Prepared for
Commander, U.S. Pacific Fleet, Executive Agent

In accordance with
The National Environmental Policy Act and
Executive Order 12114

MARIANA ISLANDS RANGE COMPLEX

ENVIRONMENTAL IMPACT STATEMENT/

OVERSEAS ENVIRONMENTAL IMPACT STATEMENT

Volume 1 of 2

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Draft

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COVER SHEET
DRAFT ENVIRONMENTAL IMPACT STATEMENT/
OVERSEAS ENVIRONMENTAL IMPACT STATEMENT
MARIANA ISLANDS RANGE COMPLEX

Lead Agency for the EIS\OEIS:	U.S. Department of the Navy
Title of the Proposed Action:	Mariana Islands Range Complex (MIRC)
Affected Jurisdiction:	Mariana Islands
Designation:	Draft Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS)

Abstract

The National Environmental Policy Act of 1969 requires Federal agencies to examine the environmental effects of their proposed actions. On behalf of the Department of Defense Representative Guam, Commonwealth of the Northern Mariana Islands (CNMI), Federated States of Micronesia and Republic of Palau (DoD REP) the Navy is preparing this EIS/OEIS to assess the potential environmental effects associated with continuing and proposed military activities within the MIRC Study Area. The Navy is the lead agency for the EIS/OEIS because of its role as Executive Agent. The National Marine Fisheries Service (NMFS), the U.S. Department of the Interior, the U.S. Department of Agriculture Wildlife Services (USDA WS), the Federal Aviation Administration (FAA), the United States Army; the United States Marine Corps, the United States Air Force and the United States Coast Guard were invited as cooperating agencies. The NMFS, U.S. Department of Interior (Office of Insular Affairs), FAA, U.S. Marine Corps and U.S. Air Force have accepted as cooperating agencies.

The military services (Services) have identified the need to support and conduct current, emerging, and future training and research, development, test, and evaluation (RDT&E) training activities in the Mariana Islands Study Area. 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 is a proposal designed to meet the Services' current and near-term operational training requirements. It would include increased training activities as a result of upgrades and modernization of existing training areas. This alternative also includes increased activities due to meeting new training and capability requirements for personnel and platforms, and an overall increase in the number and types of training events (including major exercises, the Intelligence, Surveillance and Reconnaissance/Strike [ISR/Strike] Air Force initiative at Andersen AFB, USMC training activities, and the participation of allied forces in major exercises in the MIRC). Training activities will also increase as a result of the acquisition and development of new Portable Underwater Tracking Range capabilities supporting anti-submarine warfare (ASW) and new facility capabilities supporting Military Operations in Urban Terrain (MOUT) training. Implementation of Alternative 2 would include all the actions proposed for MIRC, including the No Action Alternative and Alternative 1, and new activities related to additional Major Exercises.

Prepared by: Department of the Navy

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ES 1 EXECUTIVE SUMMARY

ES 1.1 INTRODUCTION

This Draft Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) analyzes the potential environmental consequences that may result from the Proposed Action and Alternatives, which address ongoing and proposed military training activities within the Mariana Islands Range Complex (MIRC). For the purposes of this EIS/OEIS, the MIRC and the Study Area are the same geographical areas. The MIRC consists of the ranges, airspace, and ocean areas surrounding the ranges that make up the Study Area. The Study Area does not include the sovereign territory (including waters out to 12 nautical miles [nm]) of the Federated States of Micronesia (FSM).

This Draft EIS/OEIS (hereafter referred to as "EIS/OEIS") has been prepared by the Department of the Navy (DoN) in compliance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code [U.S.C.] Section [§] 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 12114 (EO 12114), Environmental Effects Abroad of Major Federal Actions. The Navy is the lead agency for the EIS/OEIS because of its role as executive agent, and the EIS/OEIS has been prepared for the Department of Defense (DoD) Representative Guam, Commonwealth of the Northern Mariana Islands (CNMI), Federated States of Micronesia and Republic of Palau (DoD REP). 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 National Marine Fisheries Service (NMFS), United States (U.S.) Department of the Interior (Office of Insular Affairs), U.S. Department of Agriculture Wildlife Services (USDA WS), Federal Aviation Administration (FAA), U.S. Army, U.S. Marine Corps (USMC), U.S. Air Force (USAF), and U.S. Coast Guard (USCG) were invited as cooperating agencies. The NMFS, U.S. Department of Interior (Office of Insular Affairs), FAA, USMC, and USAF have agreed to be cooperating agencies.

The Proposed Action would result in critical enhancements to increase training capabilities (especially in the undersea and air warfare areas) that are necessary if the military services are to maintain a state of military readiness commensurate with the national defense mission. The Proposed Action does not involve extensive changes to the MIRC facilities, activities, or training capabilities, nor does it involve an expansion of the existing MIRC property or airspace requirements. The Proposed Action does not involve the redeployment of USMC, USAF personnel or assets, carrier berthing capability, or deployment of strategic missile defense assets to the Marianas. The Proposed Action focuses on the development and improvement of existing training capabilities in the MIRC and will not include any military construction projects.

This EIS/OEIS focuses on the achievement of service readiness activities while the Guam and CNMI Marine Relocation EIS/OEIS focuses on the relocation of forces to the Marianas with its associated infrastructure and military construction requirements, Nuclear Aircraft Carrier (CVN) Berthing, and Army Ballistic Missile Defense System. The Intelligence, Surveillance, and Reconnaissance/Strike (ISR/Strike) EIS analyzes the force structure changes and associated support personnel and infrastructure requirements for new and increased aircraft events. Cumulative impact is 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 and can result from individually minor but collectively significant actions taking place over a period of time. Along with other cumulative effects, the cumulative impacts associated with the Marine relocation and ISR/Strike actions will be analyzed within this EIS/OEIS.

The Proposed Action is to use the MIRC to support and conduct current, emerging, and future training and Research, Development, Test, and Evaluation (RDT&E) activities, while enhancing training resources through investment in the ranges. Training and RDT&E activities do not include combat operations, operations in direct support of combat, or other activities conducted primarily for purposes other than training. Three alternatives have been analyzed to determine environmental impacts. The No Action Alternative consists of the current training that occurs in the MIRC. Alternative 1 includes current training and additional training as a result of new major exercises and ISR/Strike actions. Alternative 2 consists of additional training above and beyond Alternative 1.

The MIRC Study Area is located in the Western Pacific (WestPac) and consists of three primary components: ocean surface and undersea areas, special use airspace (SUA), and training land areas. The ocean surface and undersea areas extend from the international waters south of Guam to north of Pagan (CNMI), and from the Pacific Ocean east of the Mariana Islands to the middle of the Philippine Sea to the west, encompassing 501,873 square nautical miles (nm^2) (1,299,851 square kilometers [km^2]) of open ocean and littorals (coastal areas). The MIRC Study Area includes ocean areas in the Philippine Sea, Pacific Ocean, and exclusive economic zones (EEZs) of the United States and FSM. Portions of the Marianas Trench Marine National Monument, which was established in January 2009 by Presidential Proclamation under the authority of the Antiquities Act (16 U.S.C. 431), lie within the Study Area. The range complex includes land ranges and training area/facilities on Guam, Rota, Tinian, Saipan, and Farrallon de Medinilla (FDM), encompassing 64 nm^2 (220 km^2) of land. SUA consists of Warning Area 517 (W-517), restricted airspace over FDM (R-7201), and Air Traffic Control Assigned Airspace (ATCAA) encompassing 63,000 nm^2 (216,000 km^2) of airspace. For range management and scheduling purposes, the MIRC is divided into training areas under different controlling authorities. MIRC-supported activities and training, RDT&E of military hardware, personnel, tactics, munitions, explosives, and electronic combat (EC) systems are described in Chapter 2. Figures ES-1 through ES-12, located at the end of this Executive Summary, depict the MIRC Study Area and its components covered in this EIS/OEIS.

Title 10 of the U.S.C. directs each of the U.S. Military Services (Services) to organize, train, and equip forces for combat. To fulfill their statutory missions, each of the Services needs combat-capable forces ready to deploy worldwide. U.S. military forces must have access to the ranges, operating areas (OPAREAs), and airspace needed to develop and maintain skills for the conduct of military activities. Ranges, OPAREAs, and airspace must be sustained to support the training needed to ensure a high state of military readiness. Activities involving RDT&E for military systems are an integral part of this readiness mandate.

ES 2 PURPOSE AND NEED FOR THE PROPOSED ACTION

The mission of the MIRC is to serve as the principal military training and basing venue in the WestPac with the unique capability and capacity to support required current, emerging, and future training.

The purpose of the Proposed Action is to achieve and maintain Service readiness using the MIRC to support and conduct current, emerging, and future training and RDT&E activities, while enhancing training resources through investment in the ranges. The decision to be made by the DoD REP is to determine both the scope of training and RDT&E to be conducted and the nature of range enhancements to be made within the MIRC. In making this decision, the DoD REP will consider the information and environmental impact analysis presented in this EIS/OEIS when deciding whether to implement Alternative 1, Alternative 2, or the No Action Alternative.

The need for the Proposed Action is to enable the Services to meet their statutory responsibility to organize, train, equip, and maintain combat-ready forces and to successfully fulfill their current and future global mission of winning wars, deterring aggression, and maintaining freedom of the seas. Activities involving RDT&E are an integral part of this readiness mandate.

The existing MIRC plays a vital part in the execution of this readiness mandate. Because of its close location to forward-deployed forces in WestPac, it provides the best economical alternative for forward-deployed U.S. forces to train on U.S.-owned lands. U.S. forces also train in SUA and sea space outside of U.S. territorial boundaries. The Proposed Action is a step toward ensuring the continued vitality of this essential military training resource.

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

In summary, the Military Services propose to implement actions within the MIRC to support current, emerging, and future training and RDT&E in the MIRC. These actions will be evaluated in this EIS/OEIS and include:

- Maintaining baseline training and RDT&E at mandated levels;
- Increasing training exercises from current levels;
- Accommodating force structure changes (human resources, new platforms, and additional weapons systems); and
- Developing range complex investment strategies that sustain, upgrade, modernize, and transform the MIRC to accommodate increased use and more realistic training scenarios.

To support an informed decision, the EIS/OEIS identifies objectives and criteria for military activities in the MIRC Study Area. The core of the EIS/OEIS is the development and analysis of different alternatives for achieving the Services' 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 Services' readiness mandate, as it is implemented in the MIRC. 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).

ES 2.1 WHY THE MILITARY 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 U.S.C. requires the Services to maintain, train, and equip combat-ready forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. Modern war and security operations are complex. Modern weaponry has brought both unprecedented opportunity and innumerable challenges to the military. Smart weapons, used properly, are very accurate and actually allow the military to accomplish their 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. Military training addresses all aspects of the team, from the individual to joint and coalition teamwork. To do this, the military employs a building block approach to training. Training doctrine and procedures are based on operational requirements for deployment of 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 multiservice (Joint) exercises or predeployment certification events. In order to provide the experience so important to success and survival, training must be as realistic as possible. The military often employs simulators and synthetic training to provide early skill repetition and enhance teamwork, but live training in a realistic environment is vital to success. This requires: sufficient land, 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 military forces to conduct realistic combat-like training as they undergo all phases of the graduated buildup needed for combat-ready deployment. Ranges and operating areas provide the space necessary to conduct controlled and safe training scenarios representative of those that the military 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, with land training areas, safety landing fields, and amphibious landing sites, are critical to this realism, allowing execution of multidimensional exercises in complex scenarios. They also provide instrumentation that captures the performance of tactics and equipment in order to provide the feedback and assessment that is essential for constructive criticism of personnel and equipment. The live-fire phase of training facilitates assessment of the military's ability to place weapons on target with the required level of precision while under a stressful environment. Live training will remain the cornerstone of readiness.

ES 2.1.1 The Strategic Importance of the MIRC

The MIRC is characterized by a unique combination of attributes that make it a strategically important range complex for the Services. These attributes include the following:

- Location within U.S. territory
- Live-fire ranges on the islands of Guam, Tinian, and FDM
- Expansive airspace, surface sea space, and underwater sea space
- Authorized use of multiple types of live and inert ordnance on FDM
- Support for all Navy warfare areas and numerous other Service roles, missions, and tactical tasks
- Support to homeported Navy, Army, USCG, and USAF units based at military installations on Guam and CNMI
- Training support for deployed forces
- WestPac Theater training venue for Special Warfare forces
- Ability to conduct Joint and combined force exercises
- Rehearsal area for WestPac contingencies

Due to Guam and CNMI's strategic location and DoD's ongoing reassessment of the WestPac military alignment, there has been a dramatic increase in the importance of the MIRC as a training venue and its capabilities to support required military training.

ES 3 SCOPE AND CONTENT OF THE EIS

In its analysis under NEPA, the Navy includes areas of the MIRC Study Area[1] that lie within 12 nm (22 kilometers [km]) of the shoreline, or the territorial seas. Environmental effects in the areas that are outside of U.S. territorial seas are analyzed under EO 12114 and associated implementing regulations.

ES 3.1 NEPA

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

Once final, this EIS/OEIS will supersede the *1999 EIS for Military Training in the Marianas and the Overseas Environmental Assessment Notification for Air/Surface International Warning Areas, 2002*. In addition, this EIS/OEIS will address the environmental impacts of future at-sea training events such as the Valiant Shield Exercise (last held in the summer of 2007), which was previously analyzed under separate environmental documentation.. This expanded 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 assessing environmental effects.

The first step in the NEPA process is 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. The NOI for this project was published in the *Federal Register* on June 1, 2007 (Federal Register Volume 72, No. 105, pp 30557-59). A newspaper notice was placed in two local newspapers, *Pacific Daily News* (Guam) and *Saipan Tribune* (Saipan/Tinian). The NOI and newspaper notices included information about comment procedures, a list of information repositories (public libraries), the dates and locations of the scoping meetings, and the project website address (www.MarianasRangeComplexEIS.com).

Scoping is an early and open process for developing the “scope” of issues to be addressed in the EIS and for identifying significant issues related to a Proposed Action. The scoping process for this EIS/OEIS was initiated by the publication of the NOI in the *Federal Register* and local newspapers noted above. During scoping, the public is given an opportunity to help define and prioritize issues and convey these issues to the Navy through written comments. Scoping meetings were held at three locations: Hilton Guam (Tumon Bay, Guam) on June 18, 2007; Hyatt Regency Saipan (Garapan Village, Saipan) on June 20, 2007; and Tinian Dynasty Hotel (San Jose Village, Tinian) on June 21, 2007. There were 135 total attendees, including 65 in Guam, 48 in Saipan, and 22 in Tinian. As a result of the scoping process, the Navy received comments from the public, which have been considered in the preparation of this EIS/OEIS.

[1] For the purposes of this EIS, the MIRC and the Study Area are the same geographical areas. The complex consists of the ranges and the ocean areas surrounding the ranges that make up the Study Area. The Study Area does not include the sovereign territory (including waters out to 12 nm) of the Federated States of Micronesia (FSM).

Table ES-1: Public Scoping Comment Summary

Category	Commentator	Discussion Topic/Summary of Concern
Alternatives	Guam Environmental Protection Agency Private Citizen	Alternatives outside Mariana Islands. Additional alternative that consolidates training activities on fewer ranges. Alternative that includes reducing training.
Environmental	Department of Public Lands (Saipan) Guam Environmental Protection Agency Guam Department of Agriculture U.S. Environmental Protection Agency (USEPA) Private Citizens	General environmental concerns. Development of appropriate mitigation measures.
Water Quality and Quantity	USEPA Private Citizen	Availability of fresh water.
Marine Life	Guam Department of Agriculture Private Citizens U.S. Fish & Wildlife Service (USFWS) USEPA	Impacts to marine life, essential fish habitat, and coral reefs, from sound, underwater detonations, vessel activity, disturbances, hazardous materials, and pollution. ESA-listed species.
Airborne Noise	Private Citizens	Noise from aircraft.
Invasive Species	Guam Department of Agriculture USFWS USEPA Private Citizens	Increase in invasive species, including brown tree snake, flatworm.
Birds and Terrestrial Species	CNMI Division of Fish & Wildlife Private Citizens USFWS	Activity/noise disturbance to Tinian Monarch. Impacts to native species, including arboreal snails. ESA-listed species. Habitat destruction.
Socioeconomic	USEPA	Environmental Justice.

Comments received from the public during the scoping process are categorized and summarized in Table ES-1. This table is not intended to provide a complete listing, but to show the extent of the scope of comments. These comments were received through public comment forms, which were available at each information station and were collected during the meeting. The forms could also be mailed to the address or e-mail address provided on the form. For people who wanted to submit oral comments, there were two options: a tape recorder was available for people wanting to dictate their comments directly into the recorder and a Navy representative was also available to transcribe public comments using a laptop computer. During scoping, the Marianas EIS/OEIS team set up and allowed the public to submit comments electronically via an e-mail address, marianas.tap.eis@navy.mil, which, at that time, was the preferred electronic method to offer the public for submitting comments. A total of 25 comments were received, including written and oral comments from the public meetings and written comments via mail and e-mail.

Subsequent to the scoping process, this EIS/OEIS was prepared to assess the potential effects of the Proposed Action and Alternatives on the environment. 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 similar (or the same) venues 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. 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 present commitments to specific mitigation measures.

ES 3.2 EO 12114

EO 12114 directs Federal agencies to provide for informed decision-making for major Federal actions outside the U.S. territorial sea, but not including actions within the territory or territorial sea of a foreign nation. For purposes of this EIS/OEIS, areas outside U.S. territorial sea are considered to be areas beyond 12 nm from shore. This EIS/OEIS satisfies the requirements of EO 12114, as analysis of activities or impacts occurring, or proposed to occur, outside of 12 nm is provided.

For the majority of resource sections addressed in this EIS/OEIS, projected impacts outside of U.S. territory would be similar to those within the territorial sea. 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 jurisdictional boundary. Therefore, for these resource sections, the impact analyses contained in the main body of the EIS/OEIS are 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 3.3 OTHER ENVIRONMENTAL REQUIREMENTS CONSIDERED

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

- Marine Mammal Protection Act (MMPA)
- Endangered Species Act (ESA)
- Migratory Bird Treaty Act (MBTA)
- Coastal Zone Management Act (CZMA)
- Rivers and Harbors Act (RHA)
- Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) for Essential Fish Habitat (EFH)
- Clean Air Act (CAA)
- Federal Water Pollution Control Act (Clean Water Act [CWA])
- National Historic Preservation Act (NHPA)
- National Invasive Species Act
- Resource Conservation and Recovery Act (RCRA)
- EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
- EO 13045, Environmental Health and Safety Risks to Children
- EO 13089, Protection of Coral Reefs
- EO 13112, Invasive Species.

In addition, laws and regulations of the Territory of Guam and the CNMI that are applicable to military actions are identified and addressed in this EIS/OEIS. To the extent practicable, this EIS/OEIS will be used as the basis for any required consultation and coordination in connection with applicable laws and regulations.

ES 4 PROPOSED ACTION AND ALTERNATIVES

ES 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. Section 1502.14(d) of the CEQ guidelines requires that the alternatives analysis in the EIS "include the alternative of no action." For evaluating the Proposed Action under this EIS, the current level of range management activity is used as a benchmark. By proposing the status quo as the No Action Alternative here, the Navy compares the impacts of the proposed alternatives to the impacts of continuing to operate, maintain, and use the MIRC in the same manner and at the same levels as they do now.

The No Action Alternative is representative of baseline conditions, where the action presented represents a regular and historical level of activity on the MIRC to support training activities and exercises. The No Action Alternative serves as a baseline, and represents the "status quo" when studying levels of range usage and activity. This use of the current level of operations as a baseline level is appropriate under CEQ guidance, as set forth in the *Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations*, Question #3. The current military training the MIRC was initially addressed in the 1999 Military Training in the Marianas EIS, and in several Environmental Assessments (EAs) (*e.g.*, Overseas EA Notification for Air/Surface International Warning Areas and Valiant Shield Overseas EA [OEA]) for more specific training events or platforms. Alternative 1 and Alternative 2 analyze greater use of range assets to support training activities and maximize training opportunities that fully supports the increased training requirements of the ISR/Strike initiative and increased surface and undersea training.

The Services have 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 the alternatives must be feasible, reasonable, and reasonably foreseeable in accordance with CEQ regulations (40 C.F.R. §§ 1500-1508). Reasonable alternatives include those that are practical or feasible from the technical and economic standpoint. Alternatives that are outside the scope of what Congress has approved or funded must still be evaluated in the EIS/OEIS if they are reasonable, because the EIS/OEIS may serve as the basis for modifying congressional approval or funding in light of NEPA goals and policies.

Alternatives were selected based on their ability to meet the following criteria:

1. Location where Joint U.S. forces can train within a specified geographical region.
2. Location where 7th Fleet forces can train within their area of responsibility (AOR).
3. Location where training requirements of deployed military forces can be met while remaining within range of WestPac nations.
4. Location where training can be accomplished within the territory of the United States.
5. Training capabilities must meet operational requirements by supporting realistic training.
6. Training capacity must meet Fleet deployment schedules, and Service training schedules, standards, and exercises.
7. The range complex must meet the requirements of DoD Directive 3200.15, "Sustainment of Ranges and Operating Areas (OPAREA)".
8. The range complex must be capable of implementing new training requirements and RDT&E activities.
9. The range complex must be capable of supporting current and forecasted range and training upgrades.

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 mitigation measures intended to reduce the environmental effects of military activities. Protective measures, such as Best Management Practices (BMPs) and Standard Operating Procedures (SOPs), are discussed throughout this EIS/OEIS.

ES 4.2 ALTERNATIVES ELIMINATED FROM FURTHER CONSIDERATION

Having identified criteria for generating alternatives for consideration in this EIS/OEIS (see Subsection 2.2.1), the Navy eliminated several alternatives from further consideration after initial review. Specifically, the following potential alternatives (described in Subsections 2.2.2.1-2.2.2.3) were not carried forward for analysis:

- Alternative range complex locations,
- Extensive reliance on simulated training in place of live training, and
- Concentrating the level of current training in the MIRC to fewer sites.

After careful consideration of each of these potential alternatives in light of the identified criteria, it was determined that none of them meets the Purpose and Need for the Proposed Action.

ES 4.3 ALTERNATIVES CONSIDERED

Three alternatives are analyzed in this EIS/OEIS:

1. No Action Alternative - Current Training Activities
2. Alternative 1 - Increase Training Modernization, and Upgrades
3. Alternative 2 - Increase Major At-Sea Exercises and Training.

As noted in Section 1.4, the purpose of the Proposed Action is to achieve, enhance, and maintain Military readiness using the MIRC Study Area to support current and future training. The Services propose to:

- Increase training and RDT&E from current levels as necessary;
- Accommodate mission requirements associated with force structure changes and introduction of new weapons and systems to the Services; and
- Implement enhanced range complex capabilities.

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

ES 4.3.1 No Action Alternative — Current Training Activities within the MIRC Study Area

The No Action Alternative is the continuation of existing training activities, RDT&E activities, and continuing base activities. This includes all multi-Service training activities on DoD training areas, including either a Joint expeditionary warfare exercise or a Joint multi-strike group exercise. Current military training and RDT&E activities in the MIRC have been evaluated in the Final Environmental Impact Statement for Military Training in the Marianas, June 1999 and in several Environmental Assessments (*e.g.*, OEA Notification for Air/Surface International Warning Areas and Valiant Shield OEA). As such, evaluation of the No Action Alternative in this EIS/OEIS provides a baseline for assessing environmental impacts of Alternative 1 (Preferred Alternative), and Alternative 2, as described in the following subsections.

While the No Action Alternative meets a portion of the Service's requirements, it does not meet the purpose and need. This alternative does not provide for training capabilities for ISR/Strike, undersea warfare improvements, or increased training activities within the MIRC. With reference to the criteria identified in Section 2.2.1, the No Action Alternative does not satisfy criteria 7, 8, and 9 (relating to support for the full spectrum of training requirements).

ES 4.3.2 Alternative 1 (Preferred Alternative) — Increase Training, Modernization, and Upgrades

Alternative 1 is a proposal designed to meet the Services' current and near-term training requirements. If Alternative 1 were to be selected, in addition to accommodating the No Action Alternative, it would include increased training activities as a result of upgrades and modernization of existing training areas. This alternative also includes increased activities due to meeting new training and capability requirements for personnel and platforms, and an overall increase in the number and types of events (including major exercises, the ISR/Strike Air Force initiative at Andersen Air Force Base (AFB), other services and agencies (USMC, USA, USCG, Department of Homeland Security {DHS}, and the participation of the allied forces in major exercises in the MIRC). Activities will also increase as a result of the acquisition and development of new Portable Underwater Tracking Range capabilities supporting Anti-Submarine Warfare (ASW), and new facility capabilities supporting MOUT training.

Major Exercises. Training activities would be increased to include training in major exercises, multi-Service and Joint exercises involving multiple strike groups and task forces. Major exercises provide multi-Service and Joint participation in realistic maritime and expeditionary training that is designed to replicate the types of events and challenges that could be faced during real-world contingency operations. Major exercises provide training to submarine, ship, aircraft, and special warfare forces in mission tactics, techniques, and procedures.

(Note: The Guam and CNMI Marine Relocation EIS/OEIS for the relocation of USMC forces from Okinawa to Guam examines the potential impact from activities associated with the USMC units' relocation, including activities, infrastructure changes, and training. In addition, the EIS/OEIS will address the proposed Army missile defense system on Guam, and the infrastructure required for berthing a visiting aircraft carrier. Since the MIRC EIS/OEIS will cover DoD training on existing DoD land and training areas in and around Guam and the CNMI, there will be overlap between the two EIS/OEISs in the area of increased usage of existing DoD ranges as the result of the pending relocation. These documents are being closely coordinated to ensure consistency.)

ISR/Strike. The USAF has established the ISR/Strike program at Andersen AFB, Guam. ISR/Strike will be implemented in phases over a planning horizon of FY2007–FY2016. ISR/Strike force structure consists of up to 48 fighter, 12 aerial refueling, six bomber, and four unmanned aircraft with associated support personnel and infrastructure. Environmental impacts associated with the establishment of ISR/Strike on Andersen AFB have been analyzed in the *2006 Establishment and Operation of an Intelligence, Surveillance and Reconnaissance/Strike, Andersen Air Force Base, EIS*. Implementation of Alternative 1 would result in ISR/Strike aircraft events out of Andersen AFB increasing by 45 percent over the current level (FY2006). The 45 percent increase in aircraft events out of and into Andersen AFB requires improved range infrastructure to accommodate this increased training tempo, newer aircraft, and weapon systems commensurate with ISR/Strike force structure. There will be increased activity on all the current training areas supporting USAF activities: W-517, ATCAAs, and FDM.

FDM. Public access to FDM is strictly prohibited and there are no commercial or recreational activities on or near the island. During training exercises, marine vessels are restricted within a 3-nm (5-km) radius. Published Notices to Mariners (NOTMARs) and Notice to Airmen (NOTAM) are issued at least 72 hours in advance of potentially hazardous FDM range events. NOTMARs and NOTAMs may advise restrictions from beyond 3 to 30 nm (5-56 km) radius from FDM or greater for certain training events. These temporary increased advisory restrictions are used to maintain the safety of the military and the public during training sessions in an effort to ensure better protection through notice of potentially hazardous training activity and temporary danger zones and restriction areas to the military and the public during some training sessions.

As usage of FDM increases under implementation of either Alternative 1 or Alternative 2, a permanent safety danger zone and restricted area would be established to restrict all private and commercial vessels from entering the area to minimize danger from the hazardous activity in the area. Development of a 10-nm (18-km) permanent danger zone and restricted zone area would be an established restriction, supplemented by temporary advisory notices as required for training events needing a temporary extension of the safety zone from 10-nm to 30-nm.

Anti-Submarine Warfare (ASW). ASW describes the entire spectrum of platforms, tactics, and weapon systems used to neutralize and defeat hostile submarine threats to combatant and noncombatant maritime forces. A critical component of ASW training is the Portable Underwater Tracking Range (PUTR). The acquisition and development of new PUTR capabilities would allow near real-time tracking and feedback to all participants. The PUTR should provide both a shallow water and deep water operating environment, with a variety of bottom slope and sound velocity profiles similar to potential contingency operating areas. Guam-homeported submarine crews, as well as crews of transient submarines, require ASW training events to maintain qualifications. A MIRC-instrumented ASW PUTR, target support services, and assigned torpedo retriever craft would meet support requirements for Torpedo Exercise (TORPEX) and Tracking Exercise (TRACKEX) activities in the MIRC in support of Fast Attack Submarine (SSN) and Ballistic Missile Submarine (SSBN) and other deployed forces.

Military Operations in Urban Terrain (MOUT). MOUT training is conducted within a facility that replicates an urban area, to the extent practicable. The urban area includes a central urban infrastructure of buildings, blocks, and streets; an outlying suburban residential area; and outlying facilities. Suburban area structures should represent a local noncombatant populace and infrastructure. The Services will need to repair and upgrade the existing MOUT facilities to support training requirements of special warfare units stationed at or deployed to the MIRC.

ES 4.3.3 Alternative 2 — Increase Major At-Sea Exercises and Training

Implementation of Alternative 2 would include all the actions proposed for the MIRC, including the No Action Alternative and Alternative 1, and increased training activity associated with an increase in major at-sea exercises including Fleet Strike Group Exercise (Carrier Strike Group), Integrated ASW Exercise (Strike Group), and Ship Squadron ASW Exercise (Cruiser, Destroyer).

Fleet Strike Group Exercise. Provide ships and personnel assigned to Commander, Seventh Fleet, U.S. Navy, realistic maritime training to improve the level of joint operating skill and teamwork between the Navy, Joint Forces, and Partner Nations. Submarine, ship, and aircraft crews train in tactics, techniques, and procedures for ASW, Surface Warfare (SUW), Air Warfare (AW), and operational level Command and Control (C2) of maritime forces. The exercise would take place within the MIRC Study Area.

Integrated ASW Exercise. This is an ASW exercise to be conducted by the Navy's Strike Groups to assess their ASW proficiency while located in the Seventh Fleet area of activities. The exercise is designed to assess the Strike Groups' ability to conduct ASW in the most realistic environment, against the level of threat expected, in order to effect changes to both training and capabilities (e.g., equipment, tactics, and changes to size and composition) of U.S. Navy Strike Groups. Strike Groups would receive significant training value in the assessment, as training is inherent in all at-sea exercises.

Ship Squadron ASW Exercise. The exercise will typically involve multiple ships, submarines, and aircraft in several coordinated events over a period of a week or less, focused on all elements of ASW training.

ES 5 PREFERRED ALTERNATIVE

The Preferred Alternative (Alternative 1) in this EIS/OEIS (See Chapter 2 for details) was evaluated to ensure it met the purpose and need, giving due consideration to range complex attributes such as the capability to support current and emerging Fleet training and RDT&E requirements; the capability to support realistic, essential training at the level and frequency sufficient to support the Fleet Response Training Plan (FRTP); and the capability to support training requirements while following Navy Personnel Tempo of Operations (i.e., time away from homeport) guidelines.

The Preferred Alternative maintains current activities, increases training, expands warfare missions, accommodates force structure changes (changes in weapon systems and platforms and homebase new aircraft and ships), and implements enhancements to enable each range complex to meet foreseeable needs. In addition to the discussion/analysis of the Preferred Alternative, the EIS/OEIS includes descriptions and analyses of the No Action Alternative and Alternative 2. The Navy will not make its decision of which alternative it will implement until the ROD is signed at the conclusion of the NEPA process.

ES 6 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

Chapter 3 of this EIS/OEIS describes existing environmental conditions and environmental consequences 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 following table:

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

Resource	Section
Geology, Soils, and Bathymetry	3.1
Hazardous Materials and Waste	3.2
Water Quality	3.3
Air Quality	3.4
Airborne Noise	3.5
Marine Communities	3.6
Marine Mammals	3.7
Sea Turtles	3.8
Fish and Essential Fish Habitat	3.9
Seabirds and Shorebirds	3.10
Terrestrial Species and Habitats	3.11
Socioeconomic Resources (Land Use, Transportation, Demographics, Regional Economy, Recreation)	3.12, 3.14, 3.15, 3.16, 3.17
Cultural Resources	3.13
Environmental Justice and Protection of Children	3.18
Public Health and Safety	3.19

ES 6.1 GENERAL ANALYSIS APPROACH TO ASSESSING ENVIRONMENTAL CONSEQUENCES

Each alternative analyzed in this EIS/OEIS includes several warfare areas (e.g., AW, Amphibious Warfare [AMW], ASW, Electronic Combat (EC), Mine Warfare [MIW], Naval Special Warfare [NSW], Surface Warfare [SUW], and Strike Warfare [STW], etc.). Likewise, several activities (e.g., vessel movements, aircraft overflights, weapons firing) are accomplished under each event, and those activities typically are not unique to that event. For example, many of the activities involve Navy vessel movements and aircraft overflights. Detailed descriptions of the events are contained in Appendix D. The analysis for each resource category is organized by warfare areas and/or stressors associated with that activity, rather than warfare area or activities. Chapter 3 contains the details of the analyses. The following general steps were used to analyze the potential environmental consequences of the alternatives to:

- Identify those aspects of the Proposed Action that are likely to act as stressors to resources by having a direct or indirect effect on the physical, chemical, and biotic environment of each Study Area to identify those aspects of the Proposed Action that required detailed analysis in the EIS/OEIS.

