provided an opportunity for relatively easy prey capture (Mobley et al., 2007). A report of a pod entering Hilo Bay in the 1870s indicates that on at least one other occasion, melon-headed whales entered a bay in a manner similar to the occurrence at Hanalei Bay in July 2004. Thus, although melon-headed whales entering shallow embayments may be an infrequent event, and every such event might be considered anomalous, there is precedent for the occurrence.

5. The received noise sound levels at the bay were estimated to range from roughly 95 to 149 dB re: 1 μPa. Received levels as a function of time of day have not been reported, so it is not possible to determine when the presumed highest levels would have occurred and for how long. However, received levels in the upper range would have been audible by human participants in the bay. The statement by one interviewee that he heard "pings" that lasted an hour and that they were loud enough to hurt his ears is unreliable. Received levels necessary to cause pain over the duration stated would have been observed by most individuals in the water with the animals. No other such reports were obtained from people interacting with the animals in the water.

Although NMFS concluded that sonar use was a "plausible, if not likely, contributing factor in what may have been a confluence of events (Southall et al., 2006)," this conclusion was based primarily on the basis that there was an absence of any other compelling explanation. The authors of the NMFS report on the incident were unaware, at the time of publication, of the simultaneous event in Rota. In light of the simultaneous Rota event, the Hanalei event does not appear as anomalous as initially presented and the speculation that sonar was a causative factor is weakened. The Hanalei Bay incident does not share the characteristics observed with other mass strandings of whales coincident with sonar activity (e.g., specific traumas, species composition, etc.). In addition, the inability to conclusively link or exclude the impact of other environmental factors makes a causal link between sonar and the melon-headed whale event highly speculative at best.

1980- 2004 Beaked Whale Strandings in Japan (Brownell et al., 2004)

Description: Brownell et al. (2004) compared the historical occurrence of beaked whale strandings in Japan (where there are U.S. Navy bases), with strandings in New Zealand (which lacks a U.S. Naval base) and concluded the higher number of strandings in Japan may be related to the presence of US. Navy vessels using mid-frequency sonar. While the dates for the strandings were well-documented, the authors of the study did not attempt to correlate the dates of any navy activities or exercises with those stranding dates.

To fully investigate the allegation made by Brownell et al. (2004), the Center for Naval Analysis (CNA) in an internal Navy report, looked at past U.S. Naval exercise schedules from 1980 to 2004 for the water around Japan in comparison to the dates for the strandings provided by Brownell et al. (2004). None of the strandings occurred during or soon (within weeks) after any U.S. Navy exercises. While the CNA analysis began by investigating the probabilistic nature of any co-occurrences, the strandings and sonar use were not correlated by time. Given that there was no instance of co-occurrence in over 20 years of stranding data, it can be reasonably postulated that sonar use in Japan waters by U.S. Navy vessels did not lead to any of the strandings documented by Brownell et al. (2004).

2005 North Carolina Marine Mammal Mass Stranding Event (January 15-16, 2005)

Description: On January 15 and 16, 2005, 36 marine mammals consisting of 33 short-finned pilot whales, one minke whale, and two dwarf sperm whales stranded alive on the beaches of North Carolina (Hohn et al., 2006a). The animals were scattered across a 111-km area from Cape Hatteras northward. Because of the live stranding of multiple species, the event was classified as a UME. It is the only stranding on record for the region in which multiple offshore species were observed to strand within a two- to three-day period

The U.S. Navy indicated that from January 12-14 some unit level training with mid-frequency active sonar was conducted by vessels that were 93 to 185 km from Oregon Inlet. An expeditionary strike group was also conducting exercises to the southeast, but the closest point of active sonar transmission to the inlet was 650 km away. The unit-level operations were not unusual for the area or time of year and the vessels were not involved in antisubmarine warfare exercises. Marine mammal observers on board the vessels did not detect any marine mammals during the period of unit-level training. No sonar transmissions were made on January 15-16.

The National Weather Service reported that a severe weather event moved through North Carolina on January 13 and 14. The event was caused by an intense cold front that moved into an unusually warm and moist air mass that had been persisting across the eastern United States for about a week. The weather caused flooding in the western part of the state, considerable wind damage in central regions of the state, and at least three tornadoes that were reported in the north central part of the state. Severe, sustained (one to four days) winter storms are common for this region.