- Identify the 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 resources are likely to respond given their exposure and available scientific knowledge of their responses (response analysis).
- Determine the risks those responses pose to resources and the significance of those risks.

ES 6.2 ENVIRONMENTAL STRESSORS ANALYZED

Of the potential environmental stressors considered in the analysis, the following stressors were carried forward for detailed analysis for all resources categories:

- Vessel movements
- Aircraft overflights
- Sonar
- Weapons Firing (including explosions and underwater detonations)
- Nonexplosive Mine Shapes (deployed in the ocean and recovered)
- Expended Materials
- Amphibious Landings
- Vehicle Movements
- Building Modification (repairs, maintenance, and upgrade)
- Land Detonations
- Foot Traffic

ES 6.3 SUMMARY OF ENVIRONMENTAL IMPACTS

Environmental effects which might result from the implementation of the Navy's Proposed Action or alternatives have been summarized in Table ES-3. A detailed analysis of effects is provided in Chapter 3.

Table ES-3: Summary of Environmental Impacts

Resource Category	Alternative	National Environmental Policy Act (Land and Territorial Waters, <12 nm)	Executive Order 12114 (Non-Territorial Waters, >12 nm)
Section 3.1 **Geology, Soils, and Bathymetry**	No Action Alternative, Alternative 1, or Alternative 2	Localized disturbance to topography and localized erosion would continue; however, topographic and surface soil changes would be minimal and would be managed in accordance with established protective measures. Dispersion and suspension of marine sediments as a result of detonation of underwater mines and Explosive Ordnance Disposal (EOD) demolition would continue. Continuation of disturbance to some sandy beaches; these effects would be similar to that from normal wave action during stormy conditions. Under Alternative 1 and Alternative 2 the impacts would be similar to those described under the No Action Alternative; however, the intensity of impacts to geologic resources and soils would be greater.	Impacts would be similar to those described for the No Action Alternative, Alternative 1, and Alternative 2 for territorial waters. No significant harm to geology, soils, and bathymetry resources.
Section 3.2 **Hazardous Materials and Waste**	No Action Alternative, Alternative 1, or Alternative 2	Use of training materials would continue deposition of expendable training debris on the ranges. Most of the degradation products of these materials are nonhazardous inorganic materials. Under Alternative 1 and Alternative 2 the impacts would be similar to the No Action Alternative; however the rate of deposition of expendable training debris on the ranges would slightly increase compared to the No Action Alternative. Existing ashore hazardous material and waste management systems are sufficient for handling of wastes generated under the No Action Alternative, Alternative 1, and Alternative 2.	Impacts would be similar to those described for the No Action Alternative, Alternative 1, and Alternative 2 for territorial waters. Existing hazardous materials and waste management systems are sufficient for handling of wastes generated by the No Action Alternative, Alternative 1, and Alternative 2. No significant harm to resources from hazardous materials and waste.

Table ES-3: Summary of Environmental Impacts (Continued)

Resource Category	Alternative	National Environmental Policy Act (Land and Territorial Waters, <12 nm)	Executive Order 12114 (Non-Territorial Waters, >12 nm)
Section 3.3 **Water Quality**	No Action Alternative, Alternative 1, or Alternative 2	There would be no long-term degradation of marine, surface, or groundwater quality. Releases of munitions constituents from explosives, ordnance, and small arms rounds used during training exercises would have no short-term impacts. Continued compliance with Navy policies and procedures for shipboard training Protective measures include continued compliance with Navy SOPs and BMPs for ashore management, storage, and discharge of hazardous materials and wastes, and other pollution protection measures. Impacts and protective measures for Alternative 1 and Alternative 2 would be similar to those described under the No Action Alternative.	Impacts would be similar to those described for the No Action Alternative, Alternative 1, and Alternative 2 for territorial waters. No significant harm to water quality.
Section 3.4 **Air Quality**	No Action Alternative, Alternative 1, or Alternative 2	Under the No Action Alternative there would be no significant impacts to air quality of coastal and inland areas from current emission-generating training activities. Training areas will remain in attainment of the National Ambient Air Quality Standards. Impacts to air quality under Alternative 1 and Alternative 2 of coastal and inland training areas from emission-generating activities would be similar to those under the No Action Alternative.	Impacts would be similar to those described for the No Action Alternative, Alternative 1, and Alternative 2 for territorial waters. No significant harm to air quality.
Section 3.5 **Airborne Noise**	No Action Alternative, Alternative 1, or Alternative 2	Under the No Action Alternative sound-generating events are intermittent, occur in remote 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 for such military activities. Under Alternative 1 and Alternative 2 impacts would be the same as the No Action Alternative.	Impacts would be similar to those described for the No Action Alternative, Alternative 1, and Alternative 2 for territorial waters. No significant harm to resources from airborne noise.

Table ES-3: Summary of Environmental Impacts (Continued)

Resource Category	Alternative	National Environmental Policy Act (Land and Territorial Waters, <12 nm)	Executive Order 12114 (Non-Territorial Waters, >12 nm)
Section 3.6 **Marine Communities**	No Action Alternative, Alternative 1, or Alternative 2	Under the No Action Alternative there would be no long-term impacts to marine communities. Releases of munitions constituents from explosives, ordnance, and small arms rounds used during training exercises would have no short-term impacts. Continued compliance with Navy policies and procedures for shipboard training. Protective measures include continued compliance with Navy SOPs and BMPs for ashore management, storage, and discharge of hazardous materials and wastes, and other pollution protection measures. Under Alternative 1 and Alternative 2 impacts and protective measures would be similar to those described under the No Action Alternative.	Impacts would be similar to those described for the No Action Alternative, Alternative 1, and Alternative 2 for territorial waters. No significant harm to marine communities.
Section 3.7 **Marine Mammals**	No Action Alternative, Alternative 1, or Alternative 2	<u>Vessel Movements</u> Under the No Action Alternative, Alternative 1, and Alternative 2: short-term behavioral responses would result from general vessel disturbance. The potential exists for injury or mortality from vessel collisions. No long-term population or community-level effects would be expected.	<u>Vessel Movements</u> Impacts would be similar to those described for the No Action Alternative, Alternative 1, and Alternative 2 for territorial waters.
		<u>Aircraft Overflights</u> Under the No Action Alternative, Alternative 1, and Alternative 2: potential exposure to aircraft noise inducing short-term behavioral changes exists. No long-term population or community-level effects would be expected.	<u>Aircraft Overflights</u> Impacts would be similar to those described for the No Action Alternative, Alternative 1, and Alternative 2 for territorial waters.
		<u>Munitions Use/Non-Explosive Practice Munitions</u> Under the No Action Alternative, Alternative 1, and Alternative 2: no effect is anticipated due to weapons firing/non-explosive ordnance use due to the extremely low probability of direct strikes.	<u>Munitions Use/Non-Explosive Practice Munitions</u> Impacts would be similar to those described for the No Action Alternative, Alternative 1, and Alternative 2 for territorial waters.

Table ES-3: Summary of Environmental Impacts (Continued)

<table>
<tr><th>Resource Category</th><th>Alternative</th><th>National Environmental Policy Act (Land and Territorial Waters, <12 nm)</th><th>Executive Order 12114 (Non-Territorial Waters, >12 nm)</th></tr>
<tr><td rowspan="7">Section 3.7
Marine Mammals
(Continued)</td><td>No Action Alternative,
Alternative 1,
or
Alternative 2</td><td><u>Expended Materials</u>
Under the No Action Alternative, Alternative 1, and Alternative 2: there is a low potential for ingestion of ordnance related materials and chaff and/or flare plastic end caps and pistons. No long-term population or community-level effects would be expected.</td><td><u>Expended Materials</u>
Impacts would be similar to those described for the No Action Alternative, Alternative 1, and Alternative 2 for territorial waters.</td></tr>
<tr><td rowspan="2">No Action Alternative</td><td><u>No Action Alternative Sonar Use</u>
Potential occurrences of Level B harassment events (TTS), behavioral disturbance exposures, and a potential Level A exposure.</td><td><u>No Action Alternative Sonar Use</u>
Impacts would be similar to those described for the No Action Alternative for territorial waters.</td></tr>
<tr><td colspan="2"><u>No Action Alternative Sonar Use</u>
Modeling results for all waters (territorial and non-territorial) indicate potentially 1,097 Level B harassment events (TTS), 67,872 behavioral disturbance exposures, and one potential Level A exposure resulting from the summation of MFA modeling is estimated for the pantropical spotted dolphin.</td></tr>
<tr><td rowspan="2">Alternative 1</td><td><u>Alternative 1 Sonar Use</u>
Potential occurrences of Level B harassment events (TTS), behavioral disturbance exposures, and potential Level A exposures.</td><td><u>Alternative 1 Sonar Use</u>
Impacts would be similar to those described for Alternative 1 for territorial waters.</td></tr>
<tr><td colspan="2">Modeling results for all waters (territorial and non-territorial) indicate potentially 1,246 Level B harassment events (TTS), 77,415 behavioral disturbance exposures, and two potential Level A exposures resulting from the summation of MFA modeling; one is estimated for the pantropical spotted dolphin, and one for the sperm whale.</td></tr>
<tr><td rowspan="2">Alternative 2</td><td><u>Alternative 2 Sonar Use</u>
Under Alternative 2 potential occurrences of 1,470 Level B behavioral harassment events and 91,534 behavior disturbances exists. One Level A exposure for pantropical spotted dolphin may result in mortality.</td><td><u>Alternative 2 Sonar Use</u>
Impacts would be similar to those described for Alternative 2 for territorial waters.</td></tr>
<tr><td colspan="2">Modeling results for all waters (territorial and non-territorial) indicate potentially 1,470 Level B harassment events (TTS), 91,534 behavioral disturbance exposures, and two potential Level A exposures resulting from the summation of MFA modeling; one is estimated for the pantropical spotted dolphin, and one for the sperm whale.</td></tr>
</table>

Table ES-3: Summary of Environmental Impacts (Continued)

Resource Category	Alternative	National Environmental Policy Act (Land and Territorial Waters, <12 nm)	Executive Order 12114 (Non-Territorial Waters, >12 nm)
Section 3.7 Marine Mammals (Continued)	No Action Alternative	Underwater Detonations and Explosive Ordnance Use Potential occurrences of Level B harassment (TTS) events and behavior disturbances.	Underwater Detonations and Explosive Ordnance Use Impacts would be similar to those described for the No Action Alternative for territorial waters.
		Modeling results for all waters (territorial and non-territorial) indicate potentially 15 Level B harassment (TTS) events and 42 behavior disturbances.	
	Alternative 1	Underwater Detonations and Explosive Ordnance Use Potential occurrences of Level B harassment (TTS) events and behavior disturbances.	Underwater Detonations and Explosive Ordnance Use Impacts would be similar to those described for Alternative 1 for territorial waters.
		Modeling results for all waters (territorial and non-territorial) indicate potentially of 39 Level B harassment (TTS) events and 109 behavior disturbances.	
	Alternative 2	Underwater Detonations and Explosive Ordnance Use Potential occurrences of Level B harassment (TTS) events and behavior disturbances.	Underwater Detonations and Explosive Ordnance Use Impacts would be similar to those described for Alternative 2 for territorial waters.
		Modeling results for all waters (territorial and non-territorial) indicate potentially 40 Level B harassment (TTS) events and 111 behavior disturbances.	
	No Action Alternative, Alternative 1,or Alternative 2	Endangered Species Act The No Action Alternative, Alternative 1 or Alternative 2 may affect the following endangered species within the MIRC Study Area: blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*) and sperm whale (*Physeter macrocephalus*). Critical habitat for marine mammals has not been designated within the MIRC Study Area. Navy is consulting with NMFS regarding this determination for the preferred alternative, Alternative 1.	
	No Action Alternative, Alternative 1,or Alternative 2	Marine Mammal Protection Act The No Action Alternative, Alternative 1 or Alternative 2 could expose non-ESA listed marine mammals to impacts associated with sonar, underwater detonations, and explosive ordnance use that could result in Level A or Level B harassment as defined by MMPA provisions that are applicable to the Navy. Accordingly, the Navy is working with NMFS through the MMPA permitting process to ensure compliance with the MMPA.	

Table ES-3: Summary of Environmental Impacts (Continued)

Resource Category	Alternative	National Environmental Policy Act (Land and Territorial Waters, <12 nm)	Executive Order 12114 (Non-Territorial Waters, >12 nm)
Section 3.8 **Sea Turtles**	No Action Alternative, Alternative 1, or Alternative 2	Under the No Action Alternative short term behavioral responses from vessel movements and aircraft overflights may occur. No long-term population-level effects are anticipated due to aircraft overflight. The potential exists for injury or mortality from vessel collisions. Amphibious landings could result in short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. Vehicle activity and personnel movements may cause nest failures (false crawls of nesting females, or sand compaction/ nest mortality). Long-term effects of accelerated beach erosion from vehicle tracks on the beach and craft wakes in the water may occur. No nest failures have occurred within the MIRC or in other Navy training areas in the Pacific with similar training (*e.g.* Hawaii Range Complex), and protective measures that are employed by the Navy that have been developed in consultation with USFWS avoid or reduce potential adverse effects to nesting sea turtles and habitat. Sonar would have a low probability for masking effects, although MFA and HFA sonar frequencies do not overlap with sea turtle sensitive hearing ranges. Weapons Firing/Non-Explosive Ordnance Use has a low probability of direct strikes of sea turtles, but the potential exists for short-term temporary disturbance associated with gunnery noise transmitted to the ocean surface and/or transmitted through a ship's hull. Underwater detonations and explosive ordnance have the potential for short-term behavioral responses for sea turtles. The potential for injury or mortality within a limited zone of influence (ZOI) exists. Sinking Exercises (SINKEXs) will not occur in territorial waters.	Impacts would be similar to those described for the No Action Alternative, Alternative 1, and Alternative 2 for territorial waters. Therefore, as per Section 7(a)(2) of the ESA, the Navy is consulting with NMFS for potential effects to sea turtles in the marine environment within non-territorial waters. The impacts for amphibious landings are not applicable to non-territorial waters as they occur exclusively within territorial waters. Therefore, consultation with USFWS for actions within non-territorial waters are not required. Although activities within non-territorial waters may affect sea turtles, these effects are expected to be short-term in duration, unlikely to occur, and not expected to result in take of sea turtles at sea. Therefore, no significant harm to sea turtles would occur in non-territorial waters.

Table ES-3: Summary of Environmental Impacts (Continued)

Resource Category	Alternative	National Environmental Policy Act (Land and Territorial Waters, <12 nm)	Executive Order 12114 (Non-Territorial Waters, >12 nm)
Section 3.8 **Sea Turtles** **(Continued)**	No Action Alternative, Alternative 1, or Alternative 2	Expended materials pose a low potential for ingestion of chaff and/or flare plastic end caps, parachutes, marine markers, or pistons. A low potential exists for entanglement of sea turtles with expended materials such as parachutes, flex hoses, or guide wires. Under Alternative 1 and Alternative 2 impacts would be the same as the No Action Alternative. The Navy has determined that MIRC training may affect sea turtles; therefore, as per Section 7(a)(2) of the ESA, the Navy is consulting with the USFWS for potential effects to nesting sea turtles within the MIRC. Similarly, the Navy is also consulting with NMFS for potential effects to sea turtles in the marine environment.	

Table ES-3: Summary of Environmental Impacts (Continued)

Resource Category	Alternative	National Environmental Policy Act (Land and Territorial Waters, <12 nm)	Executive Order 12114 (Non-Territorial Waters, >12 nm)
Section 3.9 **Fish and Essential Fish Habitat**	No Action Alternative, Alternative 1, or Alternative 2	Under the No Action Alternative, Alternative 1, or Alternative 2, vessel movements, amphibious landings, weapons firing/non-explosive ordnance use, and underwater detonations and explosive ordnance would result in short-term and localized disturbance to the water column. Limited injury or mortality to fish eggs and larvae would be expected. No long-term population-level effects or reduction in the quality and/or quantity of essential fish habitat would be expected. No impacts are anticipated as a result of the use of sonar. Species of Concern may be subject to temporary behavioral changes (such as swimming away from detonation) within Apra Harbor. Expended materials may result in long-term, minor, and localized accumulation of expended materials in benthic habitat. There is a limited potential for ingestion although no long-term population-level effects or reduction in the quality and/or quantity of essential fish habitat is expected.	Impacts would be similar to those described for the No Action Alternative, Alternative 1, and Alternative 2 for territorial waters. The impacts for amphibious landings are not applicable to non-territorial waters as they occur exclusively within territorial waters. The Species of Concern discussed in this section are not expected to occur in non-territorial waters. No significant harm to fish populations or habitat.
Section 3.10 **Seabirds and Shorebirds**	No Action Alternative, Alternative 1, or Alternative 2	Under the No Action Alternative, Alternative 1, or Alternative 2, impacts to seabirds and shorebirds as a result of vessel movements, aircraft overflights, amphibious landings, weapons firing/non-explosive ordnance use, underwater detonations and explosive ordnance, and expended materials would be short-term behavioral responses and an extremely low potential for injury/mortality from collisions, primarily at night. No long-term population-level effects are anticipated. An increased danger to seabirds and shorebirds at FDM could occur, although under current conditions, no long-term population-level effects are anticipated.	Impacts would be similar to those described for the No Action Alternative, Alternative 1, and Alternative 2 for territorial waters. The impacts for amphibious landings are not applicable to non-territorial waters as they occur exclusively within territorial waters. No significant harm to seabirds and shorebirds.

Table ES-3: Summary of Environmental Impacts (Continued)

Resource Category	Alternative	National Environmental Policy Act (Land and Territorial Waters, <12 nm)	Executive Order 12114 (Non-Territorial Waters, >12 nm)
Section 3.11 **Terrestrial Species and Habitats**	No Action Alternative	The Navy is currently operating under the 1999 USFWS Biological Opinion for Training in the Marianas, and the USAF is operating under the 2007 Biological Opinion for the ISR/Strike Establishment at Andersen AFB. No significant impacts will result from continued training under the No Action Alternative.	EO 12114 is not applicable for the No Action Alternative.
	Alternative 1	The Navy is consulting with USFWS to avoid/reduce adverse effects associated with increased training under Alternative 1, as per Section 7(a)(2) of the ESA. No changes to vegetation that would alter vegetation community types will result from training activities; other wildlife resources will not be affected.	EO 12114 is not applicable for Alternative 1.
	Alternative 2	Impacts would be the same as those described under Alternative 1.	EO 12114 is not applicable for Alternative 2.
Section 3.12 **Land Use**	No Action Alternative, Alternative 1, or Alternative 2	Under the No Action Alternative, Alternative 1, or Alternative 2, there are no effects on land encroachment, land forms, or soil; transportation or utility systems; scenic quality of the offshore area; or real estate use or agreements.	EO 12114 is not applicable for the No Action Alternative, Alternative 1, or Alternative 2.
Section 3.13 **Cultural Resources**	No Action Alternative, Alternative 1, or Alternative 2	Under the No Action Alternative, Alternative 1, or Alternative 2, terrestrial archaeological sites are not substantially affected by current training activities. Buildings and structures are not substantially affected by current training activities. Compliance with existing protective measures in accordance with the Navy Memorandum of Agreement (MOA), Navy Programmatic Agreement (PA), and USAF MOA to avoid cultural resources substantially reduces effects from training activities. Impacts on submerged cultural resources will not occur.	Impacts on submerged cultural resources could occur.

Table ES-3: Summary of Environmental Impacts (Continued)

Resource Category	Alternative	National Environmental Policy Act (Land and Territorial Waters, <12 nm)	Executive Order 12114 (Non-Territorial Waters, >12 nm)
Section 3.14 **Transportation**	No Action Alternative, Alternative 1, or Alternative 2	Under the No Action Alternative, Alternative 1, or Alternative 2, the impacts are the same. The FAA has established SUA W-517, R-7201, and ATCAAs for military training activities. When military aircraft are conducting training activities that are not compatible with civilian activity, the military aircraft are confined to the SUA to prevent accidental contact. Hazardous air training activities are communicated to commercial airlines and general aviation by Notices to Airmen (NOTAMs), published by the FAA. There are no additional impacts on the FAA's capabilities, no expected decrease in aviation safety, and no adverse effect on commercial or general aviation activities. Military use of the offshore ocean is also compatible with civilian use. Where naval vessels are conducting training activities that are not compatible with other uses, such as weapons firing, they are confined to surface areas and SUA away from shipping lanes and other recreational use areas. Hazardous marine training activities are communicated to all vessels and operators by Notices to Mariners (NOTMARs), published by the USCG.	Impacts would be similar to those described for the No Action Alternative, Alternative 1, and Alternative 2 for territorial waters.
Section 3.15 **Demographics**	No Action Alternative, Alternative 1, or Alternative 2	Implementation of No Action Alternative, Alternative 1, or Alternative 2 would not result in substantial shifts in population trends, or adversely affect regional spending and earning patterns; therefore, they would not result in significant impacts.	Impacts would be similar to those described for the No Action Alternative, Alternative 1, and Alternative 2 for territorial waters. The impacts to recreational and commercial fishing will not adversely affect regional spending and earning patterns; therefore, they would not result in any impacts in non-territorial waters.

Table ES-3: Summary of Environmental Impacts (Continued)

Resource Category	Alternative	National Environmental Policy Act (Land and Territorial Waters, <12 nm)	Executive Order 12114 (Non-Territorial Waters, >12 nm)
Section 3.16 **Regional Economy**	No Action Alternative, Alternative 1, or Alternative 2	Implementation of the No Action Alternative, Alternative 1, or Alternative 2 would not result in impacts to industry, commercial fishing, fishing gear use, tourism, or recreational and subsistence fishing in the Study Area as training activities in existing ranges and training areas and the increase in training activities and modernization of existing ranges and training areas proposed in Alternative 1 and Alternative 2 will not directly impact the resources in the Study Area.	Industry – The analysis of industry is not applicable to the non-U.S. territorial waters. The impacts to commercial fisheries, fishing gear, tourism, and recreational and subsistence fishing are similar to those for the territorial waters.
Section 3.17 **Recreation**	No Action Alternative, Alternative 1, or Alternative 2	Military activity in territorial waters would have no significant impact on recreational activities under the No Action Alternative, Alternative 1, or Alternative 2.	Military activity in non-territorial waters would not cause significant harm to recreational activities under the No Action Alternative, Alternative 1, or Alternative 2.
Section 3.18 **Environmental Justice and Protection of Children**	No Action Alternative, Alternative 1, or Alternative 2	Implementation of No Action Alternative, Alternative 1, or Alternative 2 would have no impact on the minority populations or protection of children within the Study Area.	Implementation of No Action Alternative, Alternative 1, or Alternative 2 would have no impact on the minority population or protection of children within the Study Area.
Section 3.19 **Public Health and Safety**	No Action Alternative, Alternative 1, or Alternative 2	Under the No Action Alternative, Alternative 1, or Alternative 2, only minor impacts to public health and safety would occur from current training activities. Impacts are reduced by access restrictions to land-based and nearshore training areas and prior notification (where appropriate) during training events. Implementation of applicable safety procedures further reduces potential impacts to public health and safety.	Under the No Action Alternative, Alternative 1, or Alternative 2 there would be no long-term harm to public health and safety in the global commons. Implementation of safety procedures would reduce impacts to public health and safety in the global commons.

ES 7 MITIGATION MEASURES

The Services are committed to demonstrating environmental stewardship while executing their national defense mission and providing compliance with a suite of Federal environmental and natural resources laws and regulations that apply to a wide variety of environments. Consistent with the Service's cooperating agency agreement with the NMFS, mitigation and monitoring measures presented in this EIS/OEIS focus on protecting and managing marine resources.

ES 8 CUMULATIVE IMPACTS

The approach taken for analysis of cumulative impacts (or cumulative effects) follows the objectives of NEPA of 1969, CEQ regulations, and CEQ guidance. CEQ regulations (40 C.F.R. §§ 1500-1508) provide the implementing procedures for NEPA. The regulations define cumulative effects as:

> “. . . the impact on the environment which results from the incremental impact of the action when added to the 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 C.F.R. 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 principle 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, “[it] 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.”

Geographic boundaries for analyses of cumulative impacts in this 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 or alternatives 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. The training area venues within the MIRC Study Area (Figures ES-1 through ES-12) are the appropriate geographical area for assessing cumulative impacts. For all other ocean resources, the ocean ecosystem of the marine waters off Mariana Islands is the appropriate geographic area for analysis of cumulative impacts.

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 need not list or analyze the effect of individual past actions; cumulative impacts analysis appropriately focuses on aggregate effects of past actions. Reasonably foreseeable future actions that may have impacts additive to the effects of the Proposed Action also are to be analyzed.

ES 9 OTHER CONSIDERATIONS

ES 9.1 POSSIBLE CONFLICTS WITH OBJECTIVES OF FEDERAL, STATE, AND LOCAL PLANS, POLICIES, AND CONTROLS

Based on evaluation with respect to consistency and statutory obligations, the Navy's Proposed Action and Alternatives for the MIRC EIS/OEIS does not conflict with the objectives or requirements of Federal, state, regional, or local plans, policies, or legal requirements. Table 4-1 provides a summary of environmental compliance requirements that may apply.

ES 9.2 RELATIONSHIP BETWEEN SHORT-TERM USE OF MAN'S ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

NEPA requires analysis of the relationship between a project's short-term impacts on the environment and the effects that those 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.

With respect to marine mammals, the Services, in partnership with the NMFS, are committed to furthering understanding of these creatures and developing ways to lessen or eliminate the impacts DoD training activities may have on these animals.

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 general welfare of the public. The Services are committed to sustainable range management, including co-use of the MIRC with general public and commercial interests. This commitment to co-use will enhance long-term productivity of the range areas surrounding the MIRC.

ES 9.3 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." Irreversible and irretrievable resource commitments are related to the use of nonrenewable 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).

For the alternatives, including the Proposed Action, most resource commitments are neither irreversible nor irretrievable. Most impacts are short-term and temporary, or long lasting but negligible. There will be no adverse effect on historic properties. No habitat associated with threatened or endangered species would be lost as result of implementation of the Proposed Action. Since there would be no building or facility construction, the consumption of materials typically associated with such construction (e.g., concrete, metal, sand, fuel) would not occur, though in the upgrade and maintenance of ranges, there would be consumption of some of those materials. 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 to what is currently experienced, 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 irretrievably lost.

ES 9.4 ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL OF ALTERNATIVES AND MITIGATION MEASURES

Increased training and testing activities on the MIRC 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 MIRC, 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 events. The use of energy sources has been minimized wherever possible without compromising safety, training, or testing activities.

At the present time, the Services, under the direction of the Energy Policy Act (EPAct) of 1992 and EO 13149, is actively testing and introducing several different types of alternate fuels (bio-diesel B100/B20, clean natural gas, fuel ethanol E85, fuel cells, etc.) to further reduce the impacts of its activities on the environment and nonrenewable resources.

ES 9.5 NATURAL OR DEPLETABLE RESOURCE REQUIREMENTS AND CONSERVATION POTENTIAL OF VARIOUS ALTERNATIVES AND MITIGATION MEASURES

Resources that would 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 they decrease the use of fossil fuels. In addition, repair and upgrade of ranges related to increased training and testing events in the MIRC Study Area would result in the irretrievable commitment of nonrenewable energy resources, primarily in the form of fossil fuels (including fuel oil), natural gas, and gasoline construction equipment. With respect to training activities, compliance with all applicable building codes, as well as project mitigation measures, would ensure that all natural resources are conserved or recycled to the maximum extent feasible. It is also possible that new technologies or systems would emerge, or would become more cost effective or user-friendly, which would further reduce reliance on nonrenewable natural resources. However, even with implementation of conservation measures, consumption of natural resources would generally increase with implementation of the alternatives.

Aircraft operations within the MIRC airspace are the single largest airborne noise source. Noise levels in excess of 90 decibels can occur. Protective measures (structural attenuation features) are in place. Sustainable range management practices are in place that protect and conserve natural and cultural resources as well as preserve access to training areas for current and future training requirements, while addressing potential encroachments that threaten to impact range capabilities.

ES 9.6 URBAN QUALITY, HISTORIC AND CULTURAL RESOURCES, AND THE DESIGN OF THE BUILT ENVIRONMENT

There are no urban areas under consideration in this EIS/OEIS and therefore no urban quality issues exist. Likewise, there is no new construction being proposed, only minor repair and upgrade to existing facilities. Terrestrial archaeological sites, buildings, or structures are not substantially affected by current training activities and an increase in training exercises would not substantially affect cultural resources if avoidance conditions and stipulations are followed.

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 Services are committed to sustainable range management, including co-use of the MIRC Study Area with the general public and commercial interests to the extent practicable and consistent with accomplishment of the Military mission and in compliance with applicable law. This commitment to co-use enhances the long-term productivity of the range areas surrounding the MIRC.