Over a two-day period (January 16-17), two dwarf sperm whales, 27 pilot whales and the minke whale were necropsied and tissue samples collected. Twenty-five of the stranded cetacean heads were examined; two pilot whale heads and the heads of the dwarf sperm whales were analyzed by CT.

Findings: The pilot whales and dwarf sperm whale were not emaciated, but the minke whale, which was believed to be a dependent calf, was emaciated. Many of the animals were on the beach for an extended period of time prior to necropsy and sampling, and many of the biochemical abnormalities noted in the animals were suspected of being related to the stranding and prolonged time on land. Lesions were observed in all of the organs, but there was no consistency across species. Musculoskeletal disease was observed in two pilot whales and cardiovascular disease was observed in one dwarf sperm whale and one pilot whale. Parasites were a common finding in the pilot whales and dwarf sperm whales but were considered consistent with the expected parasite load for wild odontocetes. None of the animals exhibited traumas similar to those observed in prior stranding events associated with mid-frequency sonar activity. Specifically, there was an absence of auditory system trauma and no evidence of distributed and widespread bubble lesions or fat emboli, as was previously observed (Fernández et al., 2005).

Sonar transmissions prior to the strandings were limited in nature and did not share the concentration identified in previous events associated with mid-frequency active sonar use (Evans and England, 2001). The operational/environmental conditions were also dissimilar (e.g., no constrictive channel and a limited number of ships and sonar transmissions). NMFS noted that environmental conditions were favorable for a shift from up-welling to down-welling conditions, which could have contributed to the event. However, other severe storm conditions existed in the days surrounding the strandings and the impact of these weather conditions on at-sea conditions is unknown. No harmful algal blooms were noted along the coastline.

Conclusions: All of the species involved in this stranding event are known to occasionally strand in this region. Although the cause of the stranding could not be determined, several whales had preexisting conditions that could have contributed to the stranding. Cause of death for many of the whales was likely due to the physiological stresses associated with being stranded. A consistent suite of injuries across species, which was consistent with prior strandings where sonar exposure is expected to be a causative mechanism, was not observed.

NMFS was unable to determine any causative role that sonar may have played in the stranding event. The acoustic modeling performed, as in the Hanalei Bay incident, was hampered by uncertainty regarding the location of the animals at the time of sonar transmissions. However, as in the Hanalei Bay incident, the response of the animals following the cessation of transmissions would imply a flight response that persisted for many hours after the sound source was no longer operational. In contrast, the presence of a severe weather event passing through North Carolina during January 13 and 14 is a possible, if not likely, contributing factor to the North Carolina UME of January 15. Hurricanes may have been responsible for mass strandings of pygmy killer whales in the British Virgin Islands and Gervais' beaked whales in North Carolina (Mignucci-Giannoni et al., 2000; Norman and Mead, 2001).

E.1.6.3 Causal Associations for Stranding Events

Several stranding events have been associated with Navy sonar activities but relatively few of the total stranding events that have been recorded occurred spatially or temporally with Navy sonar activities. While sonar may be a contributing factor under certain rare conditions, the presence of sonar it is not a necessary condition for stranding events to occur. In established range areas such as those in Hawaii and Southern California where sonar use has been routine for decades, there is no evidence of impacts from sonar use on marine mammals.

A review of past stranding events associated with sonar suggests that the potential factors that may contribute to a stranding event are steep bathymetry changes, narrow channels, multiple sonar ships, surface ducting and the presence of beaked whales that may be more susceptible to sonar exposures. The most important factors appear to be the presence of a narrow channel (e.g. Bahamas and Madeira Island, Portugal) that may prevent animals from avoiding sonar exposure and multiple sonar ships within that channel. There are no narrow channels (less than 35 nm wide and 10 nm in length) in the SOCAL Range Complex and the ships would be spread out over a wider area allowing animals to move away from sonar activities if they choose. In addition, beaked whales may not be more susceptible to sonar but may favor habitats that are more conducive to sonar effects.