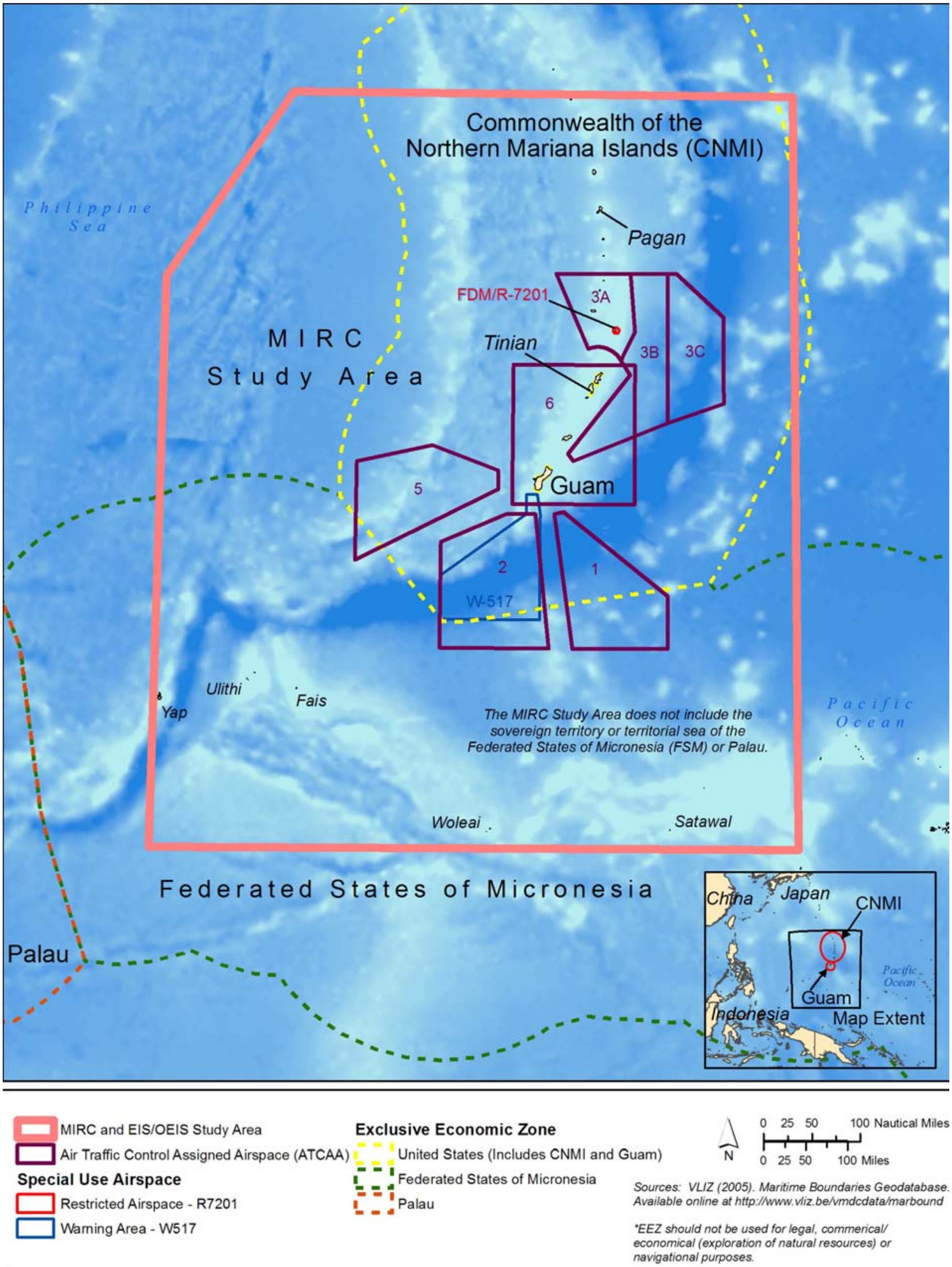
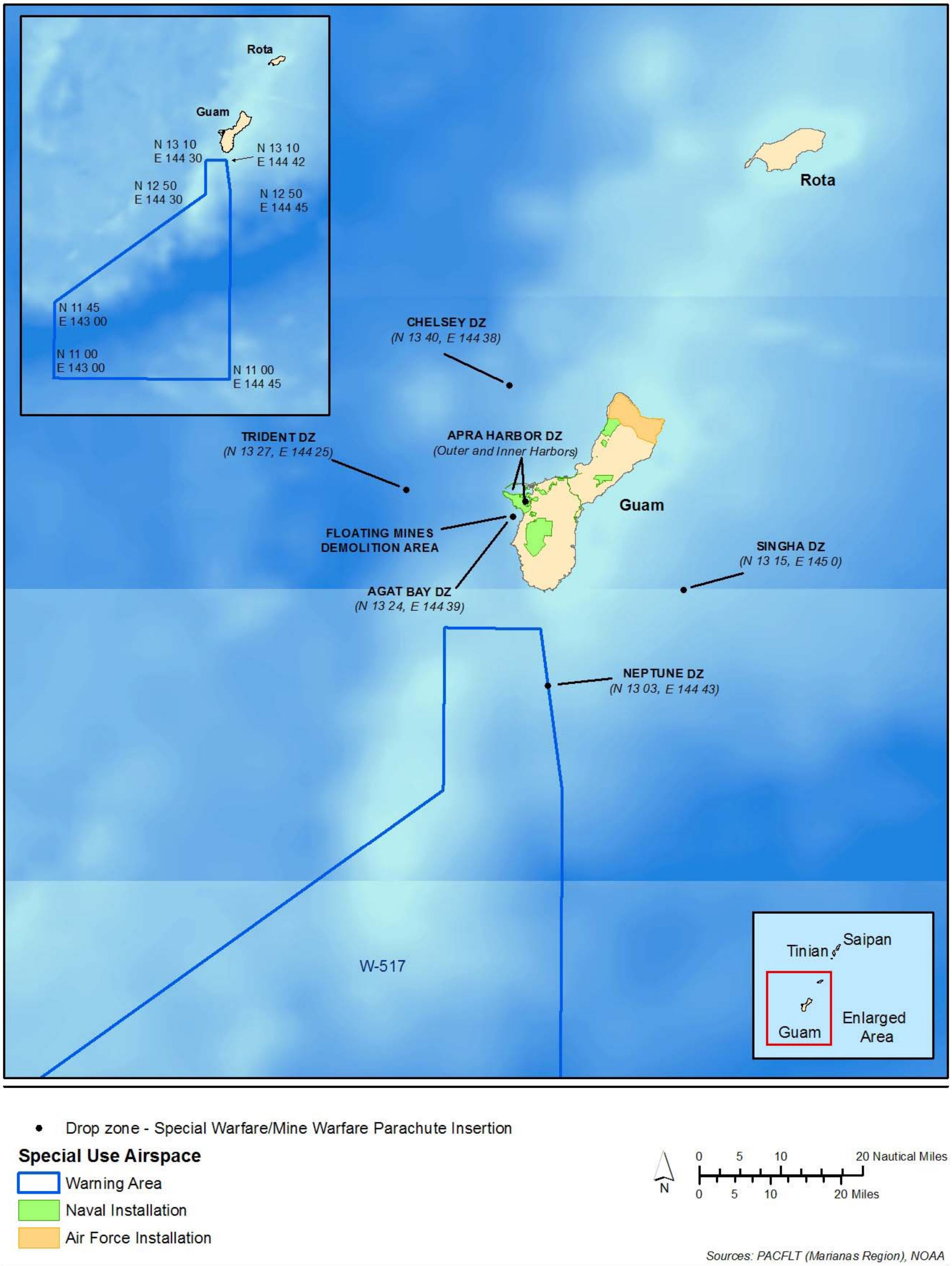
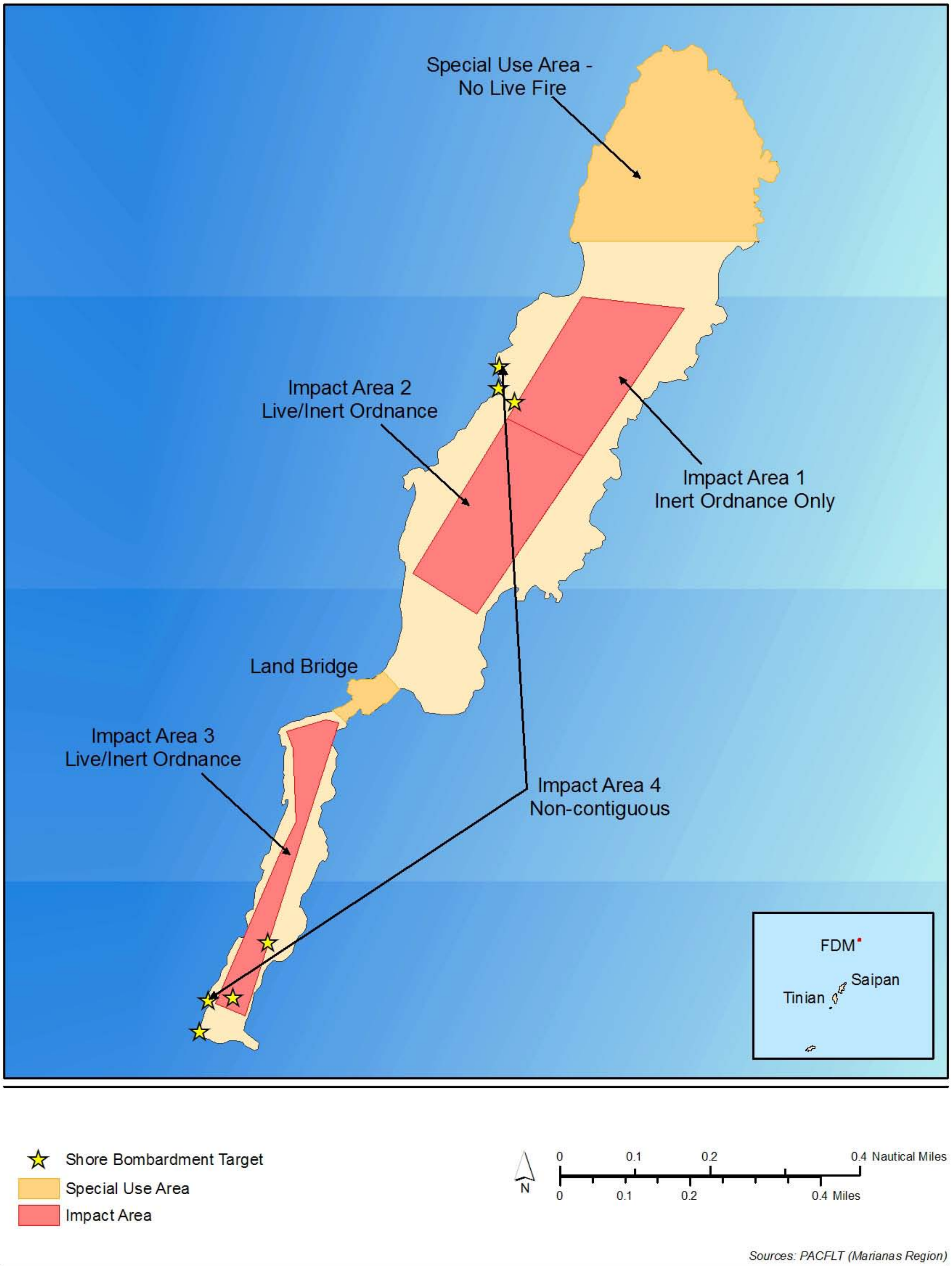


Figure ES-1: Mariana Islands Range Complex and EIS/OEIS Study Area



Source: ManTech-SRS

Figure ES-2: W-517 Aerial Training Area



Source: ManTech-SRS

Figure ES-3: Farallon de Medinilla (FDM)

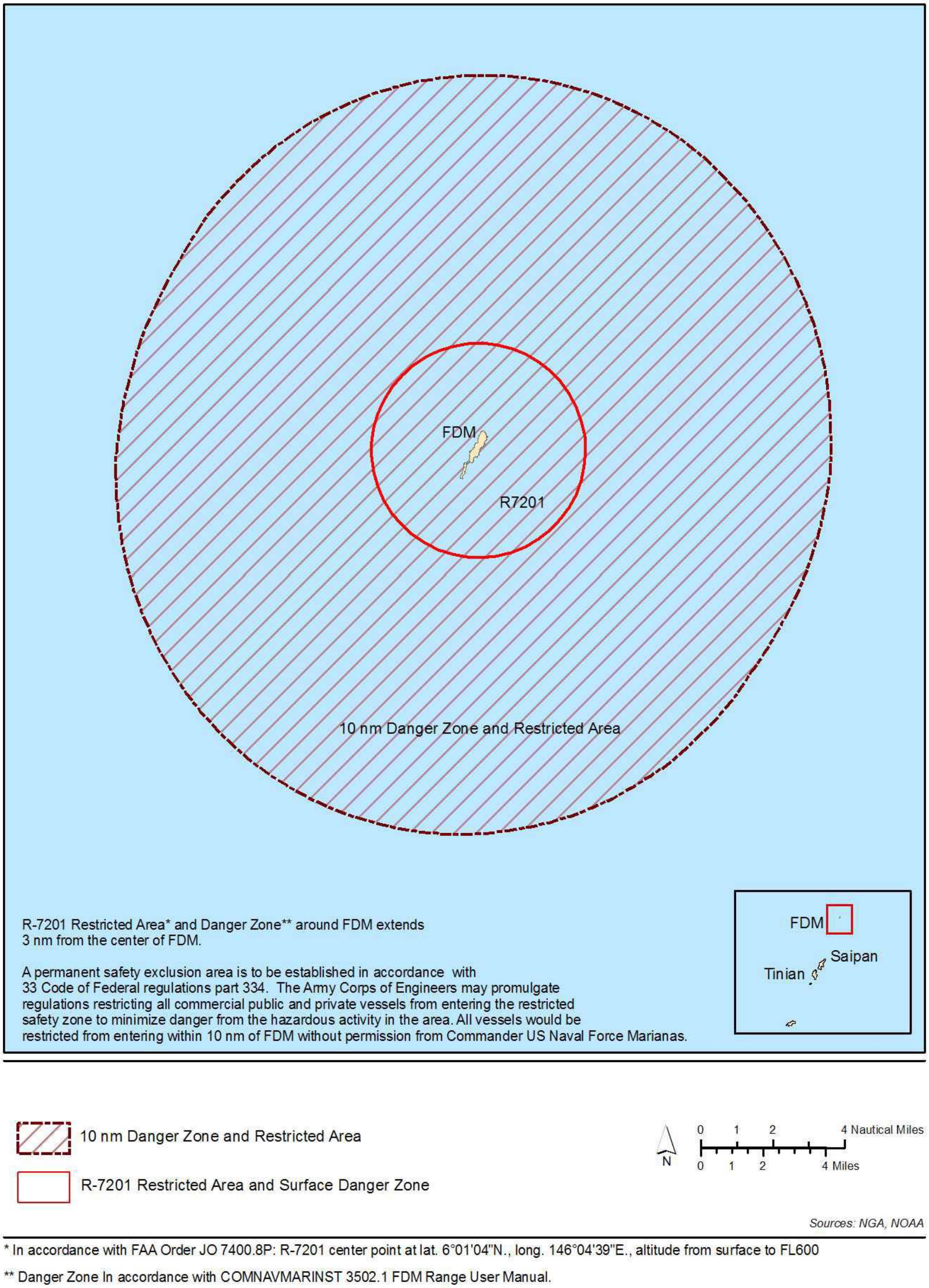
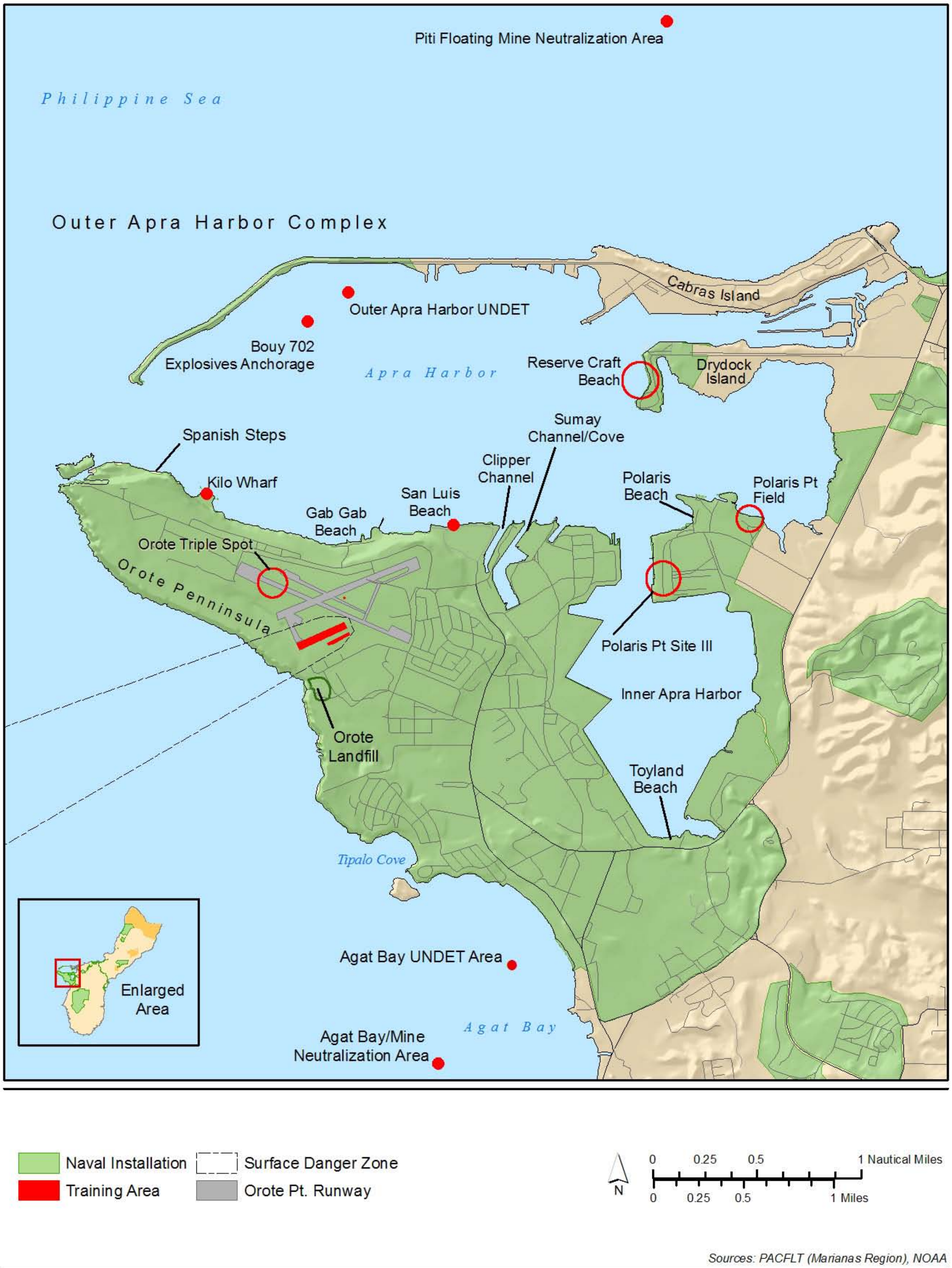
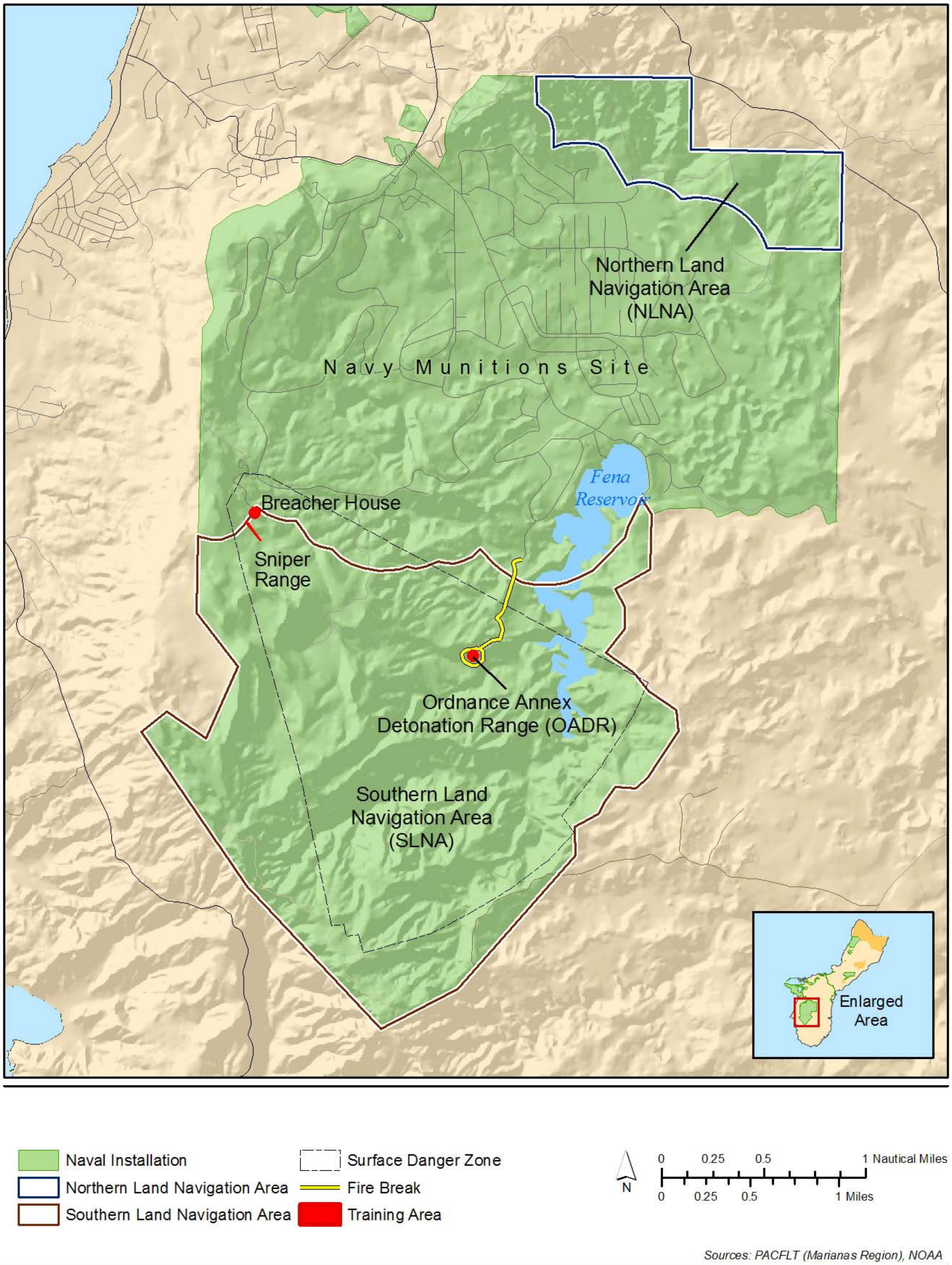


Figure ES-4: Farallon de Medinilla (FDM) 10 nm Safety Restricted Area and Danger Zone



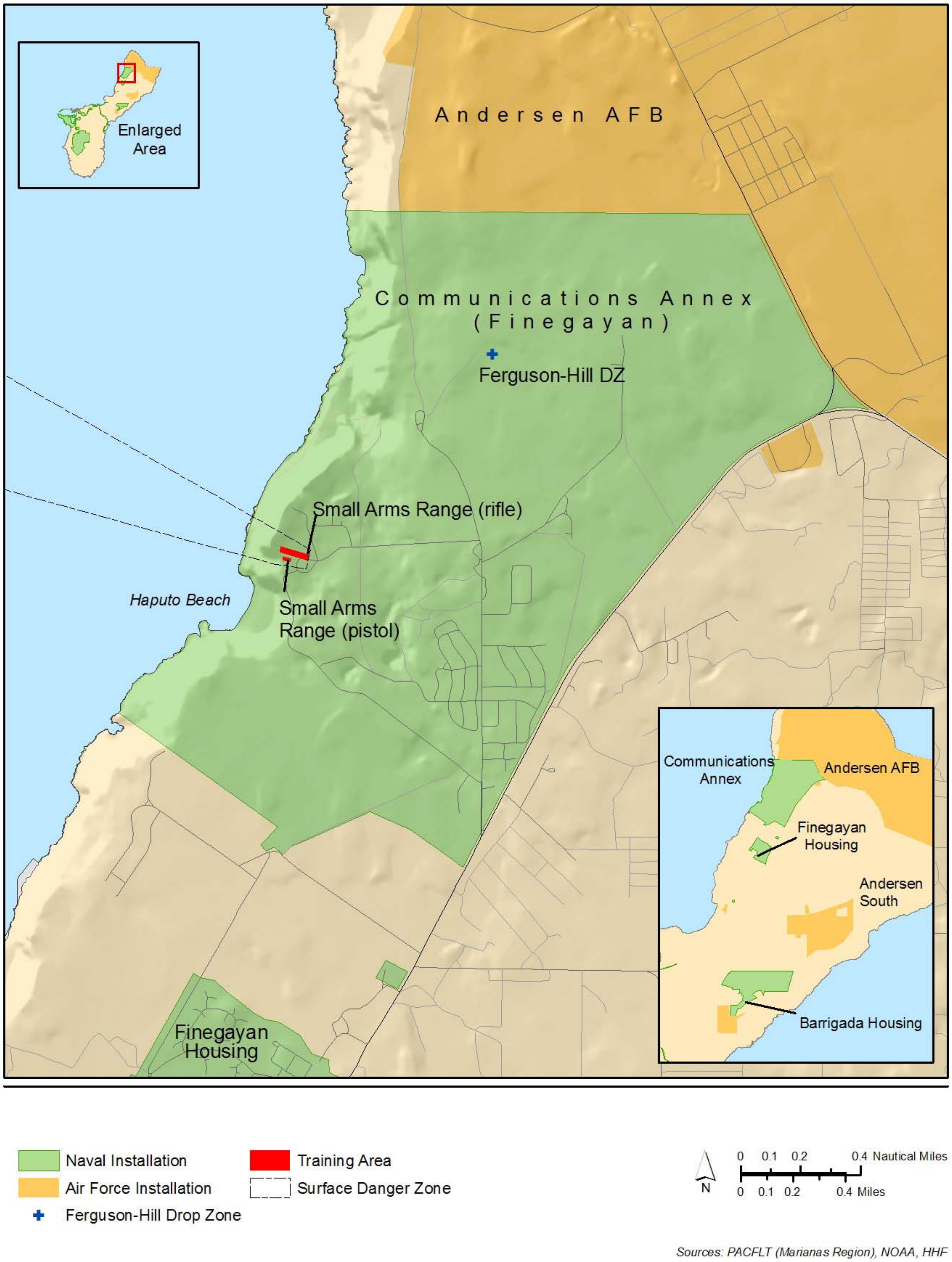
Source: ManTech-SRS

Figure ES-5: Apra Harbor and Nearshore Training Areas



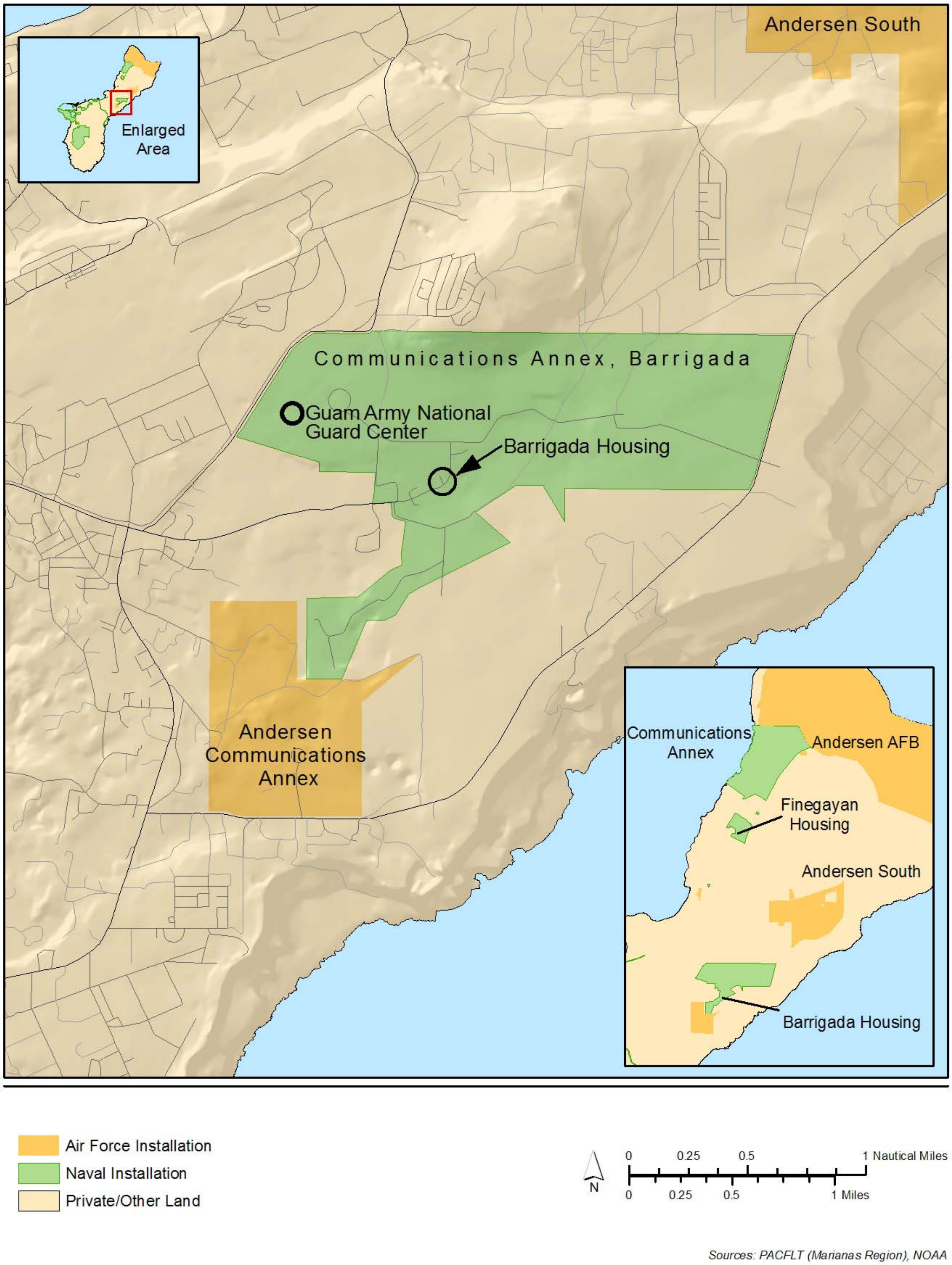
Source: ManTech-SRS

Figure ES-6: Ordnance Annex Training Areas



Source: ManTech-SRS

Figure ES-7: Finegayan Communications Annex Training Areas



Source: ManTech-SRS

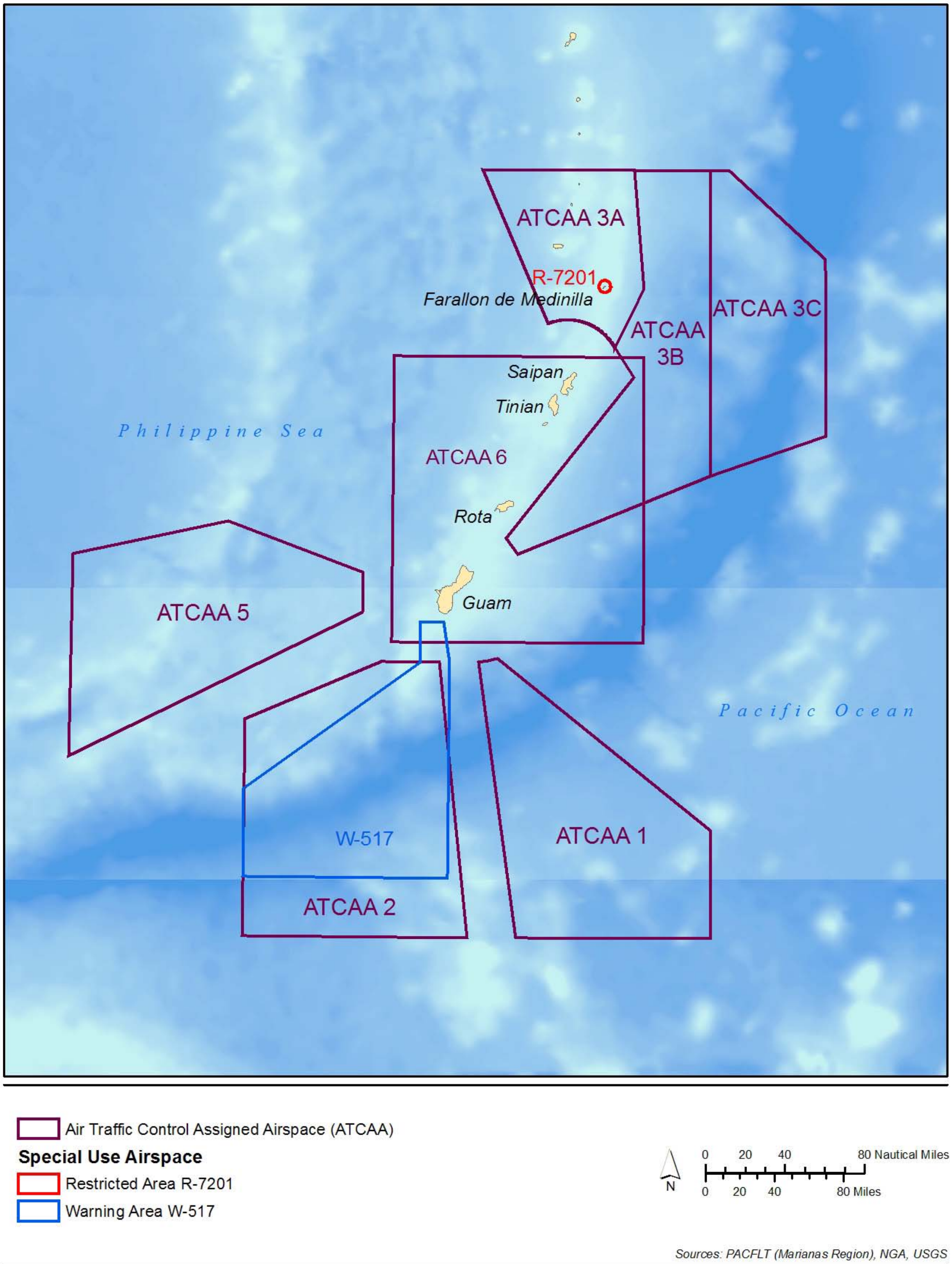
Figure ES-8: Communications Annex, Barrigada

Source: ManTech-SRS

Figure ES-9: Tinian Training Land Use and Saipan

Source: ManTech-SRS

Figure ES-10: Andersen Air Force Base Assets



Source: ManTech-SRS

Figure ES-11: MIRC ATCAAs

Source: ManTech-SRS

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Acronyms and Abbreviations

µg/L	micrograms per liter
µm	micrometers
µg/m^3	micrograms per cubic meter
µPa^2-s	squared micropascal-second
µPa	micropascal
A-	Alert Area
A-A	Air-to-Air
A-G	Air-to-Ground
A-S	Air-to-Surface
AFB	Air Force Base
AAFB	Andersen Air Force Base
AAMEX	Air-to-Air Missile Exercise
AAV	Amphibious Assault Vehicle
AAW	Anti-Air Warfare
ABR	Auditory Brainstem Response
ACHP	Advisory Council on Historic Preservation
ACM	Air Combat Maneuvers
ADAR	Air Deployed Active Receiver
ADC	Acoustic Device Countermeasure
ADV	SEAL Delivery Vehicle
AEER	Advanced Extended Echo Ranging
AEP	Auditory Evoked Potentials
AESA	Airborne Electronically Scanned Array
AFAST	Atlantic Fleet Active Sonar Training
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
AFI	Air Force Instruction
AGE	Aerospace Ground Equipment
AGL	Above Ground Level
AICUZ	Air Installations Compatible Use Zones
AIM	Air Intercept Missile
AK	Alaska
AMRAAM	Advanced Medium-Range Air-to-Air Missile
AMSP	Advanced Multi-Static Processing Program
AMW	Amphibious Warfare
ANNUALEX	Annual Exercise
AOR	area of responsibility
APCD	Air Pollution Control District
APZ	Accident Potential Zones
AQCR	Air Quality Control Region
AR	Army Reserves
AR-Marianas	Army Reserves Marianas
Army	U.S. Army
ARPA	Archaeological Resources Protection Act
ARS	Advance Ranging Source
ARTCC	Air Route Traffic Control Center
AS	Assault Support
ASDS	Advanced SEAL Delivery System
ASL	Above Sea Level
ASTA	Andersen South Training Area
ASTM	American Society for Testing and Materials
ASUW	Anti-Surface Warfare
ASW	Anti-Submarine Warfare
AT	Anti-Terrorism
AT/FP	Anti-Terrorism/Force Protection
ATC	Air Traffic Control
ATCAA	Air Traffic Control Assigned Airspace
atm	atmosphere (pressure)
ATOC	Acoustic Thermometry of Ocean Climate
ATSDR	Agency for Toxic Substances and Disease Registry
AUPM	Above & Underground Storage Tanks and Pesticide Management
AUTEC	Atlantic Undersea Test and Evaluation Center
AV-8B	Vertical/Short Takeoff and Landing Strike Aircraft
AW	Air Warfare
B-1	Strategic Bomber
B-2	Stealth Bomber
B-52	Strategic Bomber
BA	Biological Assessment
BAMS	Broad Area Maritime Surveillance
BASH	Bird Aircraft Strike Hazard
BDA	Battle-Damage Assessment
BDU	Bomb Dummy Unit
BMDTF	Ballistic Missile Defense Task Force
BMP	Best Management Practices
BO	Biological Opinion
BOMBEX	Bombing Exercise
BQM	Aerial Target Drone Designation
BRAC	Base Realignment and Closure
BSP	Bureau of Statistics and Plans
BSS	Beaufort Sea State
BZO	Battle Sight Zero
°C	degrees Centigrade
C2	Command and Control
C-4	Composition 4
C-130	Military Transport Aircraft
CA	California
CAA	Clean Air Act
CAL	Confined Area Landing
CAN	Center for Naval Analysis
CAS	Close Air Support
CASS	Comprehensive Acoustic System Simulation
CASS-GRAB	Comprehensive Acoustic System Simulation Gaussian Ray Bundle
CATM	Combat Arms and Training Maintenance
cc	cubic centimeter(s)
CCD	Carbonate Compensation Depth
CCF	Combined Control Facility
CDS	Container Delivery System
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CG	Cruiser
CHAFFEX/FLAREX	Chaff/Flare Exercise
CHESS	Chase Encirclement Stress Studies
CI	Confidence Interval
CIP	Capital Improvements Program
CITES	Convention on International Trade In Endangered Species
CIWS	Close-in Weapons System
cm	centimeters
CMC	Northern Mariana Islands Commonwealth Code
CMP	Coastal Management Plan
CNEL	Community Noise Equivalent Level
CNO	Chief of Naval Operations

CNRM Commander, Navy Region Marianas
CNMI Commonwealth of the Northern Mariana Islands
CO Carbon Monoxide
CO_2 Carbon Dioxide
COMNAVREG Commander, Navy Region Marianas
COMNAVMAR Commander, United States Naval Forces Marianas
COMPACFLT Commander, Pacific Fleet
COMPTUEX Composite Training Unit Exercise
COMSUBPAC Commander, Submarine Forces Pacific
CONEX Container Express (Shipping Container)
CONUS Continental United States
CPF Commander, U.S. Pacific Fleet
CPRW Commander, Patrol and Reconnaissance Wing
CPX Command Post Exercise
CQC Close Quarters Combat
CR Control Regulation
CRE FMP Coral Reef Ecosystem Fishery Management Plan
CRG Contingency Response Group
CRM Coastal Resources Management
CRRC Combat Rubber Raiding Craft
CRU Cruiser
CSAR Combat Search and Rescue
CSG Carrier Strike Group
CSS Commander, Submarine Squadron
CT Computerized Tomography
CTF Cable Termination Facility
CUC Commonwealth Utilities Corporation
CV Coefficients of Variation
CVN Aircraft Carrier, Nuclear
CW Continuous Wave
CWA Clean Water Act
CY Calendar Year
CZ Clear Zones
CZMA Coastal Zone Management Act
DARPA Defense Advanced Research Programs Agency
DAWR Division of Aquatic and Wildlife Resources
dB Decibel
dBA A-Weighted Sound Level
DBDBV Digital Bathymetry Data Base Variable
DDG Guided Missile Destroyer
DDT Dichlorodiphenyltrichloroethane
DES Destroyer
DESRON Destroyer Squadron
DEQ Department of Environmental Quality
DFW CNMI Division of Fish and Wildlife
DICASS Directional Command Activated Sonobuoy System
DLCD Department of Land Conservation and Development
DNL Day-Night Average A-Weighted Sound Level
DNT Dinitrotoluene
DoD Department of Defense
DoD REP DoD Representative Guam, Commonwealth of Northern Mariana Islands, Federated States of Micronesia and Republic of Palau
DoN Department of Navy
DPW Department of Public Works
DTR Demolition Training Range
DZ Drop Zone
EA-6 Electronic Attack Aircraft
EA-18 Electronic Warfare Aircraft
EA Electronic Attack
EA Environmental Assessment
EAC Early Action Compact
EC Electronic Combat
EC OPS Chaff and Electronic Combat
ECSWTR East Coast Shallow-Water Training Range
EER Extended Echo Ranging
EEZ Exclusive Economic Zone
EFD Energy Flux Density
EFH Essential Fish Habitat
EFSEC Energy Facility Site Evaluation Council
EGTTR Eglin Gulf Test and Training Range
EIS Environmental Impact Statement
EL Sound Energy Flux Density Level
EMATT Expendable Mobile ASW Training Target
EMR Electromagnetic Radiation
EMUA Exclusive Military Use Area
ENP Eastern North Pacific
ENSO El Niño/Southern Oscillation
EO Executive Order
EOD Explosive Ordnance Disposal
EODMU Explosive Ordnance Disposal Mobile Unit
EPA Environmental Protection Agency
EPAct Energy Policy Act
EPCRA Emergency Planning and Community Right to Know Act
ER Extended Range
ES Electronic Support
ESA Endangered Species Act
ESG Expeditionary Strike Group
ESGEX Expeditionary Strike Group Exercise
ESQD Explosive Safety Quantity Distance
ET Electronically Timed
ETP Eastern Tropical Pacific
EW Electronic Warfare
EX Exercise
EXTORP Exercise Torpedo
°F degrees Fahrenheit
FA-18 Flight/Attack Strike Fighter
FAA Federal Aviation Administration
FAC Forward Air Control
FACSFAC Fleet Area Control and Surveillance Facility
FAD Fish Aggregating Devices
FAST Floating At-Sea Target
FAST Fleet Anti-Terrorism Security Team
FCLP Field Carrier Landing Practice
FDM Farallon de Medinilla
FDNF Forward Deployed Naval Forces
FEA Final Environmental Assessment
FEIS Final Environmental Impact Statement
FEMA Federal Emergency Management Agency
FFG Frigate
FHA Federal Housing Administration
FICUN Federal Interagency Committee On Urban Noise
FIP Federal Implementation Plan
FIREX Fire Support
FIRP Flood Insurance Rate Map
FISC Fleet and Industrial Supply Center
FHA Federal Housing Administration
FL Flight Level

FM	Frequency Modulated
FMC	Fishery Management Council
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impact
FP	Force Protection
FP	fibropapillomatosis
FR	Federal Register
FRP	Facility Response Plan
FRTP	Fleet Response Training Plan
FSAR	Finegayan Small Arms Ranges
FSM	Federated States of Micronesia
ft	feet
ft^2	square feet
FTX	Field Training Exercise
FUTR	Fixed Underwater Tracking Range
FY	Fiscal Year
FY04 NDAA	National Defense Authorization Act For Fiscal Year 2004
g	gram
GBU	Guided Bomb Unit
GCA	Guam Code Annotated
GCA	Ground Controlled Approach
GCE	Ground Combat Element
GCMP	Guam Coastal Management Plan
GDEM	Generalized Digital Environmental Model
GDP	Gross Domestic Product
GEPA	Guam Environmental Protection Agency
GIAA	Guam International Airport Authority
GIAT	Guam International Air Terminal
GJMMP	Guam Joint Military Master Plan
GLUP	Guam Land Use Plan
GNWR	Guam National Wildlife Refuge
GovGuam	Government of Guam
GUANG	Guam Air National Guard
GUARNG	Guam Army National Guard
GUNEX	Gunnery Exercise
GVB	Guam Visitors Bureau
HABS	Historic American Building Survey
HADR	Humanitarian and Disaster Relief
HAER	Historic American Engineering Record
HAPC	Habitat Areas of Particular Concern
HARM	High Speed Anti-radiation Missile
HC	Helicopter Coordinator
HC(A)	Helicopter Coordinator (Airborne)
HCN	Hydrogen Cyanide
HE	High Explosive
HELO	Helicopter
HFA	High-Frequency Active
HFBL	High-Frequency Bottom Loss
HH	Helicopter Designation (Typically Search/Rescue/Medical Evacuation))
HMMWV	High Mobility Multipurpose Wheeled Vehicle
HMX	High Melting Explosive
HPA	Hypothalamic-pituitary-adrenal
HPO	Historic Preservation Officer
hr	hour
HRST	Helicopter Rope Suspension Training
HSC	Helicopter Sea Combat
HSWA	Hazardous and Solid Waste Act
HUD	Department of Housing and Urban Development
Hz	hertz
IAH	Inner Apra Harbor
IBB	International Broadcasting Bureau
ICAP	Improved Capability
ICMP	Integrated Comprehensive Monitoring Program
ICRMP	Integrated Cultural Resource Management Plan
ICWC	International Whaling Commission
IED	Improvised Explosive Device
IEER	Improved Extended Echo Ranging
IFR	Instrument Flight Rules
IHA	Incidental Harassment Authorization
III MEF	Third Marine Expeditionary Force
in.	inch
in^3	cubic inch
INRMP	Integrated Natural Resource Management Plan
IOC	Initial Operating Capability
IP	Implementation Plan
IR	infrared
ISR	Intelligence, Surveillance, and Reconnaissance
ISR/Strike	Intelligence, Surveillance, and Reconnaissance/Strike
IUCN	The World Conservation Union
IWC	International Whaling Commission
JDAM	Joint Direct Attack Munition
JFCOM	Joint Forces Command
JGPO	Joint Guam Program Office
JLOTS	Joint Logistics over the shore
JNTC	Joint National Training Capability
JSOW	Joint Stand-Off Weapon
JTFEX	Joint Task Force Exercise
JUCAS	Joint Unmanned Combat Air System
KD	Known Distance
KE	Kinetic Energy
kg	kilogram
kHz	kilohertz
km	kilometer
km^2	square kilometer
kts	knots
LAV	Light Armored Vehicle
lb	pound
LBA	Lease Back Area
LCAC	Landing Craft Air Cushion
LCE	Logistics Combat Element
LCS	Littoral Combat Ship
LCU	Landing Craft Utility
LFA	Low-Frequency Active
LFBL	Low-Frequency Bottom Loss
L_{eq}	Equivalent Sound Level
LHA	Amphibious Assault Ship
LHD	Amphibious Assault Ship
L_{max}	Maximum Sound Level
LGB	Laser Guided Bomb
LGTR	Laser Guided Training Round
LMRS	Long-Term Mine Reconnaissance System
ln	natural log
LOA	Letter of Agreement
LOA	Letter of Authorization
LPD	Amphibious Transport Dock
LSD	Amphibious Assault Ship
LZ	Landing Zone
m	meters
m^2	square meters
m^3	cubic meters

M-4	Assault Rifle
M-16	Assault Rifle
M-203	40 mm Grenade Launcher
M-240G	Medium Machine Gun
M-249 SAW	Light Machine Gun, Squad Automatic Weapon
MAGTF	Marine Air Ground Task Force
MARPOL 73/78	Marine Pollution Convention ‘73, modified in ‘78
MAW	Marine Air Wing
MBTA	Migratory Bird Treaty Act
MCM	Mine Countermeasure
MCMEX	Mine Exercise
MEDEVAC	Medical Evacuation
MEF	Marine Expeditionary Force
MEMC	Military Expended Material Constituent
METOC	Meteorological and Oceanographic Operations
MEU	Marine Expeditionary Unit
MFA	Mid-Frequency Active
MFAS	Medium-Frequency Active Sonar
MG	Machine Gun
mgd	million gallons per day
mg/L	milligrams per liter
MH	Helicopter Designation (Typically Multi-mission)
MHWM	Mean High Water Mark
mi.	miles
mi^2	square miles
MI	Maritime Interdiction
min	minutes
MINEX	Mine Laying Exercise
MIO	Maritime Interception Operation
MIRC	Mariana Islands Range Complex
MISSILEX	Missile Exercise
MISTCS	The Mariana Islands Sea Turtle and Cetacean Survey
MIW	Mine Warfare
MLA	Military Lease Area
mm	millimeters
MMA	Multi-mission Maritime Aircraft
MMHSRA	Marine Mammal Health and Stranding Response Act
MMHSRP	Marine Mammal Health and Stranding Response Program
MMPA	Marine Mammal Protection Act
MMR	Military Munitions Rule
MOA	Military Operations Area
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MOUT	Military Operations in Urban Terrain
MPA	Maritime Patrol Aircraft
MPRSA	Marine Protection, Research, and Sanctuaries Act
MRA	Marine Resources Assessment
MRUUV	Mission Reconfigurable Unmanned Undersea Vehicle
MSA	Munitions Storage Area
MSE	Multiple Successive Explosions
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	Mean Sea Level
MSS	Mobile Security Squadron
MTH	Marianas Training Handbook
MVA	Marianas Visitors Authority
MWR	Morale, Welfare, and Recreation
NA	Not Applicable
NAAQS	National Ambient Air Quality Standards
NAS	Naval Air Station
NAS	National Academies of Science
NATO	North Atlantic Treaty Organization
NAVBASE	Naval Base
NAVFAC PAC	Naval Facilities Engineering Command Pacific
NAVMAG	Naval Magazine
NAVSTA	Naval Station
NAWQC	National Ambient Water Quality Criteria
NCA	National Command Authority
NCRD	No Cultural Resource Damage
NCTAMS	Naval Communications Area Master Station
NCTS	Naval Computers and Telecommunications Station
NDAA	National Defense Authorization Act
NDE	National Defense Exemption
NEC	North Equatorial Current
NECC	Navy Expeditionary Combat Command
NEO	Noncombatant Evacuation Operations
NEPA	National Environmental Policy Act
NEW	Net Explosive Weight
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NITTRSS	Navy Integrated Training and Test Range Strategic Study
NLNA	Northern Land Navigation Area
nm	nautical mile
nm^2	square nautical mile
NMFS	National Marine Fisheries Service
NMMTB	National Marine Mammal Tissue Bank
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NOTAM	Notice to Airmen
NOTMAR	Notice to Mariners
NPAL	North Pacific Acoustic Laboratory
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	National Research Council
NRFCC	National Recreational Fisheries Coordination Council
NRHP	National Register of Historic Places
NRIS	National Register Information System
NRL	Naval Research Laboratory
NS	Naval Station
NSCT	Naval Special Clearance Team
NSFS	Naval Surface Fire Support
NSR	New Source Review
NSW	Naval Special Warfare
NSWG	Naval Special Warfare Group
NSWU	Naval Special Warfare Unit

NT	No Training
NUWC	Naval Undersea Warfare Center
NVG	Night Vision Goggle
NWD	No Wildlife Disturbance
NWF	Northwest Field
NWR	National Wildlife Refuge
NZ	Noise Zones
O_3	Ozone
OABH	Ordnance Annex Breacher House
OAEDS	Ordnance Annex Emergency Detonation Site
OAH	Outer Apra Harbor
OAMCM	Organic Airborne Mine Countermeasure
OCE	Officer-In-Charge of the Exercise
OEA	Overseas Environmental Assessment
OEIS	Overseas Environmental Impact Statement
OLF	Outlying Landing Field
OP	Orote Point
OPA	Oil Pollution Act
OPAREA	Operating Area
OPCQC	Orote Point Close Quarters Combat
OPFOR	Opposition Forces
OPKDR	Orote Point Known Distance Range
OPNAV	Office of the Chief of Naval Operations
OPNAVINST	Chief of Naval Operations Instruction
OPS	Operations
OR	Oregon
ORMA	Ocean Resources Management Act
OSS	Operations Support Squadron
OTB	Over-the-Beach
OTH	Over the Horizon
Pa	Pascal
PA	Programmatic Agreement
Pa•s	Pascal•seconds
PACAF	Pacific Air Forces
PACFIRE	Pre-action Calibration Firing
PACOM	U.S. Pacific Command
PAG	Port Authority of Guam
PAH	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PCB	Polychlorinated Biphenyl
PETN	Pentaerythritol Tetranitrate
pH	Hydrogen Ion Concentration
PIFSC	Pacific Islands Fisheries Science Center
PIRO	Pacific Islands Regional Office
PL	Public Law
$PM_{2.5}$	Particulate Matter 2.5 Microns in Diameter
PM_{10}	Particulate Matter 10 Microns in Diameter
PMAR	Primary Mission Area
POL	Petroleum, Oils, and Lubricants
POW	Prisoner of War
PPA	Pollution Prevention Act
ppb	parts per billion
PPF	Polaris Point Field
ppm	parts per million
psf	pounds per square foot
psi	pounds per square inch
psi-ms	pounds per square inch - milliseconds
PTP	Pre-deployment Training Phase
PTS	Permanent Threshold Shift
PUTR	Portable Underwater Tracking Range
PWC	Public Works Center
PWSS	Public Water Supply Systems
QDR	Quadrennial Defense Review
R-	Restricted Area
R&S	Reconnaissance and Surveillance
RAICUZ	Range Air Installations Compatible Use Zones
RCA	Range Condition Assessment
RCB	Reserve Craft Beach
RCD	Required Capabilities Document
RCMP	Range Complex Management Plan
RCRA	Resource Conservation and Recovery Act
RDT&E	Research, Development, Test, and Evaluation
RDX	Royal Demolition Explosive
re 1 µPa-m	referenced to 1 micropascal at 1 meter
RED HORSE	Rapid Engineer Deployable Heavy Operational Repair Squadron Engineer
REXTORP	Recoverable Exercise Torpedo
RFRCP	Recreational Fisheries Resources Conservation Plan
RHA	Rivers and Harbors Act
RHIB	Rigid Hull Inflatable Boat
RICRMP	Regional Integrated Cultural Resources Management Plan
RIMPAC	Rim of the Pacific
RL	Received Level
rms	root mean square
RNM	Rotorcraft Noise Model
ROD	Record of Decision
ROWPU	Reverse Osmosis Water Purification Unit
RSIP	Regional Shore Infrastructure Plan
RSO	Range Safety Officer
S-A	Surface-to-Air
S-S	Surface-to-Surface
S&R	Surveillance and Reconnaissance
SACEX	Supporting Arms Coordination Exercise
SAM	Surface-to-Air Missile
SAMEX	Surface-to Air Missile Exercise
SAR	Search and Rescue
SARS	Severe Acute Respiratory Syndrome
SAW	Squad Automatic Weapon
SBU	Special Boat Unit
SCD	Silicate Compensation Depth
SCUBA	Self-Contained Underwater Breathing Apparatus
SD	Standard Deviation
SDV	SEAL Delivery Vehicle
SDWA	Safe Drinking Water Act
SEAD	Suppression of Enemy Air Defense
SEAL	Sea, Air, and Land Forces
sec	second
§	Section
SEIS	Supplemental Environmental Impact Statement
SEL	Sound Exposure Level
SEPA	State Environmental Policy Act
SFCP	Shore Fire Control Parties
SFS	Security Forces Squadron
SH	Helicopter Designation (Typically Anti-Submarine)
SHAREM	Ship ASW Readiness and Evaluation Measuring
SHPO	State Historic Preservation Officer
SINKEX	Sinking Exercise
SIP	State Implementation Plan

SLAM-ER	Stand-off Land Attack Missile - Extended Range
SLC	Submarine Learning Center
SLNA	Southern Land Navigation Area
SM	Standard Missile
SMA	Shoreline Management Act
SNS	Sympathetic Nervous System
SO_2	Sulfur Dioxide
SOCAL	Southern California
SOC	Special Operations Capable
SOCEX	Special Operations Capable Exercise
SOF	Special Operations Forces
SONAR	Sound Navigation and Ranging
SOP	Standard Operating Procedure
SPCC	Spill Prevention, Control, and Countermeasure
SPIE	Special Purpose Insertion and Extraction
SPL	Sound Pressure Level
SPMAGTF	Special Purpose Marine Air Ground Task Force
SPORTS	Sonar Positional Reporting System
sqrt	Square Root
SRBOC	Super Rapid Bloom Off-board Chaff
SRF	Ship Repair Facility
SRP	Scientific Research Program
SSBN	Ship, Submersible, Ballistic, Nuclear (Submarine)
SSC	SPAWAR Systems Center
SSG	Surface Strike Group
SSGN	Guided Missile Submarine
SSN	Fast Attack Submarine
SSN	Nuclear Submarine
STD	Standard
STOM	Ship to Objective Maneuver
STW	Strike Warfare
SUA	Special Use Airspace
SURC	Small Unit River Craft
SURTASS	Surveillance Towed-Array Sensor System
SUS	Signal Underwater Sound
SUW	Surface Warfare
SVP	Sound Velocity Profile
SWFSC	Southwest Fisheries Science Center
SWPPP	Storm Water Pollution Prevention Plans
T&E	Threatened and Endangered Species
TACP	Tactical Air Control Party
TALD	Tactical Air-Launched Decoy
TAP	Tactical Training Theater Assessment And Planning
TDU	Target Drone Unit
TGEX	Task Group Exercise
TM	Tympanic Membrane
TMDL	Total Maximum Daily Loads
TNT	Trinitrotoluene
TORPEX	Torpedo Exercise
TP	Training Projectile
TRACKEX	Tracking Exercise
TRUEX	Training in Urban Environment Exercise
TS	Threshold Shift
TSCA	Toxic Substances Control Act
TSPI	Time, Space, Position, Information
TSV	Training Support Vessel
TTS	Temporary Threshold Shift
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
UCRMP	Updated Cultural Resources Management Plan
UDP	Unit Deployment Program
UJTL	Universal Joint Task List
ULT	Unit-level Training
UME	Unusual Mortality Event
UN	United Nations
UNDET	Underwater Detonations
U.S.	United States
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USC	United States Code
USCG	United States Coast Guard
USCINCPAC REP	Commander In Chief, U.S. Pacific Command Representative
USCINCPAC REP GUAM/CNMI	Commander In Chief, U.S. Pacific Command Representative Guam and the Commonwealth of the Northern Mariana Islands
USDA	United States Department of Agriculture
USDA WS	United States Department of Agriculture Wildlife Services
USEPA	United States Environmental Protection Agency
USFF	United States Fleet Forces
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USGS – BRD	United States Geological Survey Biological Resources Division
USMC	United States Marine Corps
USNS	U.S.Naval Ship
USPACOM	United States Pacific Command
USWEX	Undersea Warfare Exercise
USWTR	Undersea Warfare Training Range
UTR	Underwater Tracking Range
UUV	Unmanned Underwater Vehicle
UXO	Unexploded Ordnance
V&VE	coastal flood hazard zones
VAST-IMPASS	Virtual At-Sea Training Integrated Maritime Portable Acoustic Scoring and Simulator
VBSS	Visit, Board, Search, and Seizure
VFR	Visual Flight Rules
VoA-IBB	Voice of America - International Broadcasting Bureau
VOC	Volatile Organic Compounds
VTNF	Variable Timed, Non-Fragmentation
VTOL	Vertical Takeoff and Landing
VTUAV	Vertical Take-off and Land UAV
W-	Warning Area
WestPac	Western Pacific
WISS	Weapons Impact Scoring System
WPRFMC	Western Pacific Regional Fisheries Management Council
WS	Wildlife Service
WWII	World War Two
ZOI	Zone of Influence

CHAPTER 1 PURPOSE AND NEED FOR THE PROPOSED ACTION

1.1 INTRODUCTION

The National Environmental Policy Act of 1969 (NEPA) (42 United States Code [U.S.C.] Section [§] 4321 *et seq.*); requires Federal agencies to examine the environmental effects of their proposed actions. An Environmental Impact Statement (EIS) is a detailed public document providing an assessment of the potential effects a Federal action might have on the human, natural, or cultural environment. On behalf of the Department of Defense Representative Guam, Commonwealth of the Northern Mariana Islands (CNMI), Federated States of Micronesia and Republic of Palau (DoD REP) the Navy is preparing this EIS/OEIS to assess the potential environmental effects associated with continuing and proposed military activities within the MIRC Study Area. The Navy is the lead agency for the EIS/OEIS because of its role as Executive Agent for management of the MIRC. The National Marine Fisheries Service (NMFS), the United States (U.S.) Department of the Interior (Office of Insular Affairs), the U.S. Department of Agriculture Wildlife Services (USDA WS), the Federal Aviation Administration (FAA), the U.S Army; the U.S. Marine Corps (USMC), the U.S. Air Force (USAF), and the U.S. Coast Guard (USCG) were invited as cooperating agencies. The NMFS, U.S. Department of Interior (Office of Insular Affairs), FAA, USMC, and USAF have accepted as cooperating agencies.

This Draft EIS/OEIS will analyze the training of U.S. military forces in the onshore, nearshore, and offshore areas in and adjacent to the islands of Guam and the CNMI. The MIRC consists of existing multiple training areas of land, sea space (nearshore and offshore), undersea space, and airspace (see Figure 1-1). The MIRC is further described and discussed in detail in Chapter 2.

Guam and the CNMI are political subdivisions of the United States. Guam was annexed to the United States as a result of the Treaty of Paris of 1898. Since that time, Guam has been administered as a territory of the United States. The CNMI, also a fully integrated political subdivision of the United States, was integrated into the United States as a result of *The Covenant to Establish a Commonwealth of the Northern Mariana Islands in Political Union with the United States of America*, approved and effective March 24, 1976. Though no territory within the sovereign states of FSM and the Republic of Palau are included within the MIRC Study Area[1] and range complex, the range complex does include international waters surrounding these countries. The two sovereign states share a special historical relationship with the United States as a result of the United Nations mandate placing them in trustee status with the United States in 1946. Subsequent to this relationship, both countries exercised their political right to form independent nations and entered into treaty relationships with the United States, commonly known as the Compacts of Freely Associated States. Said treaties provide for bilateral cooperation between the United States and the FSM and Republic of Palau, respectively.

Title 10 of the U.S. Code directs each of the U.S. Military Services (Services) to organize, train, and equip forces for combat. To fulfill their statutory missions, each of the Services needs combat-capable forces ready to deploy worldwide. U.S. military forces must have access to the ranges, operating areas (OPAREAs), and airspace needed to develop and maintain skills for the conduct of military training. Ranges, OPAREAs, and airspace must be sustained to support the training needed to ensure a high state

[1] For the purposes of this EIS/OEIS, the MIRC and the Study Area are the same geographical areas. The complex consists of the ranges and the ocean areas surrounding the ranges that make up the Study Area. The Study Area does not include the sovereign territory (including waters out to 12 nm) of the Federated States of Micronesia (FSM).

of military readiness. Activities involving Research, Development, Test, and Evaluation (RDT&E) for military systems are an integral part of this readiness mandate.

The Proposed Action would result in critical enhancements of the MIRC to increase training capabilities (especially in the undersea and air warfare areas) that are necessary if the military services are to maintain a state of military readiness commensurate with the national defense mission. The Proposed Action does not involve extensive changes to the MIRC facilities, activities, or training capabilities, nor does it involve an expansion of the existing MIRC property. The Proposed Action does not involve the redeployment of USMC, USAF personnel or assets, carrier berthing capability, or deployment of strategic missile defense assets to the MIRC. The Proposed Action focuses on the development and improvement of existing training capabilities in the MIRC and will not include any military construction projects. This Draft EIS/OEIS focuses on the achievement of service readiness activities while the analyses of the Guam and CNMI Marine Relocation EIS/OEIS and Intelligence, Surveillance, and Reconnaissance (ISR)/Strike actions focus on the relocation of forces to the Marianas with its associated infrastructure and military construction requirements.

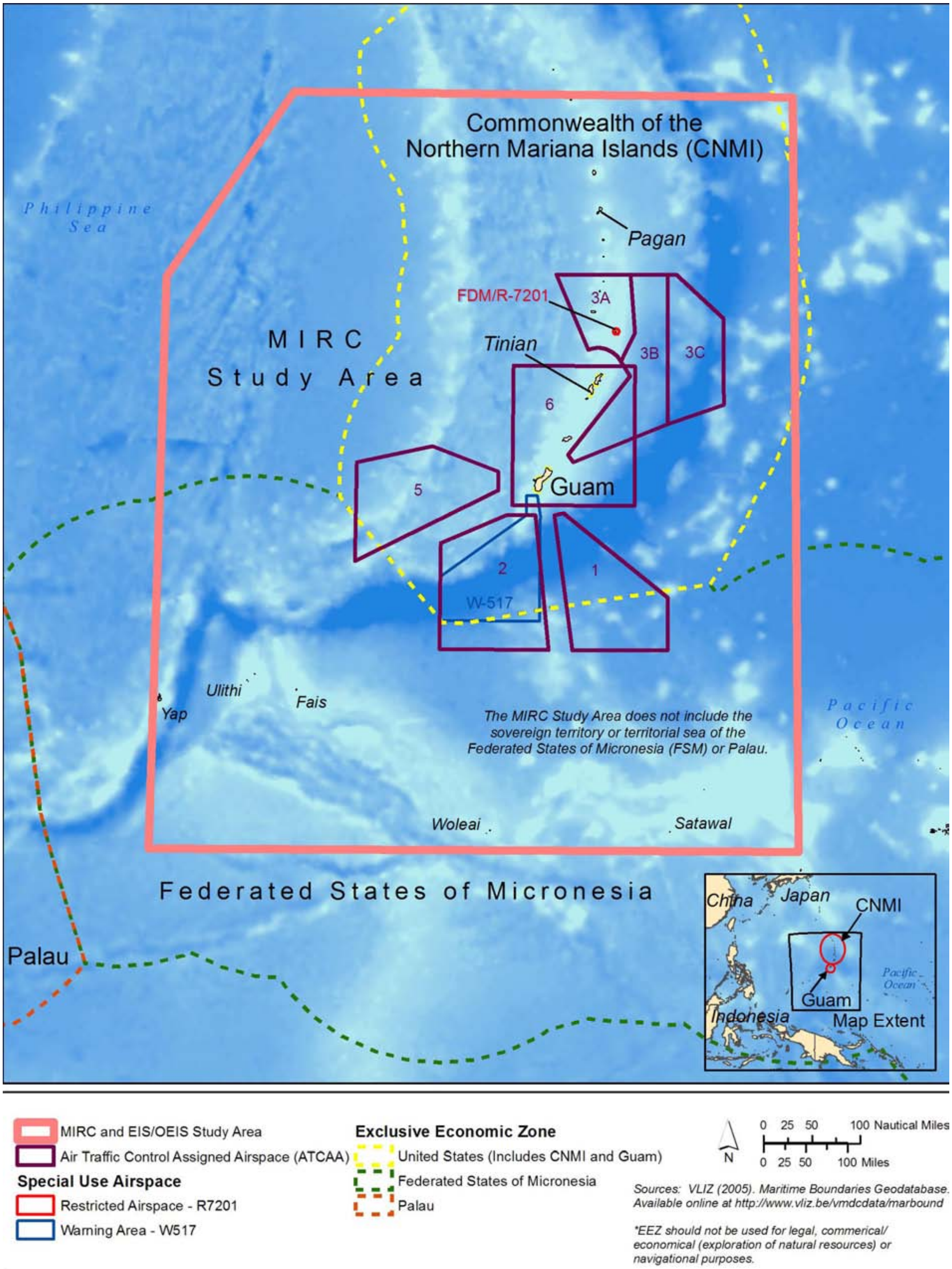
The purpose of the Proposed Action is to achieve and maintain Service readiness using the MIRC to support and conduct current, emerging, and future training and RDT&E activities, while enhancing training resources through investment in the ranges. The decision to be made by the DoD REP is to determine both the scope of training and RDT&E to be conducted and the nature of range enhancements to be made within the MIRC. In making this decision, the DoD REP will consider the information and environmental impact analysis presented in this EIS/OEIS, when deciding whether to implement Alternative 1, Alternative 2, or to select the No Action Alternative.