E.1.7 Stranding Section Conclusions

Marine mammal strandings have been a historic and ongoing occurrence attributed to a variety of causes. Over the last 50 years, increased awareness and reporting has lead to more information about species effected and raised concerns about anthropogenic sources of stranding. While there have been some marine mammal mortalities potentially associated with mid-frequency sonar effects to a small number of species (primarily limited numbers of certain species of beaked whales), the significance and actual causative reason for any impacts is still subject to continued investigation.

By comparison and as described previously, potential impacts to all species of cetaceans worldwide from fishery related mortality can be orders of magnitude more significant (100,000s of animals versus tens of animals) (Culik, 2002; ICES, 2005b; Read et al., 2006). This does not negate the influence of any mortality or additional stressor to small, regionalized sub-populations which may be at greater risk from human related mortalities (fishing, vessel strike, sound) than populations with larger oceanic level distribution or migrations. ICES (2005a) noted, however, that taken in context of marine mammal populations in general, sonar is not a major threat, nor is it a significant portion of the overall ocean noise budget.

In conclusion, a constructive framework and continued research based on sound scientific principles is needed in order to avoid speculation as to stranding causes, and to further our understanding of potential effects or lack of effects from military mid-frequency sonar (Bradshaw et al., 2005; ICES 2005b; Barlow and Gisiner, 2006; Cox et al., 2006).

Appendix F

Public Scoping Summary

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F PUBLIC SCOPING SUMMARY

F.1 GENERAL SUMMARY OF THE SCOPING PERIOD

The scoping period for the Northwest Training Range Complex (NWTRC) Environmental Impact Statement (EIS)/Overseas EIS (OEIS) began with publication of a Notice of Intent on July 31, 2007. The scoping period lasted 60 days, concluding on September 29, 2007. Five scoping meetings were held on September 10, 11, 12, 13, and 15 in the cities of: Oak Harbor, WA; Pacific Beach, WA; Grays Harbor, WA; Depoe Bay, OR; and Eureka, CA respectively. The scoping meetings were held in an open house format, presenting informational posters and written information and making Navy staff and project experts available to answer participants' questions. Additionally, a tape recorder was available to record participants' oral comments. The interaction during the information sessions was productive and helpful to the Navy.

Scoping participants could submit comments in five ways:

- Oral statements at the public meetings (as recorded by the tape recorder);
- Written comments at the public meetings;
- Written letters (received any time during the public comment period);
- Electronic mail (received any time during the public comment period); and
- Comments submitted directly on the project website (received any time during the public comment period).

In total, the Navy received comments from 50 individuals and groups. Because many of the comments addressed more than one issue, 191 total comments resulted. This summary provides an overview of comments received through these means during the scoping period. Comments are organized by issue area.

F.2 AIR QUALITY

Comments in this category expressed concern about the effects of military activities on air quality, including off-shore emissions that may be transmitted ashore by onshore winds. The EIS/OEIS should discuss which areas are in nonattainment of National Ambient Air Quality Standards.

F.3 ALTERNATIVES

Most comments regarding alternatives suggested that the Navy consider other sites to conduct its activities. Several comments expressed concern over potential impacts to the Olympic Coast National Marine Sanctuary (OCNMS).

F.4 BIOLOGICAL RESOURCES – MARINE MAMMALS, FISH AND MARINE HABITAT

A significant number of comments received expressed concerns about impacts to marine life. Many of these comments specifically related to concerns about the effect of Navy sonar on marine life, such as marine mammals, fish, sea turtles, and sea invertebrates. Participants frequently requested that the EIS/OEIS consider alternative technologies to mid-frequency active (MFA) sonar. Several comments addressed protective and mitigation measures for marine mammals when sonar is used. Other comments identified specific policies that must be considered in the Navy's analysis, such as the Marine Mammal Protection Act.

F.5 BIOLOGICAL RESOURCES—ONSHORE

Several comments addressed the protection of birds, including shorebirds, seabirds, and migratory birds. Potential stressors to birds mentioned in the comments included bird strikes and noise disturbance. Among other terrestrial issues mentioned were concerns about habitat fragmentation and potential damage to intertidal, inland, or upland resources.