The need for the Proposed Action is to enable the Services to meet their statutory responsibility to organize, train, equip, and maintain combat-ready forces and to successfully fulfill their current and future global mission of winning wars, deterring aggression, and maintaining freedom of the seas. Activities involving RDT&E are an integral part of this readiness mandate.

The existing MIRC plays a vital part in the execution of this readiness mandate. Because of its close location to forward-deployed forces (those forces close to an area of potential hostility) in the Western Pacific (WestPac), it provides the best economical alternative for forward-deployed U.S. forces to train on U.S.-owned lands. U.S. forces also train in Special Use Airspace (SUA) and sea space outside of U.S. territorial boundaries (see Figure 1-1). The Proposed Action is a step toward ensuring the continued vitality of this essential military training resource.

To support an informed decision, the EIS/OEIS identifies objectives and criteria for military activities in the MIRC (see Section 1.2, Background). The core of the EIS/OEIS is the development and analysis of different alternatives for achieving the Services' 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 Services' readiness mandate, as it is implemented in the MIRC. 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).

Once final, this EIS/OEIS will supersede the *1999 EIS for Military Training in the Marianas and the Overseas Environmental Assessment Notification for Air/Surface International Warning Areas, 2002.* In addition, this EIS/OEIS will address the environmental impacts of future at-sea training events such as the Valiant Shield Exercise (last held in the summer of 2007), which was previously analyzed under separate environmental documentation.



Source: ManTech SRS

Figure 1-1: Mariana Islands Range Complex and EIS/OEIS Study Area

This Draft EIS/OEIS is being prepared in compliance with NEPA; 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 (DoN) Procedures for Implementing NEPA (32 C.F.R. § 775); and Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*. The NEPA process ensures that environmental impacts of proposed major Federal actions are considered in agency decision-making. EO 12114 requires environmental consideration for actions that may significantly harm the environment of the global commons (*e.g.*, environment outside the U.S. territorial seas). This Draft EIS/OEIS satisfies the requirements of both NEPA and EO 12114.

1.2 BACKGROUND

The Navy is the Executive Agent for management of the MIRC. The senior Navy commander in the Mariana Islands has three overlapping roles within the MIRC: Commander, Navy Region Marianas (CNRM); Commander, U.S. Naval Forces Marianas (COMNAVMAR); and DoD REP.

- In the role of CNRM, functions include legal, environmental, facilities, public affairs, and comptroller support.
- In the role of COMNAVMAR, functions include providing management, sustainment, and training support oversight of the MIRC; providing regional coordination for all shore-based naval personnel and shore activities in Guam; and representing the Navy to the Guam community.
- In the role of DoD REP, functions include providing liaison to the governments of Guam, the CNMI, the FSM, and the Republic of Palau, and coordinating multi-service (Joint) Service planning and use, including environmental planning, of MIRC.

All Services have continuing requirements to accommodate force structure changes in Guam and CNMI. These changes require an increase in the type, tempo, and frequency of training.

The strategic mission of the MIRC is to provide training venues for the following warfare functional areas: Air Warfare (AW), Amphibious Warfare (AMW), Surface Warfare (SUW), Anti-Submarine Warfare (ASW), Mine Warfare (MIW), Strike Warfare (STW), Electronic Combat (EC), and Naval Special Warfare (NSW). These eight primary warfare areas encompass Joint and Service-level roles, missions, and tactical tasks. The MIRC should have the capabilities to provide training venues that support operational readiness through realistic live-fire training for deployed Navy, USMC, USAF units, Guam Army National Guard (GUARNG), Guam Air National Guard (GUANG), Army Reserves Marianas (AR-Marianas), USCG, and other users based and deployed in the WestPac.

1.2.1 Why the Military Trains

The U.S. 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 U.S.C. requires the Services to maintain, train, and equip combat-ready forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. Modern war and security operations are complex. Modern weaponry has brought both unprecedented opportunity and innumerable challenges to the Services. Smart weapons, used properly, are very accurate and actually allow the Services to accomplish their 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. Military training addresses all aspects of the team, from the individual to joint and coalition teamwork. To do this, the Services employ a building block approach to training. Training doctrine and procedures are based on operational requirements for deployment of 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 Joint exercises or predeployment certification events.

In order to provide the experience so important to success and survival, training must be as realistic as possible. The military often employs simulators and synthetic training to provide early skill repetition and enhance teamwork, but live training in a realistic environment is vital to success. This requires sufficient land, 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 military forces to conduct realistic combat-like training as they undergo all phases of the graduated buildup needed for combat-ready deployment. Ranges and operating areas provide the space necessary to conduct controlled and safe training scenarios representative of those that the military 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, with land training areas, safety landing fields, and amphibious landing sites are critical to this realism, allowing execution of multidimensional exercises in complex scenarios. They also provide instrumentation that captures the performance of tactics and equipment in order to provide the feedback and assessment that is essential for constructive criticism of personnel and equipment. The live-fire phase of training facilitates assessment of the military's ability to place weapons on target with the required level of precision while under a stressful environment. Live training will remain the cornerstone of readiness.

1.2.2 The Navy's Tactical Training Theater Assessment and Planning (TAP) Program

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 MIRC) in a manner that supports national security objectives and a high state of combat readiness, and (2) ensures 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 Navy's predeployment training, which is governed by the Navy's Fleet Response Training Plan (FRTP).

The Navy's Required Capabilities Document (RCD) is a product of the TAP program. The purpose of the RCD is to define quantitatively the required capabilities that would allow Navy ranges to support mission-essential training and RDT&E. 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 Navy Primary Mission Areas (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 warfare areas encompassed by Navy training activities. The eight PMARs are AAW, AMW, SUW, ASW, MIW, STW, EC, and NSW. The RCD also captures the required capabilities associated with naval aviation and surface/undersea RDT&E.

Thus, the RCD defines the nature and size of a training medium (*e.g.*, airspace) and training systems to be employed in that medium in order to conduct a specified level of training for naval forces to achieve and sustain proficiency in a given PMAR.

The RCD provides guidelines for required range capabilities, but is not range-specific. As part of TAP, the Navy has developed a series of analyses of its requirements for the Navy's range complexes. These analyses are contained in Range Complex Management Plans (RCMPs), and:

- Provide comprehensive descriptions of ranges, OPAREAs, and training areas within a given range complex;
- Assess training and RDT&E 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.

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

1.2.3 The Strategic Importance of the Existing MIRC

The MIRC is characterized by a unique combination of attributes that make it a strategically important range complex for the Services. These attributes include the following:

- Location within U.S. territory
- Live-fire ranges on the islands of Guam, Tinian, and Farallon de Medinilla (FDM)
- Expansive airspace, surface sea space, and underwater sea space
- Authorized use of multiple types of live and inert ordnance on FDM
- Support for all Navy warfare areas (PMARs) and numerous other Service roles, missions, and tactical tasks
- Support to homeported Navy, Army, USCG, and USAF units based at military installations on Guam and CNMI.
- Training support for deployed forces
- WestPac Theater training venue for Special Warfare forces
- Ability to conduct Joint and combined force exercises
- Rehearsal area for WestPac contingencies

Due to Guam and CNMI's strategic location and DoD's ongoing reassessment of the WestPac military alignment, there has been a dramatic increase in the importance of the MIRC as a training venue and its capabilities to support required military training.

1.3 OVERVIEW OF THE MIRC

Table 1-3 presents the geographical area addressed in this EIS/OEIS. The table outlines the given activities that are addressed on land, within 0 to 3 nautical miles (nm), within 3 to 12 nm, or outside of the territorial sea (not within 12 nm of shore).

1.3.1 Primary Components

The MIRC consists of three primary components: ocean surface and undersea areas, SUA, and training land areas.

The ocean surface and undersea areas of the MIRC are included in the MIRC Study Area as depicted in Figure 1-1: extending from waters south of Guam to north of Pagan (CNMI) and from the Pacific Ocean east of the Mariana Islands to the middle of the Philippine Sea to the west, encompassing 501,873 square nautical miles (nm^2) (1,299,851 square kilometers [km^2]) of open ocean and littorals (coastal areas). Chapter 2 contains specific maps for each of the training areas. The MIRC Study Area includes ocean areas in the Philippine Sea, Pacific Ocean, and the exclusive economic zones (EEZs) of United States and FSM.

The range complex includes training area/facilities on Guam, Rota, Tinian, Saipan, and FDM, encompassing 64 nm^2 of land. The MIRC Study Area includes these land areas and the offshore areas; detailed maps of all the areas are found in Chapter 2.

SUA consists of Warning Area 517 (W-517), restricted airspace over FDM (Restricted Area [R]-7201), and Air Traffic Control Assigned Airspace (ATCAA) as depicted in Figure 1-1; these areas encompass 63,000 nm^2 of airspace.

For range management and scheduling purposes, the MIRC is divided into training areas under different controlling authorities. MIRC-supported training, RDT&E of military hardware, personnel, tactics, munitions, explosives, and EC combat systems are described in Chapter 2.

Surface/Undersea Areas. Within the MIRC Study Area are surface and undersea areas routinely used by the Navy for a variety of activities; these areas are depicted in detailed maps in Chapter 2 and include the following:

- *W-517*. This 14,000-nm^2 area is a polygon-shaped area of water space under W-517 used by Navy ships for unit-level training; it begins approximately 50 nm south-southwest of Guam. Controlling authority is COMNAVMAR.
- *Offshore*. Agat Bay, Tipalao Cove, and Piti Mine Neutralization Area are nearshore training areas off of Naval Base Guam-Main Base, and are located within Federally owned coastal waters on Guam. Agat Bay and Tipalao Cove are to the east of Main Base. Piti Mine Neutralization Area is just north of the Apra Harbor Glass Breakwater. These areas are utilized for Navy littoral training activities and unit-level training. Controlling authority is COMNAVMAR.

- *Outer Apra Harbor*. Outer Apra Harbor supports commercial operations as well as Navy activities and unit-level training. Outer Apra Harbor is a deep-water port that can accommodate the Navy's largest vessels. Outer Apra Harbor provides access to areas which support Navy activities and training within the harbor, including Kilo Wharf, Gab Gab Beach, Reserve Craft Beach, Sumay Cove Channel and Basin, San Luis Beach, and Inner Apra Harbor. Controlling authorities within Outer Apra Harbor include the Commercial Port Authority, the USCG, and COMNAVMAR for military training.
- *Inner Apra Harbor*. Inner Apra Harbor is part of Naval Base Guam-Main Base. Wharves and mooring buoys support Navy shipping, and the basin supports small craft and diver training. Controlling authority is COMNAVMAR.

Airspace. The MIRC Study Area includes airspace used either exclusively by the military, or co-used with civilian and commercial aircraft. Some of this airspace is SUA, which is military airspace designated by the FAA as Warning Areas, Restricted Areas, and ATCAA. Airspace in the MIRC Study Area includes:

- *Warning Area 517 (W-517)*. W-517 is an irregular-shaped polygon comprising 14,000 nm^2 of airspace that begins south of Guam and extends south-southwest in international waters and airspace for a distance of approximately 80 to 100 nm, from the ocean surface up to unlimited altitude. Controlling Authority is COMNAVMAR.
- *Restricted Area 7201 (R-7201)*. R-7201 is a 28-nm^2 circular area over FDM that extends out in a 3-nm radius from FDM from the surface to unlimited altitude. Controlling Authority is COMNAVMAR.
- *ATCAA*. Open-ocean ATCAAs within the MIRC Study Area are utilized for military training, from unit-level training to major joint exercises. ATCAAs 1 through 3 (3A, 3B, 3C), and 5 and 6 as depicted in Figure 1-1 have been preassigned in agreements with the FAA and 36th Operational Group. The four ATCAAs encompass 63,000 nm^2 of area from south of Guam to north-northeast of FDM, from the surface to flight level (FL) 300, FL390 to FL430, or surface to unlimited, as depicted in Table 2-4. ATCAAs are activated for short periods to cover the period of training activities. COMNAVMAR coordinates all ATCAA requests with the FAA and 36th Operational Group. Other ATCAAs may be configured and requested contingent on agreement with the FAA and coordination with COMNAVMAR and 36th Operational Group.
- Airspace associated with military airfields and landing areas, such as Andersen tower and landing patterns, are not included in this analysis.

Land Range. The land areas of the MIRC include DoD training areas and facilities located on FDM, Tinian, and Guam, and non-DoD training venues on Rota.

- FDM is an island comprising approximately 182 acres of land leased by DoD from CNMI. The FDM is an un-instrumented range and supports live and inert bombing, shore bombardment, missile strikes, and strafing. Controlling authority for training on FDM is COMNAVMAR.
- The Tinian Military Lease Area (MLA) encompasses 15,400 acres on the island of Tinian, leased by DoD from CNMI. Training on Tinian is conducted on two parcels within the MLA: the Exclusive Military Use Area (EMUA) encompassing 7,600 acres on the northern third of Tinian, and the Leaseback Area (LBA) encompassing 7,800 acres and the middle third of Tinian. The MLA supports small unit-level through large field exercises and expeditionary warfare training. Controlling authority for training on Tinian is COMNAVMAR.

- Rota is the southernmost island of CNMI and provides non-DoD training facilities supporting special warfare training. Controlling authority for training on Rota is COMNAVMAR.
- Guam land-based ranges and training facilities support unit-level training, special warfare training, small arms qualifications, field exercise, and expeditionary warfare activities including Training in Urban Environment Exercise (TRUEX) (USMC Urban Warfare Training, company level). COMNAVMAR, NSW Unit ONE, and Naval Base Security are the controlling authorities for training conducted on DoD land and facilities located on Naval Base Guam which includes Main Base (6,205 acres) Ordnance Annex (8,800 acres), Communications Annex-Finegayan (3,000 acres), and Communications Annex-Barrigada (1,800 acres). The 36th Contingency Response Group (CRG) is the controlling authority for training conducted at Northwest Field (4,500 acres) and Andersen South (1,900 acres). The 36th Security Forces Squadron (SFS) controls the Pati Pt. Combat Arms Training and Maintenance (CATM) Rifle Range (21 acres) (see Subsection 3.12.2.1),

1.3.2 Strategic Vision

The U.S. Pacific Command (USPACOM) Strategic Vision for the MIRC is that it supports the training requirements of permanent, deployed military forces and temporary, deployed military forces in the WestPac. This vision emanates from the DoD Training Transformation, the USPACOM Joint Training Plan, and Service user training requirements. The Army (GUARNG and AR-Marianas), Navy, USMC, and USAF share MIRC training resources to prepare for potential WestPac military activities. The USPACOM Strategic Vision recognizes the geographical/political environment within the WestPac Theater and its corresponding training requirements. In that regard, the USPACOM Strategic Vision guides Joint and Military Service visions.

The Services share training resources throughout the WestPac. Operational forces view the MIRC as currently the best opportunity in WestPac for training. The MIRC is part of U.S. territory with a supportive local population. With range resource and infrastructure improvements, the MIRC can provide quality training venues for Service and Joint training scenarios.

1.3.2.1 Army Strategic Vision

The Army strategic vision for the MIRC is to provide training resources and venues consistent with supporting high quality and responsive training of GUARNG and AR-Marianas forces. Elements of an active Army unit, 3rd Battalion, 196th Infantry Brigade, stationed on Guam, conduct this training. The training sustains and improves GUARNG and AR-Marianas mobilization readiness in the areas of combat training activities, logistics, and civil defense.

1.3.2.2 Navy Strategic Vision

The Pacific Fleet strategic vision for the MIRC is to sustain, upgrade, modernize, and transform the MIRC to support the training requirements of Seventh Fleet, forces transiting through WestPac, and the rotational deployed units in accordance with assigned roles and missions. The Navy strategic vision is consistent with the Navy TAP program and is articulated in the RCMP for the MIRC. Additionally, the Navy, through COMNAVMAR, has the responsibility to provide MIRC training support to U.S Military Services and allied military forces. The imperatives of MIRC sustainment, upgrade, modernization, and transformation apply to all MIRC users.

1.3.2.3 Marine Corps Strategic Vision

The USMC strategic vision is to upgrade, modernize, and transform the MIRC into a training complex that accommodates the USMC Ship to Objective Maneuver (STOM) mission and Marine Air Ground Task Force (MAGTF) training requirements of the Third Marine Expeditionary Force (III MEF) and rotational deployed units.

1.3.2.4 USAF Strategic Vision

The USAF strategic vision for the MIRC is for a range complex that can support the training requirements mandated by the WestPac missions of deployed and rotational expeditionary air forces under the USAF ISR/Strike task force. The complex must support training that features air-to-air, air-to-ground, surveillance, intelligence, and tanker assets integrated into advanced, Joint, and Service-level tactical scenarios using instrumented airspace and hi-fidelity, instrumented, live, and inert target areas. Training must include an EC environment employing advanced EC threat simulators.

1.3.3 Shortfalls of the MIRC

While the MIRC provides strategically vital training attributes as described in Subsection 1.2.3, there are certain shortfalls that constrain its ability to support required training. Correcting these shortfalls would provide the enhanced training environment required by the Services that utilize the MIRC. Current shortfalls stem from the inadequate range infrastructure and limited range capabilities to meet Joint and Service training requirements. The current shortfalls include, but are not limited to, the following:

- Air-to-Air Live-Fire Capability
- AW Targets
- ASW Targets
- Close Quarters Combat (CQC) Facility
- Contiguous Airspace, Warning Areas
- EC Assets
- Fleet Area Control and Surveillance Facility (FACSFAC) Capability
- Heavy Weapons Range
- Hi-Fidelity Air-to-Ground (A-G) Inert Range
- Inadequate Military Operations in Urban Terrain (MOUT) Facility
- Limited Torpedo/MK-30 Target Recovery Capability
- Live Target Land
- Mine Shapes
- Naval Surface Fire Support (NSFS)
- No Underwater Tracking Range
- Opposition Forces (OPFOR) support
- Parachute Training Area
- Ramp Space for Navy and USMC Aircraft Deployments

- Small Arms/Sniper Range
- STOM Sea, Land, Subsurface Areas
- Time, Space, Position, Information (TSPI) Capability
- Unmanned Aerial Vehicle OPAREA

The capabilities of the MIRC must be sustained, upgraded, and modernized to address these shortfalls. Moreover, the MIRC 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. Training capacity, meaning adequate space to train on the land, sea, and in the air, is a continuing concern throughout the DoD. For the MIRC, training capacity concerns arise due to increased operational tempo, and increases or proposed increases in the size and composition of DoD forces that rely on the range complex. The activities of these forces are to be accommodated on existing land, sea, and air range areas, leading to increased intensity of use. Preserving and enhancing access to training space on and throughout the range complex is critical to maintaining adequate training capacity in the MIRC.

1.4 PURPOSE AND NEED FOR THE PROPOSED ACTION

The purpose of the Proposed Action is to:

- Achieve and maintain military readiness for deployed military forces using the MIRC to conduct and support current, emerging, and future military training and RDT&E activities on existing DoD land ranges and adjacent air and ocean areas; and
- Upgrade and modernize range complex capabilities to enhance and sustain military training and RDT&E activities and to support training in expanded Service warfare missions.

The Proposed Action is needed to provide a training environment consisting of training areas and range instrumentation with the capacity and capabilities to fully support required training tasks for deployed military forces. The Services have developed alternatives criteria based on this statement of the purpose and need for the Proposed Action (see Section 2.2).

In this regard, the MIRC furthers the Service's execution of their roles and responsibilities as mandated in Title 10. To implement this Congressional mandate, the U.S Military Services need to:

- Maintain mandated levels of military readiness by training in the MIRC.
- Accommodate future increases in training tempo on existing ranges and adjacent air and ocean areas in the MIRC and support the rapid employment of military units or strike groups.
- Achieve and sustain readiness so that the Services can quickly surge required combat power in the event of a national crisis or contingency operation consistent with Service training requirements and airspace requirements for the development of future live fire ranges.
- Support the acquisition, testing, training, and fielding of advanced platforms and weapons systems into Service force structure.
- Maintain the long-term viability of the MIRC while protecting human health and the environment, and enhancing the quality of training, communications, and safety within the range complex.

1.5 THE ENVIRONMENTAL REVIEW PROCESS

NEPA 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 major Federal action might have on the human, natural, or cultural environment. The Navy undertakes environmental planning for Navy actions occurring in, or affecting, the 50 states, territories, and possessions of the U.S. Additionally, as a matter of policy, Navy applies NEPA to those proposed actions that could produce significant effects in the U.S. territorial sea, which extends seaward 12 nm pursuant to Presidential Proclamation 5928 of 27 December 1988. The Navy therefore includes areas of the MIRC that lie within 12 nm of the coast in its analysis under NEPA.

Environmental effects in the areas that are beyond the U.S. territorial sea are analyzed under EO 12114 and associated implementing regulations.

1.5.1 National Environmental Policy Act (NEPA)

The first step in the NEPA process is 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. The NOI for this project was published in the Federal Register on June 1, 2007 (*Federal Register*, Volume 72, No. 105, pp 30557-59). A newspaper notice was placed in two local newspapers, *Pacific Daily News* (Guam) and *Saipan Tribune* (Saipan/Tinian). The NOI and newspaper notices included information about comment procedures, a list of information repositories (public libraries), the dates and locations of the scoping meetings, and the project website address (www.MarianasRangeComplexEIS.com).

Scoping is an early and open process for developing the "scope" of issues to be addressed in the EIS and for identifying significant issues related to a Proposed Action. The scoping process for this EIS/OEIS was initiated by the publication of the NOI in the Federal Register and local newspapers noted above. During scoping, the public is given an opportunity to help define and prioritize issues and convey these issues to the Navy through written comments. Scoping meetings were held at three locations: Hilton Guam (Tumon Bay, Guam) on June 18, 2007; Hyatt Regency Saipan (Garapan Village, Saipan) on June 20, 2007; and Tinian Dynasty Hotel (San Jose Village, Tinian) on June 21, 2007. There were 135 total attendees, including 65 in Guam, 48 in Saipan, and 22 in Tinian, as shown in Table 1-1. As a result of the scoping process, the Navy received comments from the public, which have been considered in the preparation of this EIS/OEIS.

Table 1-1: Meeting Locations, Dates, and Attendees—Scoping

Location	Date	Public Attendees
Hilton Guam, Tumon Bay, Guam	18 June 2007	65
Hyatt Regency Saipan, Garapan Village, Saipan	20 June 2007	48
Tinian Dynasty Hotel, San Jose Village, Tinian	21 June 2007	22

Comments received from the public during the scoping process are categorized and summarized in Table 1-2. This table is not intended to provide a complete listing, but to show the extent of the scope of comments. These comments were received through public comment forms, which were available at each information station and were collected during the meeting. The forms could also be mailed to the address or e-mail address provided on the form. For people that wanted to submit oral comments, there were two options: a tape recorder was available for people wanting to dictate their comments directly into the recorder and a Navy representative was also available to transcribe public comments using a laptop computer. During scoping, the Marianas EIS/OEIS team set up and allowed the public to submit comments electronically via an e-mail address: marianas.tap.eis@navy.mil. A total of 25 comments were received, including written and oral comments from the public meetings and written comments via mail and e-mail.

Table 1-2: Public Scoping Comment Summary

Category	Commentator	Discussion Topic/Summary of Concern
Alternatives	Guam Environmental Protection Agency Private Citizen	Alternatives outside Mariana Islands. Additional alternative that consolidates training activities on fewer ranges. Alternative that includes reducing training.
Environmental	Department of Public Lands (Saipan) Guam Environmental Protection Agency Guam Department of Agriculture U.S. Environmental Protection Agency Private Citizens	General environmental concerns. Development of appropriate mitigation measures.
Water Quality and Quantity	U.S. Environmental Protection Agency Private Citizen	Availability of fresh water.
Marine Life	Guam Department of Agriculture Private Citizens U.S. Fish & Wildlife Service U.S. Environmental Protection Agency	Impacts to marine life, essential fish habitat, and coral reefs, from sound, underwater detonations, vessel activity, disturbances, hazardous materials, and pollution. ESA-listed species.
Airborne Noise	Private Citizens	Noise from aircraft.
Invasive Species	Guam Department of Agriculture U.S. Fish & Wildlife Service U.S. Environmental Protection Agency Private Citizens	Increase in invasive species, including brown tree snake, flatworm.
Birds and Terrestrial Species	CNMI Division of Fish & Wildlife Private Citizens U.S. Fish & Wildlife Service	Activity/noise disturbance to Tinian Monarch. Impacts to native species, including arboreal snails. ESA-listed species. Habitat destruction.
Socioeconomics	U.S. Environmental Protection Agency	Environmental Justice

Subsequent to the scoping process, the Navy and Federal and local regulators met quarterly to discuss additional scoping issues of concerns prior to development of this Draft EIS/OEIS. This Draft EIS/OEIS was prepared to assess the potential effects of the Proposed Action and alternatives on the environment. It was then provided to the U.S. Environmental Protection Agency (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 similar (or the same) venues 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. The Final EIS/OEIS will then be made available to the public.

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 present commitments to specific mitigation measures.

1.5.2 Executive Order (EO) 12114

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 EEZ, 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. This Draft EIS/OEIS satisfies the requirements of EO 12114, as analysis of activities or impacts occurring, or proposed to occur, outside of 12 nm (22 km) is provided. Table 1-3 presents a list of training and RDT&E activities (by warfare area) and the geographical area in which they occur (land, 0-3 nm, 3-12 nm, and 12 nm and beyond). The table presents typical activities that are addressed pursuant to NEPA (because they occur on land, within 0-3 nm, or within 3-12 nm) or EO 12114 (because they occur outside of the territorial sea [not within 12 nm of shore]).

Table 1-3: Geographical Occurrence of Training and RDT&E Activities

Training Activities		Land	0-3 nm	3-12 nm	Beyond 12 nm
AW	Air Combat Maneuvers	X	X	X	X
	Air-to-Air Missile Exercise				X
	Surface-to-Air Gunnery Exercise				X
	Surface-to-Air Missile Exercise				X
AMW	Conduct Amphibious Training Activities (Guam, Tinian)	X	X	X	X
	Naval Surface Fire Support (FDM)	X	X	X	X
ASW	Anti-Submarine Warfare Tracking Exercise (ASW TRACKEX) – Maritime Patrol Aircraft (MPA)		X	X	X
	Anti-Submarine Warfare Tracking Exercise (ASW TRACKEX) – Helicopter		X	X	X
	Anti-Submarine Warfare Tracking Exercise (ASW TRACKEX) – Surface Ship			X	X
	Anti-Submarine Warfare Tracking Exercise (ASW TRACKEX) – Submarine		X	X	X
EC	Electronic Combat Exercises	X	X	X	X
MIW	Mine Laying Exercise (MINEX – Air to Subsurface)				X
	Mine Countermeasures		X		
	Land Demolitions	X	X		
NSW	Insertion/Extraction	X	X		
	Special Warfare Training	X	X		
SUW	Surface-to-Surface Gunnery Exercise (GUNEX)				X
	Air-to-Surface Bombing Exercise (BOMBEX)				X
	Sinking Exercise (SINKEX)				X
STW	High Speed Anti-radiation Missile (HARM) Exercise (Non-firing)	X	X	X	X
	Air to Ground BOMBEX	X	X		
Support Ops	Intelligence, Surveillance, and Reconnaissance (ISR)	X	X	X	X
	Unmanned Aerial Vehicle Training and RDT&E	X	X	X	X

1.5.3 Other Environmental Requirements Considered

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

- Migratory Bird Treaty Act (MBTA)
- Coastal Zone Management Act (CZMA)
- Rivers and Harbors Act (RHA)
- Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) for Essential Fish Habitat (EFH)
- Clean Air Act (CAA)
- Federal Water Pollution Control Act (Clean Water Act [CWA])
- National Historic Preservation Act (NHPA)
- National Invasive Species Act
- Resource Conservation and Recovery Act (RCRA)
- EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
- EO 13045, Environmental Health and Safety Risks to Children
- EO 13089, Protection of Coral Reefs
- EO 13112, Invasive Species

In addition, laws and regulations of the Territory of Guam and the CNMI that are applicable to military actions are identified and addressed in this EIS/OEIS. To the extent practicable, the analysis in this EIS/OEIS will be used as the basis for any required consultation and coordination in connection with applicable laws and regulations.

1.5.3.1 Marine Mammal Protection Act (MMPA) Compliance

The MMPA established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction (MMPA, 1972). The act further regulates "takes" of marine mammals on the high seas by vessels or persons under U.S. jurisdiction. The term "take," as defined in Section 3 of the MMPA (16 U.S.C. 1362), 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 and 2004 amendments to the MMPA. The 1994 amendments provided two levels of harassment: Level A (potential injury) and Level B (potential disturbance).

As applied to military readiness activities, the National Defense Authorization Act for Fiscal Year 2004 (FY04 NDAA) (Public Law [PL] 108-136) amended the MMPA to (1) clarify the applicable definition of harassment; (2) exempt such activities from the "specified geographical region" and "small numbers" requirements of Section 101(1)(5)(A) of the MMPA; (3) require consideration of personnel safety, practicality of implementation, and impact on effectiveness of military readiness activities by NMFS in making its determination regarding least practicable adverse impact; and (4) establish a national defense exemption. PL 107-314, Section 315(f), defines "military readiness activities" to include "all training activities 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." The testing and training with active sonar constitutes a military readiness activity under this definition.

The definition of "harassment" as applied to military readiness activities 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"), or
- 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 U.S.C. 1362 [18][B][i],[ii]).

Section 101(a)(5) of the MMPA directs the Secretary 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). These incidental takes are allowed only if NMFS issues regulations governing the permissible methods of taking. In order to issue regulations, NMFS must make a determination that (1) the taking will have a negligible impact on the species or stock, and (2) the taking will not have an unmitigable adverse impact on the availability of such species or stock for subsistence uses.

In addition, the MMPA requires NMFS to develop regulations governing the issuance of a Letter of Authorization (LOA) and to publish these regulations in the Federal Register. Specifically, the regulations for each allowed activity establish:

- 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 (as clarified above).
- Requirements for monitoring and reporting of such taking. For military readiness activities (as described in the NDAA), a determination of "least practicable adverse impacts" on a species or stock includes consideration, in consultation with the DoD, of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

In support of the Proposed Action, the Navy applied for an LOA pursuant to Section 101(a) (5) (A) of the MMPA. After the application was reviewed by NMFS, a Notice of Receipt of Application was published in the Federal Register. Publication of the Notice of Receipt of Application initiated the 30-day public comment period, during which time anyone could obtain a copy of the application by contacting NMFS. NMFS intends to publish a proposed rule for public comment coincident with the publication of this EIS/OEIS. The public will be afforded 30 days to comment on this proposed rulemaking. NMFS will consider and address all comments received during the public comment period, and anticipates issuing the final rule, if appropriate, toward the end of Calendar Year (CY) 2009.

1.5.3.2 The Endangered Species Act (ESA)

The ESA (16 U.S.C. 1531 to 1543) applies to Federal actions in two separate respects. First, the ESA requires that Federal agencies, in consultation with the responsible wildlife agency (e.g., NMFS), 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 (16 U.S.C. 1536 [a][2]). Those actions that "may affect" a listed species or adversely modify critical habitat must also follow the regulations implementing the ESA consultation requirement.

In addition, 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" (16 U.S.C. 1532[19]).

1.5.4 Government-to-Government Consultations

The Navy has held a number of Government-to-Government consultations between June and July 2007. The purpose was to present the Proposed Action and Alternatives of the EIS/OEIS and to initiate consultations. Meetings included Guam legislative and executive branches of government; Mayor's Council; Chamber of Commerce; the CNMI legislative and executive branches of government including briefings to the Governors and their staffs at each jurisdiction, and Congressional delegations from each jurisdiction.

1.5.5 Regulatory Agency Briefings

The DoD held a number of regulatory quarterly agency briefings and meetings starting in June 2007 with the following regulators/stakeholders: National Oceanic and Atmospheric Administration (NOAA)/NMFS, U.S. Fish and Wildlife Service (USFWS), Guam Department of Agriculture Division of Aquatics and Wildlife, the Commonwealth Department of Natural Resources, the Territorial and Commonwealth Historic Preservation Offices, Commonwealth Department of Environmental Quality, the Guam Environmental Protection Agency and the Guam military and civilian task force.

The parties to these meetings raised a variety of issues and concerns. In brief, some of the main concerns included clarification between the MIRC EIS and the JGPO actions covered by the Guam and CNMI Military Relocation EIS/OEIS, the USAF actions in the ISR/Strike EIS, and the Navy's Kilo Wharf Extension EIS. Discussion provided clarification on current quantity and types of training, the proposed increase in both the quantity and quality of training activities (including live-fire exercises), new training and research and development activities and systems, and how these actions differ from the proposals under the Defense Policy Review Initiative or Guam and CNMI Military Relocation EIS/OEIS. Discussions included concerns for the cumulative impacts as the result of the proposed actions contained in the above mentioned EIS/OEIS efforts including proposed Government of Guam and CNMI infrastructure improvements. These discussions on cumulative impacts included dialogue on social and economic impacts including effects on the indigenous populations, commercial and subsistence fishing concerns, island infrastructure concerns and traffic concerns. The discussions on natural resource regulatory agency included concern for effects on coral reefs, concern for effective control and quarantine of invasive species particularly the brown tree snake, concern for cumulative effects on threatened and endangered species, expended debris and materials in the water, underwater detonations and their effects on fish and marine mammals, use of sonar within the Exclusive Economic Zone (EEZ) surrounding the islands, noise encroachment, fuel spill issues, and conflicts with sportsmen that use the areas within the MIRC.

1.6 RELATED ENVIRONMENTAL DOCUMENTS

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 investments in the MIRC. In contrast, the Guam and CNMI Military Relocation EIS/OEIS will analyze the relocation of Marines from Okinawa, construction of berthing for visiting aircraft carriers, and establishment of a U.S. Army (Army) Ballistic Missile Defense Task Force (BMDTF). The Relocation EIS/OEIS will analyze construction and modification of facilities on Guam and Tinian to support relocation of approximately 8,552 Marines of III MEF, and 9,000 dependents to Guam from Okinawa by 2014. This includes aviation and waterfront activities, training, main encampment, family housing and associated utilities, and infrastructure improvements.

1.6.1 Documents Incorporated by Reference

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." Some of the programs and projects within the geographical scope of this EIS/OEIS that have undergone environmental review and documentation to ensure NEPA compliance include:

- Andersen Air Force Base Cargo Parachute Drop Zone EA, December 2000.
- Beddown of Training and Support Initiatives at Northwest Field, Environmental Assessment, Andersen Air Force Base, Guam, EA June 2006.
- Environmental Assessment/Overseas Environmental Assessment of the SH-60R Helicopter/ ALFS Test Program, October 1999.
- Final Environmental Impact Statement, Establishment and Operation of an Intelligence, Surveillance, and Reconnaissance and Strike Capability, Andersen Air Force Base, Guam, November 2006.
- Marianas Training Handbook, COMNAVMARIANAS Instruction 3500.4, June 1999.
- Marine Resource Assessment for the Marianas Operating Area, August 2005.
- Environmental Assessment, MOUT Training at Andersen South, Guam, January 2003.
- Valiant Shield – Final Programmatic Overseas Environmental Assessment, August 2007.

1.6.2 Relevant Environmental Documents Being Prepared Concurrently with this EIS/OEIS

NOTE: The following documents are either draft or are in progress at this time. If these documents become final prior to the finalization of the MIRC EIS/OEIS, the relevant analysis from that document will be incorporated into the MIRC EIS/OEIS.

- Guam and CNMI Military Relocation EIS/OEIS *(Note: The cumulative impact analysis for the MIRC EIS/OEIS will be coordinated with the cumulative impacts analysis for the activities covered in the Relocation EIS/OEIS.)*
- Programmatic Overseas EA for MK-48 Advanced Testing Capability Torpedo Service Weapons Test and Sinking Exercises in Four Pacific Ocean Locations.

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CHAPTER 2 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

The Department of Defense (DoD) Representative Guam, Commonwealth of the Northern Mariana Islands (CNMI), Federated States of Micronesia (FSM) and Republic of Palau (DoD REP) proposes to improve training activities in the Mariana Islands Range Complex (MIRC) by selectively improving critical facilities, capabilities, and training capacities. The Proposed Action would result in focused critical enhancements and increases in training that are necessary to maintain a state of military readiness commensurate with the national defense mission. The Proposed Action includes minor repairs and upgrades to facilities and capabilities but does not include any military construction requirements. This is part of the periodically scheduled reviews of facilities and capabilities within the MIRC.

The U.S. Military Services (Services) need to implement actions within the MIRC to support current, emerging, and future training and Research, Development, Test, and Evaluation (RDT&E) activities. Training and RDT&E activities do not include combat operations, operations in direct support of combat, or other activities conducted primarily for purposes other than training. These actions will be evaluated in this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) and include:

- Maintaining baseline training and RDT&E activities at mandated levels;
- Increasing training activities and exercises from current levels;
- Accommodating increased readiness activities associated with the force structure changes (human resources, new platforms, additional weapons systems, including undersea tracking capabilities and training activities to support Intelligence, Surveillance, and Reconnaissance[ISR]/Strike); and
- Implementing range complex investment strategies that sustain, upgrade, modernize, and transform the MIRC to accommodate increased use and more realistic training scenarios.

This chapter is divided into the following major subsections: Subsection 2.1 provides a detailed description of the MIRC. Subsections 2.2 to 2.5 describe the major elements of the Proposed Action and Alternatives to the Proposed Action. Subsections 2.4 and 2.5 describe Alternative 1 and Alternative 2.

2.1 DESCRIPTION OF THE MIRC[1]

Military activities in MIRC occur (1) on the ocean surface, (2) under the ocean surface, (3) in the air, and (4) on land. Summaries of the land, air, sea, undersea space addressed in this Draft EIS/OEIS are provided in Tables 2-1, 2-2, 2-3, 2-4, and 2-5. To aid in the description of the training areas covered in the MIRC Draft EIS/OEIS, the range complex is divided into major geographic and functional areas. Each of the individual training areas fall into one of three major MIRC training areas:

- The Surface/Subsurface Area consists of all sea and undersea training areas in the MIRC.
- The Airspace Area includes all Special Use Airspace (SUA) in the MIRC.
- The Land Area includes all land training area in the MIRC.

[1] For the purposes of this EIS, the MIRC and the Study Area are the same geographical areas. The complex consists of the ranges and the ocean areas surrounding the ranges that make up the Study Area. The Study Area does not include the sovereign territory (including waters out to 12 nm) of the Federated States of Micronesia (FSM).

Figures 2-1 through 2-11 depict the major geographic divisions of the training areas, and Table 2-1 provides a summary of the area within the major geographical areas. Tables 2-2, 2-3, 2-4, and 2-5 summarize the functional training areas of the MIRC.

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

Area Name	Airspace (nm^2)			Sea Space (nm^2)	Undersea Space (nm^2)	Land Range (acres)
	Warning Area	Restricted Airspace	ATCAA / Other			
MIRC	14,000	28	63,000	501,873	14,000	24,894

* Source: 366 Report to Congress. Notes: nm^2 – square nautical miles; ATCAA - Air Traffic Control Assigned Airspace.

The military Services use suitable MIRC air, land, sea, and undersea areas for various military training activities. For purposes of scheduling, managing, and controlling these activities and the ranges, the MIRC is divided into multiple components that are overseen by specific Services.

2.1.1 MIRC Overview

The MIRC includes land training areas, ocean surface areas, and undersea areas as depicted in Figure 1-1. These areas extend from the waters south of Guam to north of Pagan (CNMI), and from the Pacific Ocean east of the Mariana Islands to the Philippine Sea to the west; encompassing 501,873 square nautical miles (nm^2) (1,299,851 square kilometers [km^2]) of open ocean and littorals. The MIRC does not include the sovereign territory (including waters out to 12 nautical miles [nm]) of the FSM. Portions of the Marianas Trench National Monument, which was established in January 2009 by Presidential Proclamation under the authority of the Antiquities Act (16 U.S.C. 431), lie within the Study Area.

2.1.2 Navy Controlled and Managed Training Areas of the MIRC

Table 2-2 provides an overview of each Navy controlled and managed area and its location. Figures 2-1 through 2-8 depict these training areas.

Table 2-2: Navy Controlled and Managed MIRC Training Areas[2]

Training Area	Detail/Description
Warning Area	
W-517	W-517 is special use airspace (SUA) (approximately 14,000 nm^2) that overlays deep open ocean approximately 50 miles south-southwest of Guam and provides a large contiguous area that is relatively free of surface vessel traffic. Commercial air traffic lanes constrain the warning area; however, Air Traffic Control Assigned Airspace (ATCAA) 2 overlays most of W-517, permitting coordination of scheduling of short-lived airspace training events with the Federal Aviation Administration (FAA). W-517 altitude limits are from the surface to infinity and capable of supporting Gunnery Exercise (GUNEX), Chaff and Electronic Combat (EC), Missile Exercise (MISSILEX), Mine Exercise (MINEX), Sinking Exercise (SINKEX), Torpedo Exercise (TORPEX), and Carrier training activities. Descriptions of training are included in Appendix D. Figure 2-1 depicts the W-517 Training Area.
Restricted Area	
Farallon de Medinilla (FDM) /R-7201	FDM, which is leased by the DoD from the CNMI, consists of the island land mass and the restricted airspace designated R-7201. The land mass (approximately 182 acres), is approximately 1.7 miles long and 0.3 miles wide. It contains a live-fire and inert bombing range and supports live-fire and inert engagements such as surface-to-ground and air-to-ground GUNEX, BOMBEX, MISSILEX, Fire Support, and Precision Weapons (including laser seeking). R-7201 is the Restricted Area surrounding FDM (extending 3-nm radius from center of FDM, encompassing 28 nm^2, and altitude limits from surface to FL600). Public access to FDM is strictly prohibited and there are no commercial or recreational activities on or near the island. During training exercises, marine vessels are restricted within a 3-nm (5-kilometer [km]) radius, although published Notices to Mariners (NOTMARs) may advise restrictions beyond a 3-nm (5-km) radius out to 30 nm (56 km) or greater as needed for certain training events. These increased advisory restrictions are used in an effort to ensure better protection to the military and the public during some training sessions. For these specific exercises, NOTMARs and Notices to Airmen (NOTAMs) are issued at least 72 hours in advance. Figure 2-2 depicts Farallon de Medinilla. Figure 2-3 shows the FDM Restricted Area and Danger Zone. Figure 2-10 shows R-7201 and MIRC ATCAAs.

[2] See Appendix D for descriptions of training activities, including activities such as GUNEX, MISSILEX, Mine Exercise (MCMEX), SINKEX, TORPEX, and BOMBEX.

Table 2-2: Navy Controlled and Managed MIRC Training Areas (Continued)

Training Area	Detail/Description
Offshore	
Agat Bay	Agat Bay supports deepwater Mine Countermeasure (MCM) training, military dive activities, and parachute insertion training. Underwater detonation charges up to 20 pounds Net Explosive Weight (NEW) are used. Hydrographic surveys to determine hazards for military approaches are periodically conducted in this area. Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.
Tipalao Cove	Tipalao Cove provides access to a small beach area capable of supporting a shallow draft amphibious landing craft and has been proposed for use as a Landing Craft Air Cushion (LCAC) and Amphibious Assault Vehicle (AAV) landing site. Tipalao Cove supports military diving activities and hydrographic survey training. Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.
Drop Zones	Drop Zones (DZ) in the Offshore Areas are shown in Figure 2-1. A DZ may be used for the air-to-surface insertion of personnel/equipment. Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.
Piti Floating Mine Neutralization Area	The Piti Floating Mine Neutralization Area lies north of Apra Harbor and supports Explosive Ordnance Disposal (EOD) training, with underwater explosive charges up to 20 pounds NEW. Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.
Apra Harbor	
Outer Apra Harbor (OAH)	Commanding Officer United States (U.S.) Coast Guard (USCG) is the Captain of the Port and controls OAH. Navy Security zones extend outward from the Navy controlled waterfront and related military anchorages/moorings. OAH supports frequent and varied training requirements for Navy Sea, Air, Land Forces (SEALs), EOD, and Marine Support Squadrons including underwater detonations (explosive charges up to 10 pounds NEW are permitted at a site near Buoy 702), military diving, logistics training, small boat activities, security activities, drop zones, visit board search, and seizures (VBSS) and amphibious craft navigation (LCAC, LCU, and AAVs). Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.
Kilo Wharf	Kilo Wharf is used for ordnance handling and is a training site with limited capabilities due to explosive safety constraints; however, when explosive constraints are reduced it is used for Anti-Terrorism/Force Protection (AT/FP) training and VBSS activities. Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.

Table 2-2: Navy Controlled and Managed MIRC Training Areas (Continued)

Training Area	Detail/Description
Apra Harbor Naval Complex (Main Base): The Main Base comprises a total of approximately 4,500 acres.	
Inner Apra Harbor	The inner portion of Apra Harbor (sea space) is Navy controlled and includes the submerged lands, waters, shoreline, wharves, and piers and is associated with the Main Base (658 acres). Activities include military diving, logistics training, small boat activities, security activities, drop zones, torpedo/target recovery training, VBSS, and amphibious landings (LCAC, LCU, and AAVs). Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.
Gab Gab Beach	Gab Gab Beach is used for both military and recreational activities. The western half of Gab Gab Beach is primarily used to support EOD and Naval Special Warfare (NSW) training requirements. Activities include military diving, logistics training, small boat activities, security activities, drop zones, and AT/FP. Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.
Reserve Craft Beach	Reserve Craft Beach is a small beach area located on the western shoreline of Dry Dock Island. It supports both military and recreational activities. It is used as an offload area for amphibious landing craft including LCACs; EOD inert training activities; military diving, logistics training, small boat activities, security activities, and AT/FP. Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.
Sumay Channel/Cove	Sumay Channel/Cove provides moorage for recreational boats and an EOD small boat facility. It supports both military and recreational activities. It is used for insertion/extraction training for NSW and amphibious vehicle ramp activity, military diving, logistics training, small boat activities, security activities, and AT/FP. Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.
Clipper Channel	Clipper Channel provides insertion/extraction training for NSW, military diving, logistics training, small boat activities, security activities, and AT/FP. The Clipper Channel has the potential to support amphibious vehicle ramp activity. Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.
San Luis Beach	San Luis Beach is used for both military and recreational activities. San Luis Beach is used to support EOD and NSW training requirements. Activities include military diving, logistics training, small boat activities, security activities, drop zones, and AT/FP. Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.
Main Base/Polaris Point	
Polaris Point Field (PPF)	Polaris Point Field supports both military and recreational activities and beach access to small landing craft. PPF supports small field training exercises, temporary bivouac, craft laydown, parachute insertions (freefall), assault training activities, AT/FP, and EOD and Special Forces Training. Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.
Polaris Point Beach	Polaris Point Beach supports both military and recreational activities and beach access to small landing craft and LCAC. Polaris Point Beach supports military diving, logistics training, small boat activities, security activities, drop zones, and AT/FP. Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.

Table 2-2: Navy Controlled and Managed MIRC Training Areas (Continued)

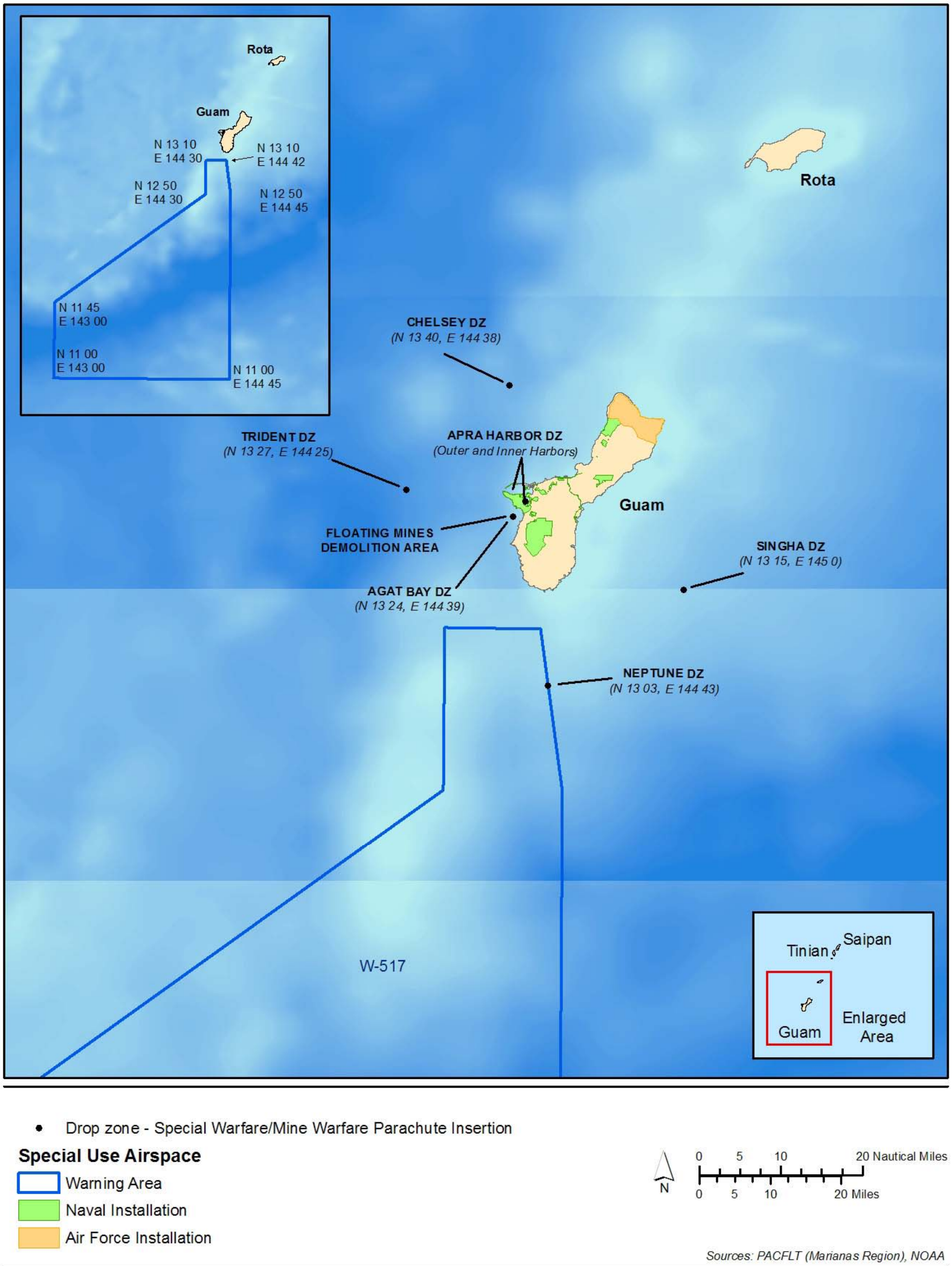
Training Area	Detail/Description
Main Base/Polaris Point (continued)	
Polaris Point Site III	Polaris Point Site III is where Guam-homeported submarines and the submarine tender are located and is the primary site location for docking, training, and support infrastructure. Additionally, it supports AT/FP and torpedo/target logistics training. Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.
Main Base/Orote Point	
Orote Pt. Airfield/ Runway	Orote Point Airfield consists of expeditionary runways and taxiways and is largely encumbered by the Explosive Safety Quantity Distance (ESQD) arcs from Kilo Wharf. Orote Pt. Airfield runways are used for vertical and short field military aircraft. They provide a large flat area that supports Field Training Exercise (FTX), parachute insertions, emergency vehicle driver training, and EOD and Special Warfare training. The airfield is on the National Register of Historic Places (NRHP). Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.
Orote Pt. Close Quarter Combat Facility (OPCQC)	The OPCQC, commonly referred to as the Killhouse, is a small one-story building providing limited small arms live-fire training. Close Quarter combat (CQC) is one activity within Military Operations in Urban Terrain (MOUT)-type training. It is a substandard training facility and the only designated live-fire CQC facility in the MIRC. Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.
Orote Pt. Small Arms Range/ Known Distance Range (OPKDR)	The Orote Pt. Known Distance Range (OPKDR) supports small arms and machine gun training (up to 7.62mm), and sniper training out to a distance of 500 yards. The OPKDR is a long flat cleared area with an earthen berm that is used to support marksmanship. The OPKDR is currently being upgraded to an automated scored range system. Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.
Orote Pt. Triple Spot	The Orote Pt. Triple Spot is a helicopter landing zone on the Orote Pt. Airfield Runway. It supports personnel transfer, logistics, parachute training, and a variety of training activities reliant on helicopter transport. Figure 2-4 depicts the Apra Harbor and Nearshore Training Areas.
Navy Munitions Site (Ordnance Annex): Comprises approximately 8,800 acres.	
Ordnance Annex Breacher House (OABH)	The breacher house is a concrete structure in an isolated part of the Ordnance Annex that is used for tactical entry using a small explosive charge. Live-fire is not authorized in the breacher house. An adjacent flat area allows for a helicopter landing zone (LZ) supporting airborne raid type events. Figure 2-5 depicts the Ordnance Annex Training Areas.
Ordnance Annex Emergency Detonation Site (OAEDS)	The OAEDS is located within a natural bowl-shaped high valley area within the Ordnance Annex and is used for emergency response detonations, up to 3,000 pounds. A flat area near OAEDS allows for helicopter access. EOD activities are the primary types of training occurring at OAEDS. Figure 2-5 depicts the Ordnance Annex Training Areas.

Table 2-2: Navy Controlled and Managed MIRC Training Areas (Continued)

Training Area	Detail/Description
Navy Munitions Site (Ordnance Annex) (continued)	
Ordnance Annex Sniper Range	The Ordnance Annex Sniper Range is an open terrain, natural earthen backstop area that is used to support marksmanship training. The Ordnance Annex Sniper Range is approved for up to .50 cal sniper rifle with unknown distance targets. Figure 2-5 depicts the Ordnance Annex Training Areas.
Northern Land Navigation Area (NLNA)	The NLNA is located in the northeast corner of Ordnance Annex where small unit FTX and foot and vehicle land navigation training occurs. Figure 2-5 depicts the Ordnance Annex Training Areas.
Southern Land Navigation Area (SLNA)	The SLNA is located in the southern half of Ordnance Annex where foot land navigation training occurs. Figure 2-5 depicts the Ordnance Annex Training Areas.
General	Air training activities occur here, including combat search and rescue (CSAR), insertion/extraction, and fire bucket training. Figure 2-5 depicts the Ordnance Annex Training Areas.
Communications Annex: The Communications Annex comprises approximately 3,000 acres at Finegayan and 1,800 acres at Barrigada. The annex includes open area and secondary forest available for small field exercises, and Haputo Beach for small craft (combat rubber raiding craft [CRRC]) type landings	
Finegayan Communications Annex	Finegayan Communications Annex supports FTX and MOUT training. Haputo Beach is used for small craft (e.g., CRRC) landings and Over the Beach insertions. Haputo Beach is part of the Haputo ecological reserve area. The Finegayan Small Arms Ranges (FSAR) are located in the Finegayan Communications Annex. Also referred to as the "North Range," FSAR supports qualification and training with small arms up to 7.62mm. The small arms ranges are known distance ranges consisting of a long flat cleared, earthen bermed area that is used to support marksmanship. Within the Finegayan Housing area is a small group of unoccupied buildings that support a company-sized (approximately 200-300) ground combat unit to conduct MOUT-type training, including use of LZ and DZ. A new DZ (called Ferguson-Hill) is under review with the FAA. Open areas provide command and control (C2) and logistics training; bivouac, vehicle land navigation, and convoy training; and other field activities. Figure 2-6 depicts the Finegayan Communications Annex Training Areas and Figure 2-7 depicts the Communications Annex, Barrigada.
Barrigada Communications Annex	Barrigada Communications Annex supports FTX and MOUT training. The Barrigada Housing area contains a few unoccupied housing units available for MOUT-type training. Open areas (former transmitter sites) provide command and control (C2) and logistics training; bivouac, vehicle land navigation, and convoy training; and other field activities.

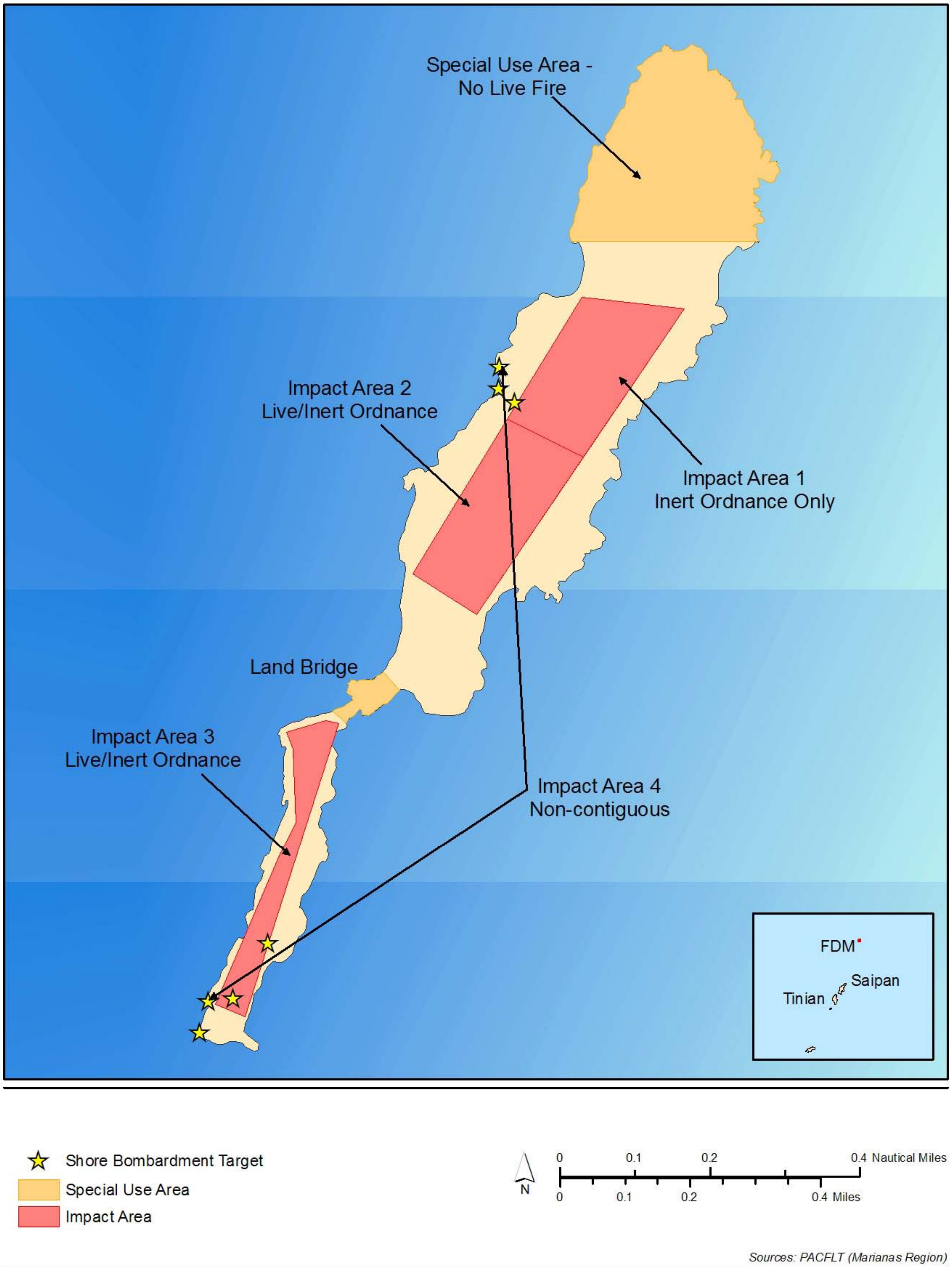
Table 2-2: Navy Controlled and Managed MIRC Training Areas (Continued)

Training Area	Detail/Description
Tinian: Tinian Military Lease Area (MLA). The MLA consists of 15,400 acres divided into two parcels.	
Exclusive Military Use Area (EMUA)	The EMUA is DoD-leased land (7,600 acres) covering the northern third of Tinian. The key feature is North Field, an unimproved expeditionary World War II (WWII) era airfield used for vertical and short-field landings. North Field is also used for expeditionary airfield training including C2, air traffic control (ATC), logistics, armament, fuels, rapid runway repair, and other airfield-related requirements. North Field is a National Historic Landmark. The surrounding area is used for force-on-force airfield defense and offensive training. The EMUA has two sandy beaches, Unai Chulu and Unai Dankulo (Long Beach), that are capable of supporting LCAC training at high tides. Only Unai Chulu has been used for LCAC training; however, storm damage and tree growth requires craft landing zone and beach improvements prior to use. Unai Dankulo also has the capability to support LCAC landings with craft landing zone and beach improvements. Unai Babui is a rocky beach capable of supporting narrow single-lane AAV landings; however, it would require channel, landing zone, and beach improvements. There are no active live-fire ranges on the EMUA, except sniper small arms into bullet traps. Future plans for any live-fire ranges will be addressed in other National Environmental Policy Act (NEPA) documents. Tinian is capable of supporting Marine Expeditionary Unit (MEU) and Marine Air Wing (MAW) events such as ground element training and air element training, Noncombatant Evacuation Operation (NEO), airfield seizure, and expeditionary airfield training, and special warfare activities, including large MEU and MAW training events. Figure 2-8 depicts the Tinian Training Land Use and Saipan.
Lease Back Area (LBA)	The LBA is DoD-leased land (7,800 acres) covering the central portion of the island, and makes up the middle third of Tinian. A key feature is the proximity to the commercial airport on the southern boundary of the LBA. The runway is not instrumented; however, it is capable of landing large aircraft. The airport has limited airfield services. The LBA is used for ground element training including MOUT-type training, C2, logistics, bivouac, vehicle land navigation, convoy training, and other field activities. There are no active live-fire ranges on the LBA, except sniper small arms into bullet traps. Figure 2-8 depicts the Tinian Training Land Use and Saipan.