F.6 CULTURAL RESOURCES

Participants commenting on cultural resources were primarily concerned with impacts to tribal access, and recreational and subsistence fishing. A few comments also addressed the issue of potential damage to historically or culturally significant sites.

F.7 CUMULATIVE IMPACTS

Comments in this category expressed concern about the overall impact of past and present military activity in the Pacific Northwest and requested that the Navy initiate cleanup activities. Specific mention was made of the cumulative nature of activities at Naval Magazine Indian Island and the Naval Undersea Warfare Center Keyport Range. Additional comments requested that the Navy study the impacts of other actions, such as placement of wave electrical generation equipment, wind generators on Bear Ridge, and activities at Coast Guard Station Humboldt Bay and Eureka/Arcata airport.

F.8 ENVIRONMENTAL JUSTICE

Commenters requested that the EIS/OEIS identify any disproportionate impacts to disempowered groups of people.

F.9 HAZARDOUS MATERIALS

Of the comments regarding hazardous materials, the primary concern was the effects of depleted uranium use on the environment in general.

F.10 HEALTH AND SAFETY

One comment expressed concern about safety implications to commercial and recreational divers from MFA sonar. Another commenter was concerned about potential increases in aviation mishaps with increased unmanned aerial system use.

F.11 NOISE

Several commenters expressed concern about any increase in airborne noise that could result from increased aircraft activity or offshore gun or bomb training.

F.12 MISCELLANEOUS

Comments were received that requested that the EIS/OEIS consider the protection of surfing waves and for analysis of impact to research activities.

F.13 MITIGATION MEASURES

Most comments regarding mitigation measures focused on marine mammals. For example, it was requested that the Navy employ better protective measures in future sonar exercises, such as conducting more monitoring and enforcing larger safety zones around ships. Several comments mentioned special mitigation measures in and around the OCNMS.

F.14 POLICY/NATIONAL ENVIRONMENTAL POLICY ACT PROCESS

Comments on the National Environmental Policy Act (NEPA) process included several that felt the information available during scoping was not adequate enough to generate comments. One commenter requested that the scoping period be extended beyond 60 days and that another scoping meeting be held in Seattle.

F.15 RECREATION

One comment expressed concern about closing navigable waters for military activities. Such closures would negatively impact recreational fishing, boating and diving.

F.16 SOCIOECONOMICS

Several comments regarding socioeconomic concerns included questions about the effects on commercial shipping, commercial diving and commercial fishing.

F.17 SONAR AND UNDERWATER DETONATIONS

Many comments mentioned concerns about the effect of Navy sonar on marine life, such as marine mammals, fish, sea turtles, and sea invertebrates. Participants frequently requested that the EIS/OEIS consider alternative technologies to MFA sonar. Several comments addressed protective and mitigation measures for marine mammals when sonar is used. Three comments specifically mentioned concerns about underwater detonations and their potential impact to the marine environment.

F.18 WATER RESOURCES

Comments regarding water resources included general concerns about the potential for water quality to be affected by military activities.

F.19 SUMMARY OF COMMENTS

Table F-1 provides a breakdown of areas of concern based on comments received during scoping.

Table F-1: Breakdown of Scoping Comments by Resource Area

Resource Area	Count	Percent of Total
Biological Resources - Marine Mammals	23	12.04%
Biological Resources - Fish & Marine Habitat	17	8.90%
Sonar Underwater Detonations	16	8.38%
Policy/NEPA	14	7.33%
Olympic Coast National Marine Sanctuary	12	6.28%
Other Navy EIS Studies and Unrelated Activities	12	6.28%
Water Resources	11	5.76%
Recreation	9	4.71%
Socioeconomics	9	4.71%
Cultural Resources	8	4.19%
Cumulative Impacts	7	3.66%
Health and Safety	7	3.66%
Threatened and Endangered Species	7	3.66%
Biological Resources - Onshore	6	3.14%
Mitigation	6	3.14%
Proposed Action	6	3.14%
Alternatives	5	2.62%
Noise	5	2.62%
Hazardous Materials / Hazardous Waste	4	2.09%
Miscellaneous	4	2.09%
Air Quality	2	1.05%
Environmental Justice	1	0.52%
TOTAL	191	