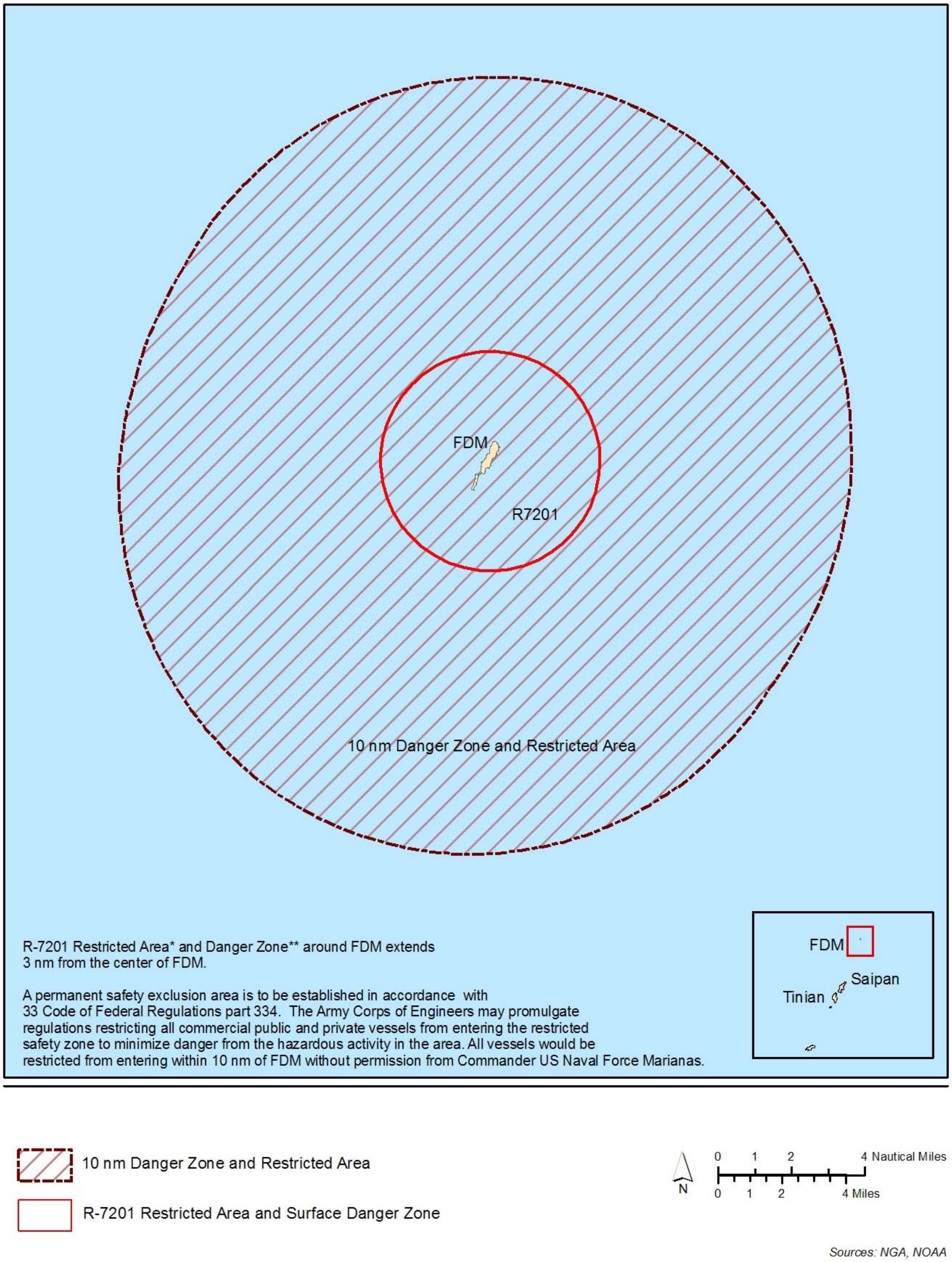
Source: ManTech-SRS

Figure 2-1: W-517 Aerial Training Area



Source: ManTech-SRS

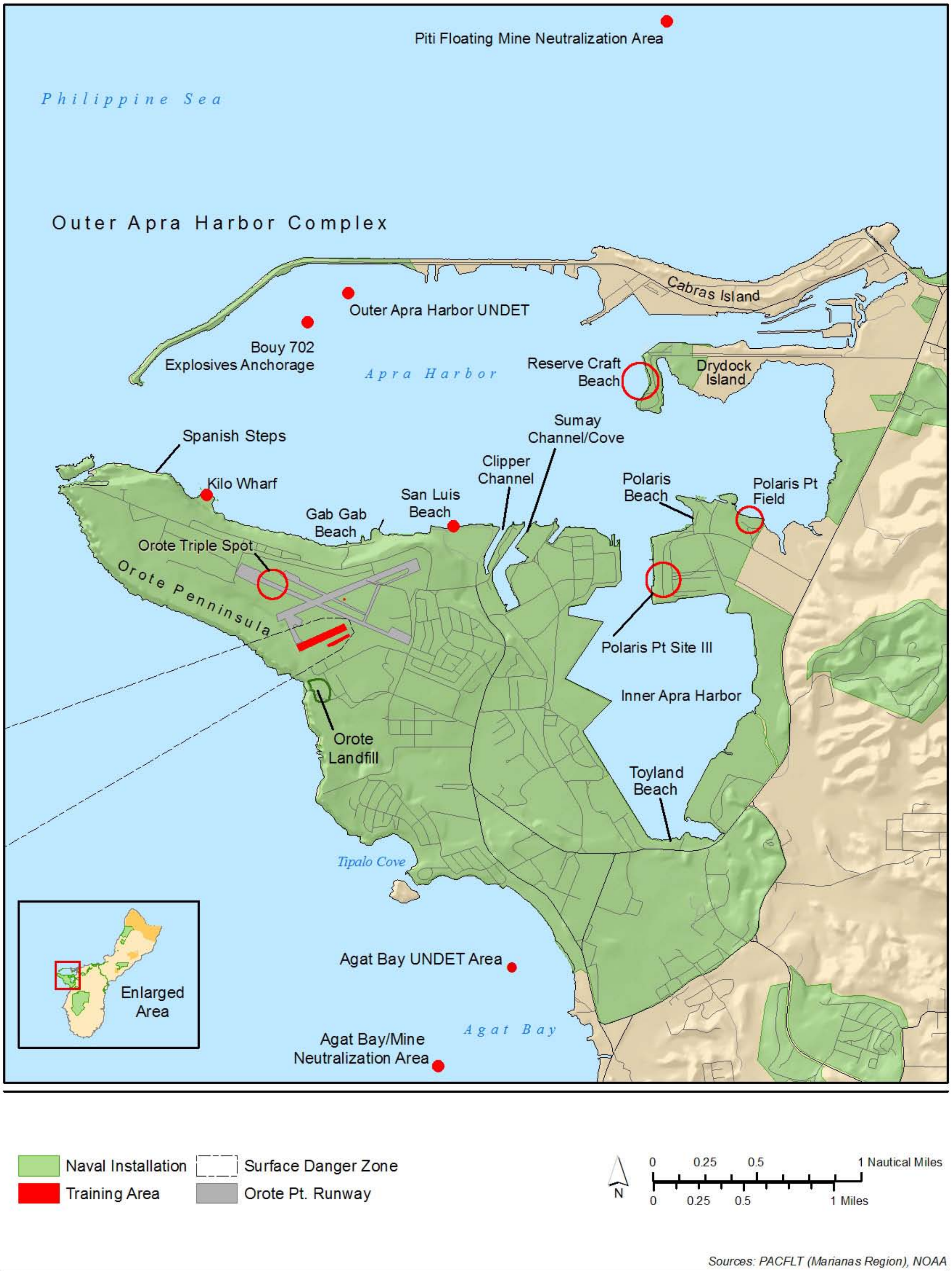
Figure 2-2: Farallon de Medinilla (FDM)



* In accordance with FAA Order JO 7400.8P: R-7201 center point at lat. 6°01'04"N., long. 146°04'39"E., altitude from surface to FL600

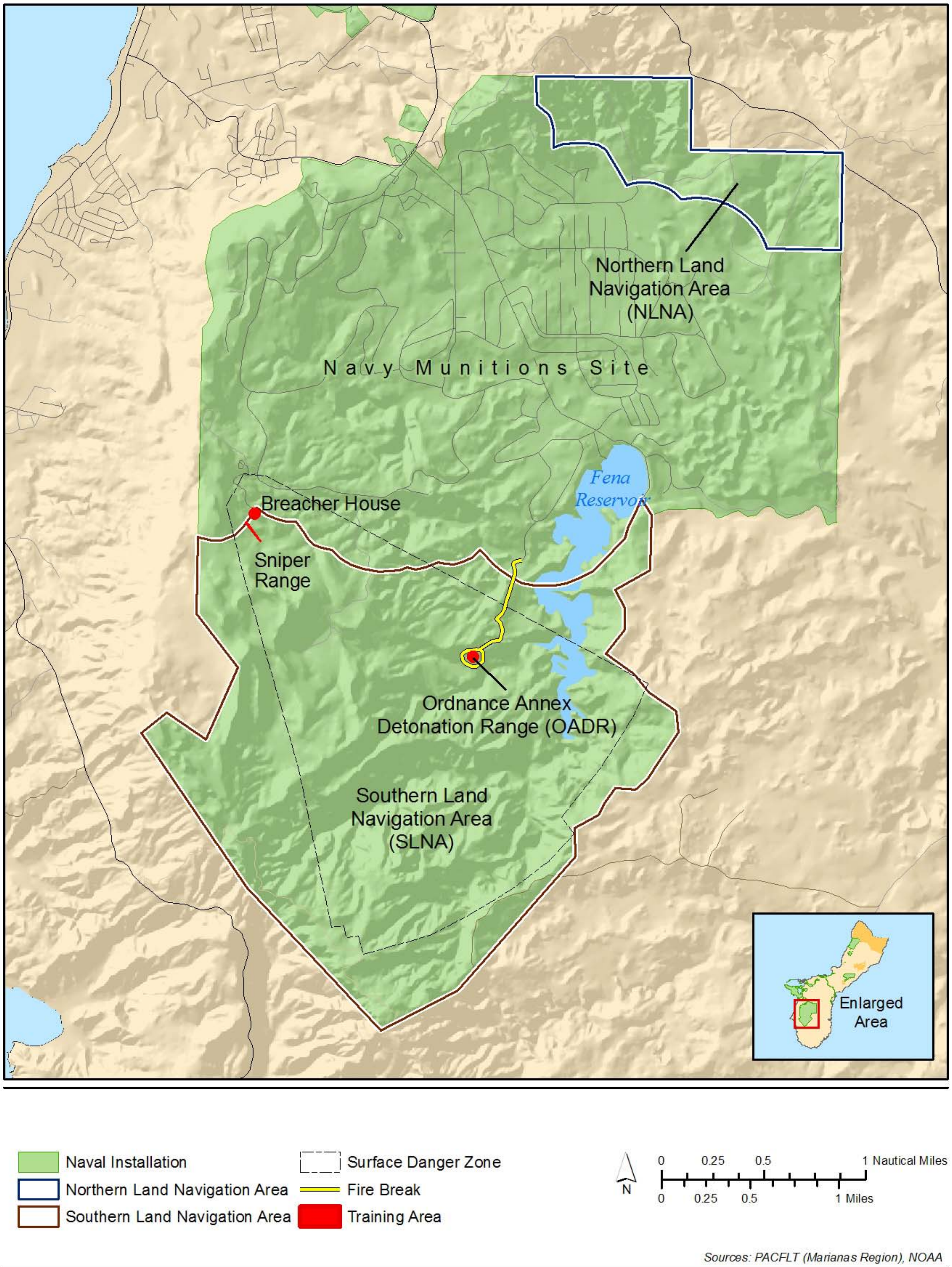
** Danger Zone In accordance with COMNAVMARINST 3502.1 FDM Range User Manual.

Figure 2-3: Farallon de Medinilla (FDM) Restricted Area and Danger Zone



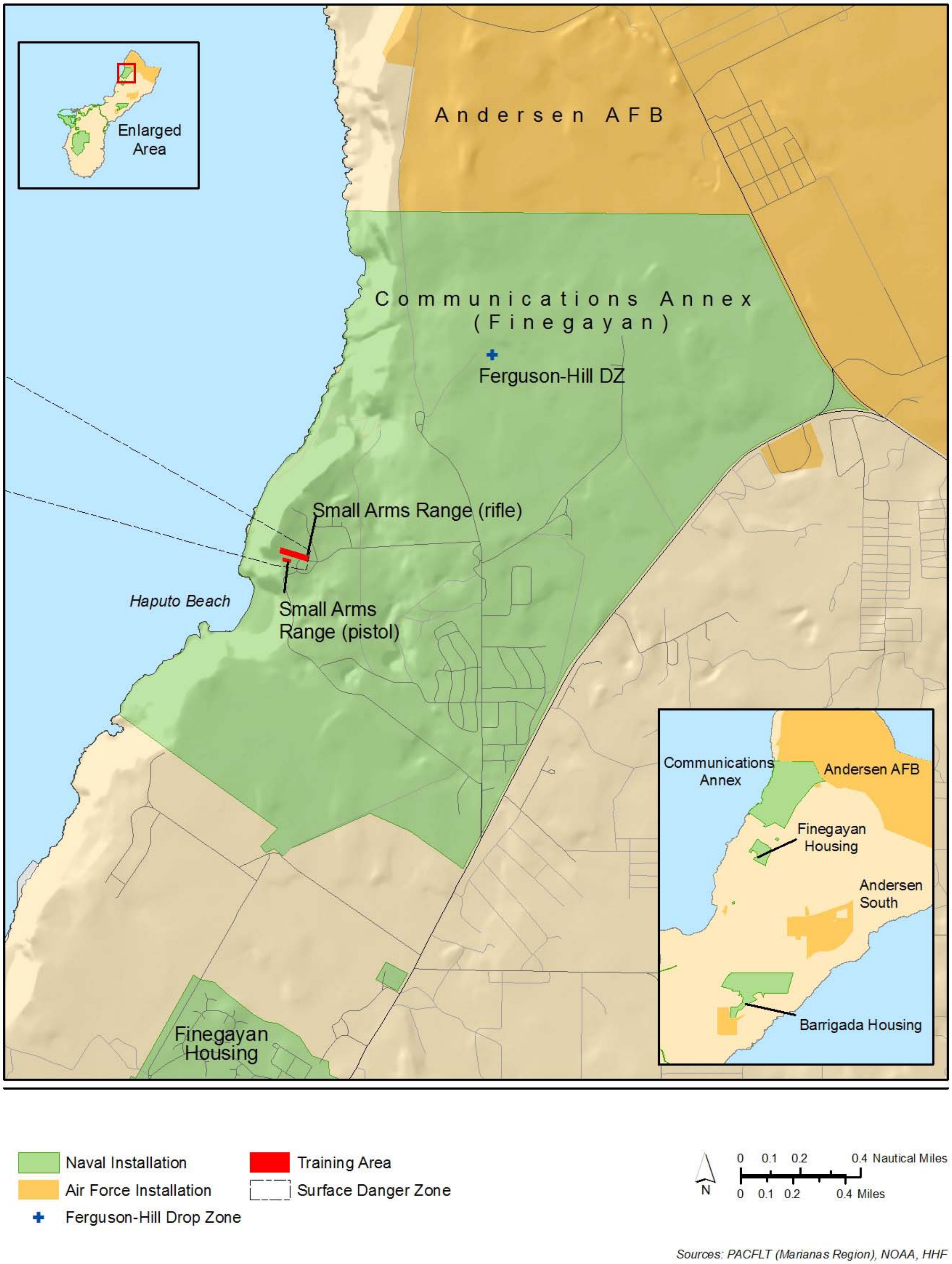
Source: ManTech-SRS

Figure 2-4: Apra Harbor and Nearshore Training Areas



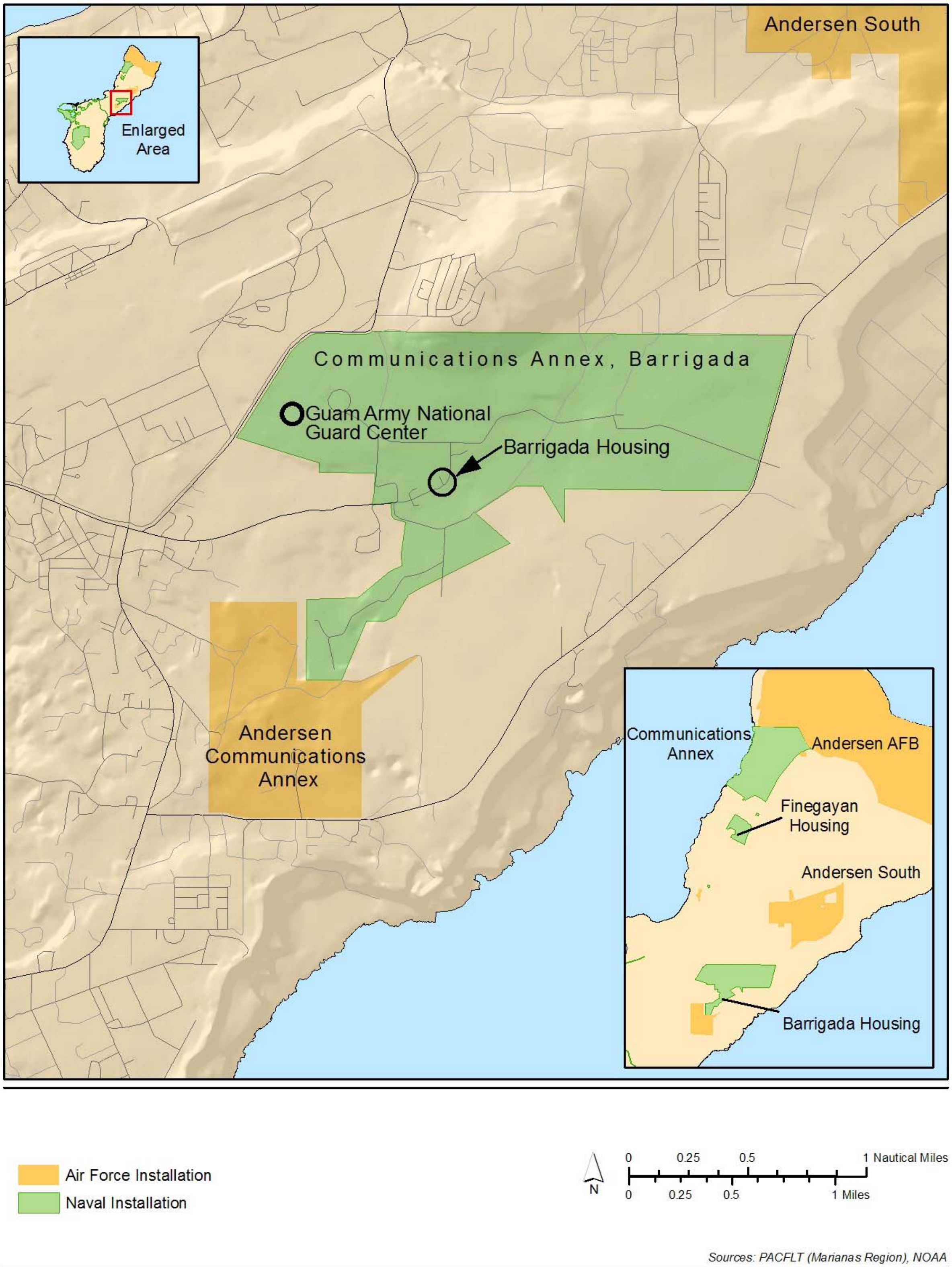
Source: ManTech-SRS

Figure 2-5: Ordnance Annex Training Areas



Source: ManTech-SRS

Figure 2-6: Finegayan Communications Annex Training Areas



Source: ManTech-SRS

Figure 2-7: Communications Annex, Barrigada

Source: ManTech-SRS

Figure 2-8: Tinian Training Land Use and Saipan

2.1.3 Air Force Controlled and Managed Training Areas of the MIRC

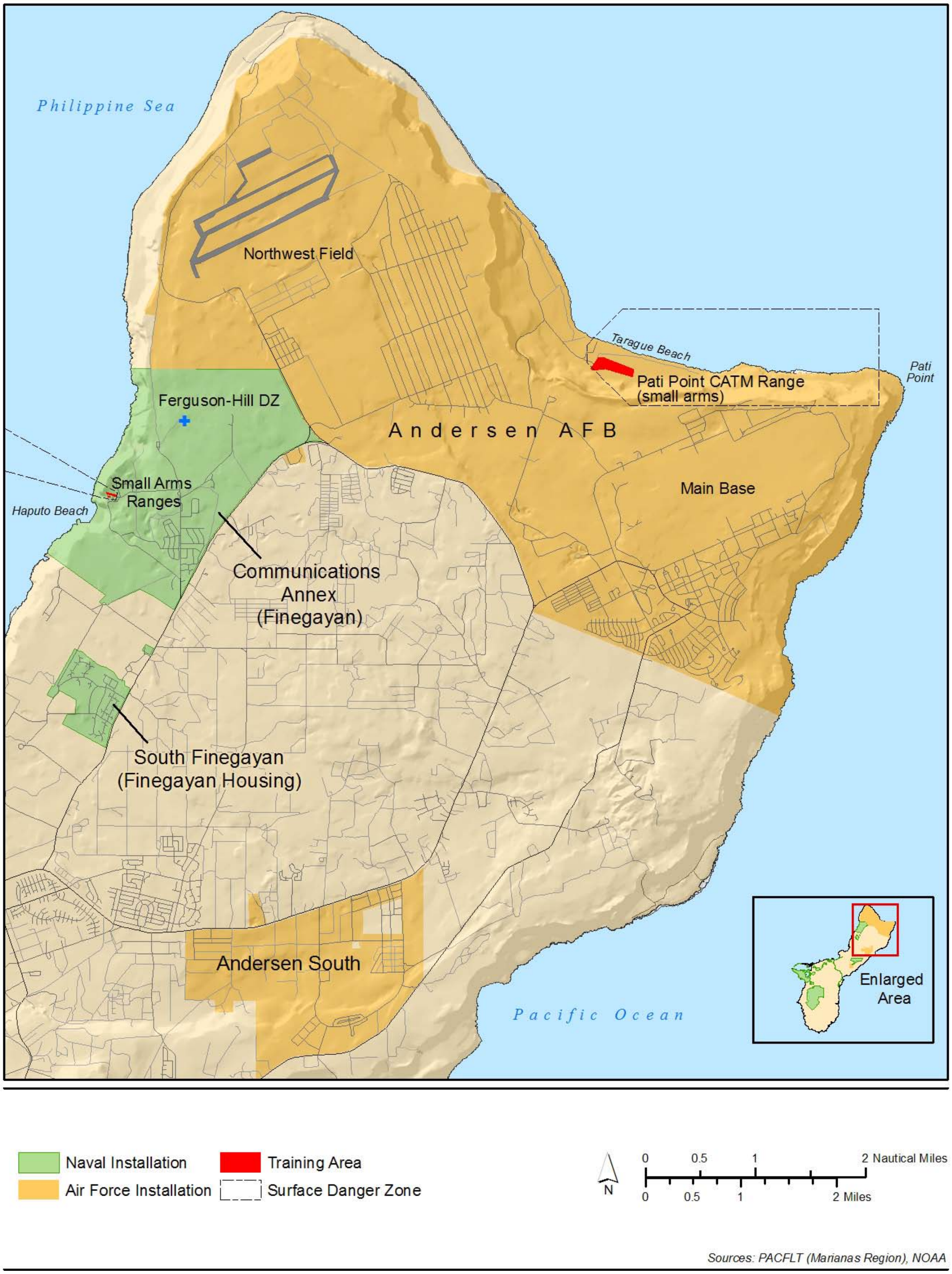
Administered by 36th Wing, the Main Base at Andersen AFB comprises about 11,500 acres. The base is used for aviation, small arms, and Air Force EOD training. As a large working airfield, the base has a full array of operations, maintenance, and community support facilities. 36th Wing supports all U.S. military aircraft and personnel transiting the Mariana Islands. 36th Wing is host to deployed bomber, fighter, and aerial refueling squadrons, and with the completion of the ISR/Strike initiative will host rotationally deployed F-22 aircraft, and permanently deployed air lift and refueling aircraft, and RQ-4 Global Hawk Unmanned Aerial Vehicle (UAV). Facilities are available for cargo staging and inspection. Undeveloped terrain consists of open and forested land. The coastline of the base consists of high cliffs and a long, narrow recreation beach (Tarague Beach) to the northeast. Multiple exposed coral pillars negate use of this beach for amphibious landings by landing craft or amphibious vehicles.

The 36th Contingency Response Group (CRG) is the controlling authority for operations and training conducted on Andersen Air Force Base (11,000 acres). The 36th CRG controls training at Northwest Field (4,500 acres) and Andersen South (1,900 acres). The 36th Security Forces Squadron (SFS) controls the Pati Pt. Combat Arms Training and Maintenance (CATM) Range (21 acres).

Table 2-3 provides an overview of each Air Force controlled and managed area and its location. Figure 2-9 depicts those training areas associated with Andersen AFB.

Table 2-3: Air Force Controlled and Managed MIRC Training Areas

Training Area	Detail/Description
Northwest Field	Northwest Field is an unimproved expeditionary WWII era airfield used for vertical and short field landings. Approximately 280 acres of land are cleared near the eastern end of both runways for parachute drop training. The south runway is used for training of short field and vertical lift aircraft and often supports various types of ground maneuver training. Helicopter units use other paved surfaces for Confined Area Landing (CAL), simulated amphibious ship helicopter deck landings, and insertions and extractions of small maneuver teams. About 3,562 acres in Northwest Field are the primary maneuver training areas available at Andersen AFB for field exercises and bivouacs. Routine training exercises include camp/tent setup, survival skills, land navigation, day/night tactical maneuvers and patrols, blank ammunition and pyrotechnics firing, treatment and evaluation of casualties, fire safety, weapons security training, perimeter defense/security, field equipment training, and chemical attack/response. The Air Force will complete its Northwest Field Beddown and Training and Support Initiative, co-locating at Northwest Field the Rapid Engineer Deployable Heavy Operations Repair Squadron Engineers (RED HORSE) and its Silver Flag training unit, the Commando Warrior training program, and the Combat Communications squadron. Additional information concerning these activities is contained in the Northwest Field Beddown Initiative Environmental Assessment (EA).
Andersen South	Andersen South consists of abandoned military housing and open area consisting of 1,922 acres. Andersen South open fields and wooded areas are used for basic ground maneuver training including routine training exercises, camp/tent setup, survival skills, land navigation, day/night tactical maneuvers and patrols, blank ammunition and pyrotechnics firing, treatment and evaluation of casualties, fire safety, weapons security training, perimeter defense/security, field equipment training. Vacant single-family housing and vacant dormitories are used for MOUT training and small-unit tactics. The buildings may need repairs and upgrade to be suitable for consistent use in training.
Main Base	Andersen Main Base is dedicated to its primary airfield mission. Administered by 36th Wing, the Main Base at Andersen AFB comprises about 11,500 acres. The base is used for aviation, small arms, and Air Force EOD training. As a working airfield, the base has a full array of operations, maintenance, and community support facilities. 36th Wing supports all U.S. military aircraft and personnel transiting the MIRC. Facilities are available for cargo staging and inspection.
Pati Point (Tarague Beach) Combat Arms and Training Maintenance (CATM) Range and EOD Pit	Pati Point consists of 21 acres used for the CATM small arms range. The CATM range supports training with pistols, rifles, machine guns up to 7.62mm, and inert mortars up to 60mm. Training is also conducted with the M203 40mm grenade launcher using inert training projectiles only.



Source: ManTech-SRS

Figure 2-9: Andersen Air Force Base Assets

2.1.4 Federal Aviation Administration Air Traffic Controlled Assigned Airspace

As per the Letter of Agreement (LOA) dated 15 May, 2007 between Guam Air Route Traffic Control Center (ARTCC), Commander, U.S. Naval Forces Marianas (COMNAVMAR), and 36th Operations Group, COMNAVMAR is designated the scheduling and using agency for W-517, and ATCAAs 1, 2, 3A, 3B, 3C, 4, 5, and 6. Guam ARTCC is designated the Controlling Agency. Guam ARTCC decommissioned ATCAA 4 in November 2007.

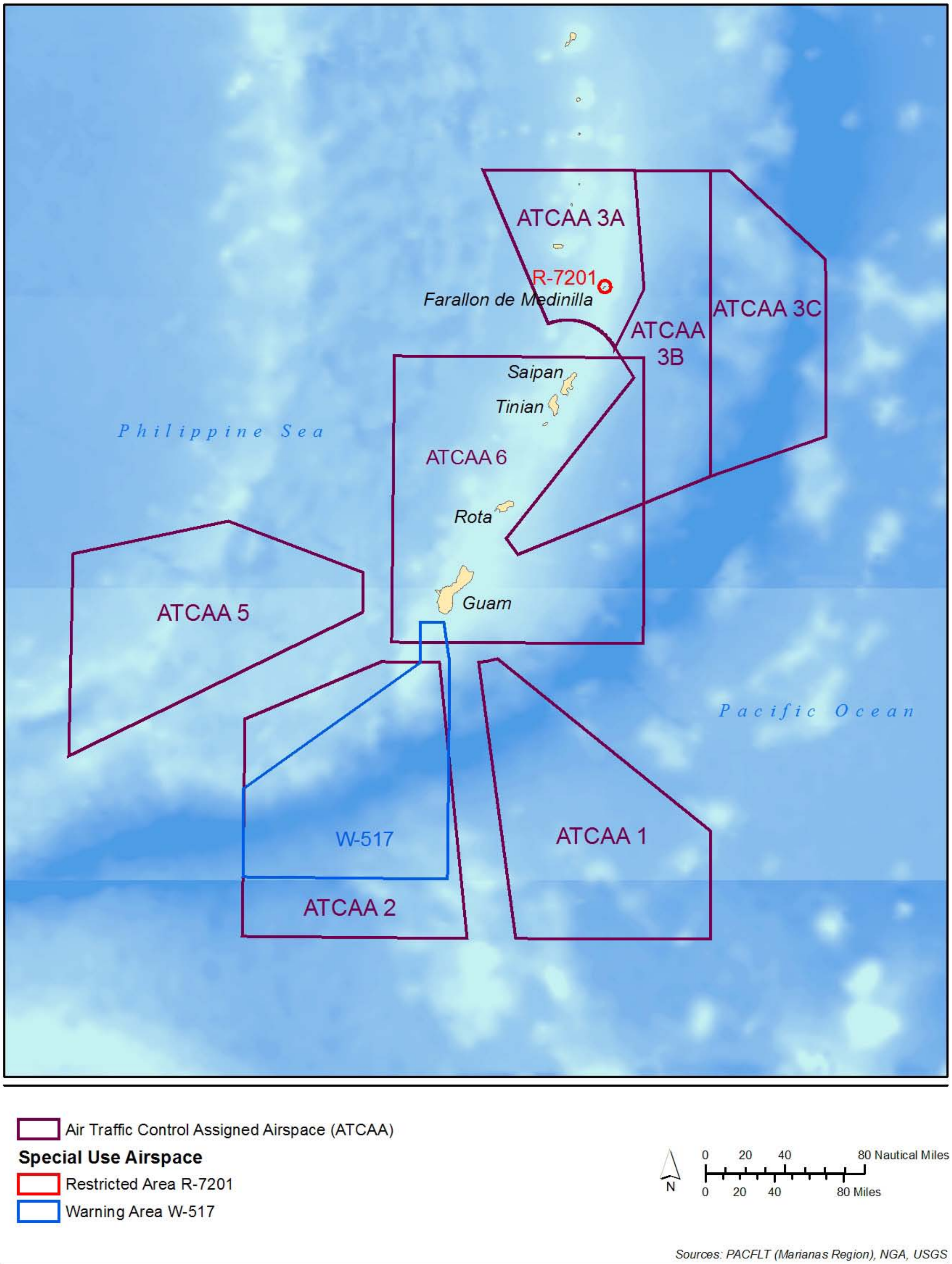
Range control consists of scheduling with training and operational units and notifying others of that schedule via Notice to Airmen (NOTAM) and Notice to Mariners (NOTMAR).

Table 2-4 provides more detailed information about the ATCAA. Figure 2-10 shows the location of the ATCAA.

Table 2-4: FAA Air Traffic Controlled Assigned Airspace

Subcomplex Name/Training Area				
Air Traffic Controlled Assigned Airspace:				
Airspace	**nm²**	**Lower Limit**	**Upper Limit**	**Over Land?**
ATCAA 1	10,250	Surface	Unlimited	No
ATCAA 2	13,750	Surface	Unlimited	No
ATCAA 3A	5,000	Surface	Unlimited	No, except for FDM
ATCAA 3B	7,750	Surface	FL300	No
ATCAA 3C	8,000	Surface	Unlimited	No
ATCAA 5	10,500	Surface	FL300	No
ATCAA 6	15,300	FL390	FL430	No
W-517 lies mostly within ATCAA 2. **R-7201 lies within ATCAA 3A.**				

Sources: Commander, Naval Forces Marianas; Federal Aviation Administration



Source: ManTech-SRS

Figure 2-10: MIRC ATCAAs

2.1.5 Other MIRC Training Assets

Other MIRC training areas include training facilities controlled and managed by the AR-Marianas and the Guam Army National Guard (GUARNG) and the Government of the CNMI.

Table 2-5 provides more detailed information about these other MIRC training assets. Figure 2-8 locates the Army Reserve Center, Saipan. Figure 2-11 locates the NSWU-1 leased pier space and laydown area on Rota.

Table 2-5: Other MIRC Training Assets

Subcomplex Name/ Training Area	Detail/Description
Guam:	
Army Reserve Center	Located on Barrigada Communications Annex, and supporting approximately 1,200 Army reservists. Contains an indoor small arms range (9mm).
Guam Army National Guard Center	Located on Barrigada Communications Annex and supports approximately 1,000 Guam Army National Guard personnel. Contains armory, classrooms, administrative areas, maintenance facilities, and laydown areas.
Saipan:	
Army Reserve Center	Saipan Army Reserve Center (Figure 2-8) contains armory, classrooms, administrative areas, maintenance facilities, and laydown areas and supports C2, logistics, AT/FP, bivouac, and other headquarter activities.
Commonwealth Port Authority	The Navy has access to approximately 100 acres of Port Authority area including wharf space which supports VBSS, AT/FP, and NSW training activities.
East Side of northern Saipan (Marpi Pt. area)	With the coordination of the Army Reserve Unit Saipan and the approval of CNMI government, land navigation training is conducted on non-DoD lands.
Rota: Rota, which is about 40 miles from Guam, is capable of supporting long-range NSW missions between Guam, Tinian, and FDM. Boat refueling is conducted at commercial marina on Rota, as well as Saipan and Tinian.	
Commonwealth Port Authority	The Navy has access to Angyuta Island seaward of Song Song's West Harbor as a Forward Staging Base/overnight bivouac site. The island is adjacent to the commercial port facility and leased space is used for boat refueling and maintenance.
Municipality of Rota	Certain types of special warfare training including hostage rescue, NEO, and MOUT are conducted with local law enforcement, on non-DoD lands.

Source: ManTech-SRS

Figure 2-11: Rota

2.2 PROPOSED ACTION AND ALTERNATIVES

The purpose of the Proposed Action is to achieve and maintain Service readiness using the MIRC to support current and future training activities. The Services propose to:

1. Maintain baseline training activities at current levels.
2. Increase training activities from current levels as necessary.
3. Accommodate force structure changes (new platforms and weapons systems).
4. Implement range enhancements associated with the MIRC.

2.2.1 Alternatives Development

The analysis of alternatives is the heart of an EIS and is intended to provide the decision-maker and the public with a clear understanding of relevant issues and the basis for choice among identified options. National Environmental Policy Act (NEPA) requires that an EIS be prepared to evaluate the environmental consequences of a range of reasonable alternatives. Reasonable alternatives must meet the stated purpose and need of the Proposed Action. Reasonable alternatives include those that are practical or feasible from the technical and economic standpoint.

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. Section 1502.14(d) of the CEQ guidelines requires that the alternatives analysis in the EIS "include the alternative of no action." For evaluating the Proposed Action under this EIS, the current level of range management activity is used as a benchmark. By proposing the status quo as the No Action Alternative, the Navy compares the impacts of the proposed alternatives to the impacts of continuing to operate, maintain, and use the MIRC in the same manner and at the same levels as they do now.

The No Action Alternative is representative of baseline conditions, where the action presented represents a regular and historical level of activity on the MIRC to support training activities and exercises. The No Action Alternative serves as a baseline, and represents the "status quo" when studying levels of range usage and activity. This use of the current level of operations as a baseline level is appropriate under CEQ guidance, as set forth in the *Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations*, Question #3. The No Action Alternative, or the current level of training and RDT&E activities, has been analyzed in the *Military Training in the Marianas EIS*, *June 1999* and in several EAs (e.g., OEA Notification for Air/Surface International Warning Areas and Valiant Shield OEA) for more specific training events or platforms. The preferred alternative analyzes greater use of range assets to support training activities and maximize training opportunities that fully support the increased training requirements of the ISR/Strike initiative and increased surface and undersea training.

The Services have 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 the alternatives must be feasible, reasonable, and reasonably foreseeable in accordance with CEQ regulations (40 C.F.R. 1500-1508). Reasonable alternatives include those that are practical or feasible from the technical and economic standpoint. Alternatives that are outside the scope of what Congress has approved or funded must still be evaluated in the EIS/OEIS if they are reasonable, because the EIS/OEIS may serve as the basis for modifying congressional approval or funding in light of NEPA goals and policies.

Alternatives were selected based on their ability to meet the following criteria:

1. Location where Joint U.S. forces can train within a specified geographical region.
2. Location where 7th Fleet forces can train within their area of responsibility (AOR).
3. Location where training requirements of deployed military forces can be met while remaining within range of Western Pacific (WestPac) nations.
4. Location where training can be accomplished within the territory of the United States.
5. Training capabilities must meet operational requirements by supporting realistic training.
6. Training capacity must meet Fleet deployment schedules, and Service training schedules, standards, and exercises.
7. The range complex must meet the requirements of DoD Directive 3200.15, "Sustainment of Ranges and Operating Areas (OPAREA)."
8. The range complex must be capable of implementing new training requirements and RDT&E activities.
9. The range complex must be capable of supporting current and forecasted range and training upgrades.

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 considered in this EIS/OEIS includes mitigation measures intended to reduce the environmental effects of Navy activities. Protective measures, such as Best Management Practices (BMPs) and Standard Operating Procedures (SOPs) are discussed throughout this EIS/OEIS.

2.2.2 Alternatives Eliminated from Further Consideration

Alternatives that included additional training areas capabilities and platforms were reviewed to be included in this document, including a Fixed Underwater Tracking Range (FUTR), support for the Littoral Combat Ship (LCS), use of the existing mortar range on Tinian, and expansion of amphibious landings beyond those covered in the 1999 Military Training in the Marianas EIS. Activities that would require additional area or platforms or activities with insufficient information to characterize the action were eliminated from further consideration because there was insufficient information to perform an impact analysis. In addition, the timing for these activities may occur outside the reasonable timetable (5-10 years) for this EIS/OEIS. Under NEPA, these projects are too premature to analyze. These additional training capabilities, training platforms, and/or areas may be addressed in the future.

2.2.2.1 Alternative Range Complex Locations

Consideration of alternative locations for training presently conducted in the MIRC was rejected from further analysis because it does not meet the criteria set forth for the purpose and need of the Proposed Action. This document provides a description of existing training and RDT&E activities and reasonably foreseeable alternative levels of activity within the MIRC, and an analysis of the environmental consequences of training and RDT&E activities.

The MIRC is the only capable and efficient training location within the territory of the United States in the WestPac for military services homeported, deployed to, or returning from regions in the WestPac and the Indian Ocean. The MIRC has the capability to support a large number of forces (multi-national air, land, and sea components), has extensive existing range assets, and accommodates training and testing responsibilities both geographically and strategically, in a location under U.S. control. The U.S. military's physical presence and training capabilities are critical in providing stability to the Pacific Region. Strategically located in the WestPac, the MIRC has a unified presence of Army, Marine Corps, Navy, Air Force, National Guard, and Coast Guard elements. The MIRC's strategic location provides the Pacific Joint Commander an area from which he can launch strategic engagement plans that may include multinational training with allied nations from North America, Australia, and Asia or training U.S. forces for contingency response to a humanitarian or geo-political crisis. Multi-national training not only provides a well-trained force, but also furthers international cooperation in the WestPac area.

The open ocean of the MIRC presents a realistic environment for strike warfare training, contingency operations training including amphibious training activities, and ASW. Training may be conducted in the open ocean, close to land masses, and in unobstructed airspace so that battle situations may be realistically simulated. There is room and space to operate within proximity of land but at safe distances from other simultaneous training. This allows both training of locally based units and the necessary build-up of capability through training that culminates in multi-force training in waters offshore of Guam and CNMI. There are land-based ranges on Guam and CNMI. The premier capability of the MIRC is the combination of large ocean and airspace to support undersea, surface, air, and space warfare training combined with land-based ranges.

One of DoD's highest priorities is maintaining the readiness and sustainability of U.S. forces. Readiness is the overall ability of forces to arrive on time where needed, and be sufficiently trained, equipped, and supported to effectively carry out assigned missions. Forces must be placed and maintained such that they can be utilized in a timely fashion. A timely response is directly related to the amount of time required to reach the destination, and dependent on distance traveled. The distance from the potential threat can vary based on unit type and need, as well as mode of transport. Traditionally, forces were deployed in a slow steady buildup over time. Now, however, crises manifest quickly in a variety of locations. Forces must be placed and maintained such that they can provide a rapid and timely response. Therefore, it is imperative to locate forces so that the amount of time required to reach a crisis location is kept to a minimum. Table 2-6 shows the response time by air and sea once forces are deployed from Guam, Alaska, Hawaii, and California to South Korea, Japan, Taiwan, and Singapore, respectively. As the table shows, deployed forces that use the MIRC have reduced response times compared to forces positioned in Alaska, Hawaii, or California.

Table 2-6: Response Times to Asia by Air and Sea

	Guam	Alaska	Hawaii	California
Air Deployment (based on C-17 speed of 450 knots) - hours				
South Korea	4.4	8.2	10.1	13.4
Japan	3.3	7.6	8.7	12.2
Taiwan	3.8	10.4	11.2	15.2
Singapore	6.4	14.9	15.1	19.6
Sea Deployment (based on ship speed of 20 knots) - days				
South Korea	4.2	7.7	9.5	12.5
Japan	3.1	7.1	8.1	11.5
Taiwan	3.5	9.7	10.5	14.3
Singapore	6.0	14.0	14.2	18.4

The greatest flexibility for the U.S. military to train is on ranges located in the United States. Other governments, while having strategic advantages to ensuring force capabilities in the region, may be unwilling to consider an expansion of training within their borders. This could limit the response flexibility of U.S. troops during times of maximum threat. Guam and CNMI are U.S. territories, and thus afford the greatest flexibility and the fewest restrictions from a government to government standpoint.

For the above reasons, it is neither reasonable, practicable, nor appropriate to seek alternative locations for training conducted in the MIRC. This alternative, therefore, has been eliminated from further consideration in the EIS/OEIS.

2.2.2.2 Simulated Training

Training by the military Services includes extensive use of computer-simulated virtual training environments, and conducting command and control (C2) exercises with assigned role play and modeling versus actual 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, these methods do not provide the requisite level of realism necessary to attain combat readiness, and cannot replicate the high-stress environment encountered during an actual combat situation.

The Services continue to research new ways to provide realistic training through simulation, but there are limits to realism that simulation can provide, most notably in dynamic environments involving numerous forces, and where the training media is too complex to accurately model. Simulation cannot replicate the dynamics of the natural environment, especially the unanticipated. A good example of this is the behavior of sound in the ocean, as currents and sea temperature may change quickly under certain weather conditions, thereby invalidating standard assumptions. Simulators may assist in developing an understanding of basic skills and equipment operation, but cannot offer a complete picture of the detailed and instantaneous interaction within each command and among the many commands and warfare communities that actual training at sea provides. A simulator can not replicate the dynamic maneuvering of various ships/units within any area of ocean.

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.

While classroom training and computer simulations are valuable methods for basic training they are no substitute for real-time, at-sea training which mimics the conditions the Services and their allies would encounter in actual operating environments. Therefore, the use of training ranges, unlike simulators, is vital. The training that occurs in these designated training areas allows for safe and effective multi-warfare training.

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.

2.2.2.3 Concentrating the Level of Current Training in the MIRC to Fewer Sites

During scoping, an alternative to decrease the training venues within the MIRC and increase the level of training activities in those venues was suggested. This alternative suggested increasing training activities in certain venues by increasing event tempo and frequency, through improvements in coordination and schedules. This would allow some training venues to be eliminated and the concentrated impacts of training would occur at fewer sites. A concentration of training at fewer locations would not support the same amount of training, would jeopardize the quality of training, and would raise significant safety concerns. In addition, a concentration in training activities could jeopardize the ability of specialty forces, transient units, and Strike Groups using the MIRC to train together, as the training for some units is incompatible with the training for other groups because of operational or safety actions required. This could preclude the forces from being ready and qualified for operations. Lastly, a concentration in training activities in the MIRC would cause a large disruption in training schedules if unforeseen circumstances such as weather conditions precluded training to occur. Without the flexibility of multiple training venues, units would have their schedule disrupted, or would have to travel to other range complexes to fulfill training requirements. This would result in an unacceptable increase in time away from the AOR, increase cost of training, and not meet the criteria for the purpose and need. For these reasons, this alternative has been eliminated from further consideration in the EIS/OEIS.

2.2.3 Proposed Action and Alternatives Considered

Three alternatives are analyzed in this EIS/OEIS:

1. The No Action Alternative – Current Training within the MIRC.
2. Alternative 1 – Current training; increased training supported by modernization and upgrades/modifications to existing capabilities; training associated with ISR/Strike; and multi-national and/or joint exercises.
3. Alternative 2 – Current training; increased training supported by modernization and upgrades/modifications to existing capabilities; training associated with ISR/Strike; increased multi-national and/or joint exercises; and additional naval exercises.

Note that each Alternative builds on the previous Alternative, so that Alternative 2 would capture all the activities proposed, including those current training activities under the No Action Alternative.

The Preferred Alternative in this EIS/OEIS is Alternative 1.

The major exercise footprints that are included in the alternatives are summarized in Table 2-7 at the end of this chapter. Table 2-8 summarizes the component training activities that make up the major exercises and unit-level training for the Proposed Action and Alternatives discussed in the following sections.

2.3 NO ACTION ALTERNATIVE – CURRENT TRAINING WITHIN THE MIRC

The No Action Alternative is the continuation of training activities, RDT&E activities, and continuing base activities. This includes all multi-Service training activities on DoD training areas, including either a joint expeditionary warfare exercise or a joint multi-strike group exercise. The current military training in the MIRC was initially analyzed in the 1999 *Final Environmental Impact Statement Military Training in the Marianas* and in several EAs (*e.g*., OEA Notification for Air/Surface International Warning Areas and Valiant Shield OEA) for more specific training events or platforms. As such, evaluation of the No Action Alternative in this EIS/OEIS provides a baseline for assessing environmental impacts of Alternative 1 (Preferred Alternative), and Alternative 2, as described in the following subsections.

While the No Action Alternative meets a portion of the Service's requirements, it does not meet the purpose and need. This Alternative does not provide for training capabilities for ISR/Strike, undersea warfare improvements, or increased training activities within the MIRC. With reference to the criteria identified in Section 2.2.1, the No Action Alternative does not satisfy criteria 7, 8, and 9 (relating to support for the full spectrum of training requirements).

2.3.1 Description of Current Training Activities within the MIRC

Each military training activity described in this EIS/OEIS meets a requirement that can be traced ultimately to requirements from the National Command Authority (NCA) composed of the President of the United States and the Secretary of Defense. Based upon NCA requirements, the Joint Staff develops a set of high-level strategic warfighting missions, called the Universal Joint Task List (UJTL). The Joint Forces Command (JFCOM) and each military Service uses the UJTL to develop specific statements of required tactical tasks. Each Service derives its tactical tasks from the UJTLs. These Service-level tactical task lists are in turn applied to training requirements that the MIRC is to support with range and training area capabilities. Service tactical tasks that encompass the current training activities within the MIRC are listed in Table 2-8, are briefly described below in Service-specific groupings, and are described in greater detail in Appendix D. The source for these lists is the MIRC Range Complex Management Plan (RCMP).

2.3.1.1 Army Training

Surveillance and Reconnaissance (S&R). S&R are conducted to evaluate the battlefield and enemy forces, and to gather intelligence. For training of assault forces, opposition forces (OPFOR) units may be positioned ahead of the assault force and permitted a period of time to conduct S&R and prepare defenses against an assaulting force. S&R training has occurred at urban training facilities at Finegayan and Barrigada on Guam, and both the Exclusive Military Use Area (EMUA) and the Lease Back Area (LBA) on Tinian.

Field Training Exercise (FTX). An FTX is an exercise wherein the battalion and its combat and combat service support units deploy to field locations to conduct tactical training activities under simulated combat conditions. A company or smaller-sized element of the Army Reserve, GUARNG, or Guam Air National Guard (GUANG) will typically accomplish an FTX within the MIRC, due to the constrained environment for land forces. The headquarters and staff elements may simultaneously participate in a Command Post Exercise (CPX) mode. FTXs have occurred on Guam at Polaris Point Field, Orote Point Airfield/Runway, NLNA, Andersen Air Force Base Northwest Field, and Andersen South Housing Area, and on Tinian at the EMUA.

Live-Fire. Live-fire training is conducted to provide direct fire in support of combat forces. Limited live-fire training has occurred at Pati Pt. CATM Range.

Parachute Insertions and Air Assault. These air training activities are conducted to insert troops and equipment by parachute and/or by fixed or rotary wing aircraft to a specified objective area. These training activities have occurred at Orote Point Triple Spot, Polaris Point Field, and the Ordnance Annex Breacher House. Additionally, Orote Point Airfield/Runway supports personnel, equipment, and Container Delivery System (CDS) airborne parachute insertions.

Military Operations in Urban Terrain (MOUT). MOUT training activities encompass advanced offensive close quarter battle techniques used on urban terrain conducted by units trained to a higher level than conventional infantry. Techniques include advanced breaching, selected target engagement, and dynamic assault techniques using organizational equipment and assets. MOUT is primarily an offensive operation, where noncombatants are or may be present and collateral damage must be kept to a minimum. MOUT can consist of more than one type. One example might be a “raid,” in which Army Special Forces or Navy SEALs use MOUT tactics to seize and secure an objective, accomplish their mission, and withdraw. Another example might be a Marine Expeditionary Force (MEF) using MOUT tactics to seize and secure an objective for the long term. Regardless of the type, training to neutralize enemy forces must be accomplished in a built-up area featuring structures, streets, vehicles, and civilian population. MOUT training involves clearing buildings; room-by-room, stairwell-by-stairwell, and keeping them clear. It is manpower intensive, requiring close fire and maneuver coordination and extensive training. Limited, non–live-fire, MOUT training is conducted at the OPCQC House, Ordnance Annex Breacher House, Barrigada Housing, and Andersen South Housing Area. Additionally, the OPCQC supports “raid” type MOUT training on a limited basis.

2.3.1.2 Marine Corps Training

Ship to Objective Maneuver (STOM). STOM is conducted to gain a tactical advantage over the enemy in terms of both time and space. The maneuver is not aimed at the seizure of a beach, but builds upon the foundations of expanding the battlespace. STOM has occurred at the EMUA on Tinian.

Operational Maneuver. This training exercise supports forces achieving a position of advantage over the enemy for accomplishing operational or strategic objectives. These exercises have occurred at NLNA and SLNA.

Noncombatant Evacuation Operation (NEO). NEO training activities are conducted when directed by the Department of State, the DoD, or other appropriate authority whereby noncombatants are evacuated from foreign countries to safe havens or to the United States, when their lives are endangered by war, civil unrest, or natural disaster. NEO training activities have occurred at the EMUA on Tinian.

Assault Support (AS). AS exercises provide helicopter support for C2, assault escort, troop lift/logistics, reconnaissance, search and rescue (SAR), medical evacuation (MEDEVAC), reconnaissance team insertion/extract and Helicopter Coordinator (Airborne) duties. Assault support provides the mobility to focus and sustain combat power at decisive places and times. It provides the capability to take advantage of fleeting battlespace opportunities. Polaris Point Field and OPKDR provide temporary sites from which the MEU commander can provide assault support training to his forces within the MIRC. Assault support training activities have also occurred on Tinian at the EMUA.

Reconnaissance and Surveillance (R&S). R&S is conducted to evaluate the battlefield, enemy forces, and gather intelligence. For training of assault forces, OPFOR units may be positioned ahead of the assault force and permitted a period of time to conduct R&S and prepare defenses to the assaulting force. These types of training activities have occurred on Tinian at the EMUA.

Military Operations in Urban Terrain (MOUT). Marine Corps MOUT training is similar in nature and intent to Army MOUT training. MOUT training is conducted at the Ordnance Annex Breacher House. Additionally, the OPCQC supports "raid" type MOUT training on a limited basis.

Direct Fire. Direct Fire, similar in nature and content to Navy Marksmanship exercises, is used to train personnel in the use of all small arms weapons for the purpose of defense and security. Direct Fire training activities are strictly controlled and regulated by specific individual weapon qualification standards. These training activities have occurred at FDM and OPKDR. Another form of Marine Corps Direct Fire exercises involves the use of aircraft acting as forward observers for Naval Surface Fire Support (NSFS). During this training, Marine aircraft will act as spotters for the ships and relay targeting and battle hit assessments information. These types of training activities utilize FDM and ATCAA 3A airspace.

Exercise Command and Control (C2). This type of exercise provides primary communications training for command, control, and intelligence, providing critical interpretability and situation awareness information. C2 exercises have occurred at Andersen AFB.

Protect and Secure Area of Operations (Protect the Force). Force protection training activities increase the physical security of military personnel in the region to reduce their vulnerability to attacks. Force protection training includes moving forces and building barriers, detection, and assessment of threats, delay, or denial of access of the adversary to their target, appropriate response to threats and attack, and mitigation of effects of attack. Force protection includes employment of offensive as well as defensive measures. Force protection training activities have occurred at Northwest Field on Andersen Air Force Base.

2.3.1.3 Navy Training

Anti-Submarine Warfare (ASW) Training. ASW training engages helicopter and sea control aircraft, ships, and submarines, operating alone or in combination, in training to detect, localize, and attack submarines. ASW training involves sophisticated training and simulation devices utilizing sonobuoys, ship sonar systems, submarine sonar systems, and helicopter dipping sonar systems utilizing both passive and active modes. Underwater targets which emit sound through the water are also used. When the objective of the exercise is to track the target but not attack it, the exercise is called a Tracking Exercise (TRACKEX). A Torpedo Exercise (TORPEX) takes the training activity one step further, culminating in the release of an actual torpedo, which can be either a running Exercise Torpedo (EXTORP) or non-running Recoverable Exercise Torpedo (REXTORP). All torpedoes used in such training have inert warheads.

- *ASW Training Targets.* ASW training targets are used to simulate target submarines. They are equipped with one or a combination of the following devices:
  - Acoustic projectors emanating sounds to simulate submarine acoustic signatures;
  - Echo repeaters to simulate the characteristics of the echo of a particular sonar signal reflected from a specific type of submarine; and
  - Magnetic sources to trigger magnetic detectors.

  Two anti-submarine warfare targets are used in the Study Area. The first is the MK-30 Mobile ASW Training Target. The MK-30 target is a torpedo-like, self-propelled, battery powered underwater vehicle capable of simulating the dynamic, acoustic, and magnetic characteristics of a submarine. The MK-30 is 21 inches in diameter and 20.5 feet in length. These targets are launched by aircraft and surface vessels and can run approximately four hours dependent on the programmed training scenario. The MK 30 is recovered after the exercise for reconditioning and subsequent reuse.
- *MK-84 Range Pingers*. MK-84 range pingers are used in association with the Portable Underwater Tracking Range and are active acoustic devices that allow ships, submarines, and target simulators to be tracked by means of deployed hydrophones. The signal from a MK-84 pinger is very brief (15 milliseconds) with a selectable frequency at 9.24 kHz, 12.93 kHz, 33.15 kHz, or 36.95 kHz and a source level of approximately 190 dB Sound Pressure Level (SPL).

Air Warfare (AW) Training. AW training includes one or more of the following training activities.

- *Surface-to-Air Missile Exercise (S-A MISSILEX).* Missiles are fired from either aircraft or ships against aerial targets.
- *Air-to-Air Missile/Gunnery Exercise (A-A MISSILEX/GUNEX).* Involve a fighter or fighter/attack aircraft and may involve firing missiles/guns at an aerial target. The missiles fired are not recovered.
- *Surface-to-Air Gunnery Exercise (S-A GUNEX).* S-A GUNEX does not occur in the MIRC due to a requirement for commercial air service to tow targets.
- *Chaff/Flare Exercise (CHAFFEX/FLAREX).* Ship and aircraft crews practice defensive maneuvering while expending chaff and/or flares to evade targeting by a simulated missile threat. Chaff consists of thin metallic strips that reflect radio frequency energy, confusing radar. No ordnance is used, only chaff and flares.
- *Air Combat Maneuver (ACM).* Two to eight fighter aircraft engage in aerial combat, typically at high altitudes, far from land.

Surface Warfare (SUW) Training SUW training includes one or more of the following training activities.

- *Surface-to-Surface Gunnery Exercise (S-S GUNEX).* S-S GUNEX activities take place in the open ocean to provide gunnery practice for Navy and Coast Guard ships utilizing shipboard gun systems and small craft crews supporting NSW, EOD, and Mobile Security Squadrons (MSS) utilizing small arms. GUNEX training activities conducted in W-517 involve only surface targets such as a MK-42 Floating At Sea Target (FAST), MK-58 marker (smoke) buoys, or 55-gallon drums. The systems employed against surface targets include the 5-inch, 76mm, 25mm chain gun, 20mm Close-in Weapon System (CIWS), .50 caliber machine gun, 7.62mm machine gun, small arms, and 40mm grenade.

- *Air-to-Surface Gunnery Exercise (A-S GUNEX.).* A-S GUNEX training activities are conducted by rotary-wing aircraft against targets (FAST and smoke buoy). Rotary-wing aircraft involved in this operation would use either 7.62mm or .50 caliber door-mounted machine guns. GUNEX training occurs in the MIRC Offshore Areas including W-517.
- *Visit Board Search and Seizure (VBSS)*. These exercises involve the interception of a suspect surface ship by a Navy ship and are designed to train personnel to board a ship, other vessel, or transport to inspect and examine the ship's papers or examine it for compliance with applicable resolutions or sanctions. Seizure is the confiscating or taking legal possession of the vessel and contraband (goods or people) found in violation of resolutions or sanctions. A VBSS can be conducted both by ship personnel trained in VBSS or by NSW SEAL teams trained to conduct VBSS on uncooperative vessels. Employment onto the vessel designated for inspection is usually done by small boat or by helicopter.
- *Sinking Exercise (SINKEX).* A 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 is typically a decommissioned combatant or merchant ship that has been made environmentally safe for sinking. SINKEX conducted in the MIRC have been conducted in deep water and beyond 50nm of land in a location where it will not be a navigation hazard to other shipping. 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 may be 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 for 4 to 8 hours and possibly over 1 to 2 days, especially if inert ordnance, such as 5-inch gun projectiles or MK-76 dummy bombs, is used during the first hours. A SINKEX is conducted under the auspices of a permit from the U.S. Environmental Protection Agency (EPA).

Strike Warfare (STW) Training. STW training consists of the following training activities.

- *Air-to-Ground Bombing Exercises (Land) (BOMBEX-Land).* BOMBEX (Land) allows aircrews to train in the delivery of bombs and munitions against ground targets. The weapons commonly used in this training on FDM are inert training munitions (e.g., MK-76, BDU-45, BDU-48, and BDU-56), and live MK-80-series bombs and precision-guided munitions (Laser Guided Bombs [LGBs] or Laser Guided Training Round [LGTRs]). Cluster bombs, fuel-air explosives, and incendiary devices are not authorized on FDM. Depleted uranium rounds are not authorized on FDM. BOMBEX exercises can involve a single aircraft, or a flight of two, four, or multiple aircraft. The types of aircraft that frequent FDM are F/A-18, F-22, F-15, F-16, B-1B, B-2, B-52, and H-60, and possibly UAVs. FDM is an uncontrolled and un-instrumented, laser-certified range with fixed targets, which includes Container Express (CONEX) boxes in various configurations within the live-fire zones, high fidelity anti-aircraft missiles, and gun-shape targets within the inert-only zone. COMNAVMAR is the scheduling authority. All aircraft without aid of an air controller must make a clearance pass prior to engaging targets as instructed in the FDM Range Users Manual (COMNAVMAR Instruction [COMNAVMARINST] 3502.1).
- *Air-to-Ground Missile Exercises (A-G MISSILEX).* A-G MISSILEX trains aircraft crews in the use of air-to-ground missiles. On FDM it is conducted mainly by H-60 Aircraft using Hellfire missiles and occasionally by fixed-wing aircraft using Maverick missiles. A basic air-to-ground attack involves one or two H-60 aircraft. Typically, the aircraft will approach the target, acquire

the target, and launch the missile. The missile is launched in forward flight or at hover at an altitude of 300 feet Above Ground Level (AGL).

Naval Special Warfare (NSW) Training. NSW forces train to conduct military operations in five Special Operations mission areas: unconventional warfare, direct action, special reconnaissance, foreign internal defense, and counterterrorism. Specific training events in the MIRC include:

- *Naval Special Warfare (NSW)*. NSW personnel perform special warfare training using tactics that are applicable to the specific tactical situations where the NSW personnel are employed. They are specially trained, equipped, and organized to conduct special operations in maritime, littoral, and riverine environments. Several general training activities and scenarios are called out in this EIS, and while there is a baseline of special operation exercises, training is always evolving to meet the tactical requirements and special weapons required to complete the mission assigned. Exercises involving NSW personnel include, but are not limited to the following:
  - Amphibious Warfare Exercises
  - BOMBEX (Air-to-Ground)
  - Breaching
  - Close Air Support (CAS)
  - Direct Action
  - Escape and Evasion
  - High Mobility Multipurpose Wheeled Vehicle (HMMWV) Training
  - Insertion/Extraction
  - Immediate Action Drills
  - Land Demolitions
  - Land Navigation
  - Maritime Training Activities
  - Marksmanship
  - MOUT
  - Nearshore Hydrographic Reconnaissance
  - NSW Physical Conditioning Training Exercises
  - Over-the-Beach
  - Over-the-Beach Stalk
  - Special Boat Team Training Activities
  - Swimmer/CRRC Over-the-Beach
  - UAV Operations (OPS)
  - Unmanned Underwater Vehicles (UUV) OPS
  - Underwater Detonation
  - VBSS

References to NSW training activity contained in the list above will be discussed as they occur within the text of this document.

- *Airfield Seizure.* Airfield Seizure training activities are used to secure key facilities in order to support follow-on forces, or enable the introduction of follow-on forces. An airfield seizure consists of a raid/seizure force from over the horizon assaulting across a hostile territory in a combination of helicopters, vertical takeoff and landing (VTOL aircraft), and other landing craft with the purpose of securing an airfield or a port. NSW teams have conducted this training at Northwest Field on Andersen Air Force Base.
- *Breaching.* Breaching training teaches personnel to employ any means available to break through or secure a passage through an enemy defense, obstacle, minefield, or fortification. This enables a force

to maintain its mobility by removing or reducing natural and man-made obstacles. In the NSW sense, breacher training activities are designed to provide personnel experience knocking down doors to enter a building or structure. During the conduct of a normal breach activity, battering rams or less than 1.2 pounds net explosive weight (NEW) is used to knock down doors. Training has occurred at OPCQC House and the Ordnance Annex Breacher House (OABH). (Maximum charge permitted at the OABH is no more than 3 pounds NEW.) However, explosives at OPCQC are not permitted, which limits the value of conducting this training at OPCQC.

- *Direct Action.* NSW Direct Action is either covert or overt directed against an enemy force to seize, damage, or destroy a target and/or capture or recover personnel or material. Training activities are small-scale offensive actions including raids; ambushes; standoff attacks by firing from ground, air, or maritime platforms; designate or illuminate targets for precision-guided munitions; support for cover and deception operations; and sabotage inside enemy-held territory. Units involved are typically at the squad or platoon level staged on ships at sea. They arrive in the area of operations by helicopter or CRRC across a beach. NSW teams are capable of using small craft to island hop from Guam to Rota, Rota to Tinian, Tinian to Saipan, and Saipan to FDM; however, this is not a frequent event. Once at FDM, small arms, grenades, and crew-served weapons (weapons that require a crew of several individuals to operate) are employed in direct action against targets on the island. Participation in Tactical Air Control Party/Forward Air Control (TACP/FAC) training in conjunction with a BOMBEX-Land also occurs. NSW and visiting Special Forces training in the MIRC will frequently include training that utilizes the access provided by Gab Gab Beach to Apra Harbor and Orote Point training areas, as well as training in the OPCQC.
- *Insertion/Extraction*. Insertion/extraction activities train forces, both Navy (primarily Special Forces and EOD) and Marine Corps, to deliver and extract personnel and equipment. These activities include, but are not limited to, parachute, fast rope, rappel, Special Purpose Insertion/Extraction (SPIE), CRRC, and lock-in/lock-out from underwater vehicles. Training activities have been conducted at Outer Apra Harbor, Inner Apra Harbor, Gab Gab Beach (western half), Reserve Craft Beach, and Polaris Point Field. Additionally, parachute, fast rope, and rappel training have been conducted at Orote Point Airfield/Runway, Orote Point Triple Spot, OPCQC House, Dan Dan Drop Zone, OPKD Range, and the Ordnance Annex Breacher House.
- *Military Operations in Urban Terrain (MOUT)*. NSW MOUT training is similar in nature and intent to Army and Marine Corps MOUT training, but typically on a smaller scale. MOUT training is conducted at the Ordnance Annex Breacher House. Additionally, the OPCQC supports “raid” type MOUT training on a limited basis.
- *Over the Beach (OTB).* NSW personnel use different methods of moving forces from the sea across a beach onto land areas in order to get closer to a tactical assembly area or target depending on threat force capabilities. A typical OTB exercise would involve a squad (8 personnel) to a platoon (16 personnel) or more of NSW personnel being covertly inserted into the water off of a beach area of hostile territory. However, the insertion could be accomplished by other means, such as fixed-winged aircraft, helicopter, submarine, or surface ship. From the insertion point several miles at sea, the SEALs may use a CRRC, Rigid Hull Inflatable Boat (RHIB), SEAL Delivery Vehicle (SDV), Advanced SEAL Delivery System (ASDS), or swim to reach the beach, where they will move into the next phase of the exercise and on to the objective target area and mission of that phase of the exercise.

Amphibious Warfare (AMW) Training. AMW training includes individual and crew, small unit, large unit, and Marine Air Ground Task Force (MAGTF)-level events. Individual and crew training include operation of amphibious vehicles and naval gunfire support training. Small-unit training activities include events leading to the certification of a MEU as “Special Operations Capable” (SOC). Such training includes shore assaults, boat raids, airfield or port seizures, and reconnaissance. Larger-scale amphibious exercises are carried out principally by MAGTFs or elements of MAGTFs embarked with Expeditionary Strike Groups (ESG), and include the following training exercises.

- *Naval Surface Fire Support (FIREX Land).* FIREX (Land) on FDM consists of the shore bombardment of an Impact Area by Navy guns as part of the training of both the gunners and Shore Fire Control Parties (SFCP). A SFCP consists of spotters who act as the eyes of a Navy ship when gunners cannot see the intended target. From positions on the ground or air, spotters provide the target coordinates at which the ship's crew directs its fire. The spotter provides adjustments to the fall of shot, as necessary, until the target is destroyed. On FDM, spotting may be conducted from the special use "no fire" zone or provided from a helicopter platform. No one may land on the island without the express permission of COMNAVMAR (COMNAVMARINST 3502.1).
- *Marksmanship.* Marksmanship exercises are used to train personnel in the use of small arms weapons for the purpose of ship self defense and security. Basic marksmanship training activities are strictly controlled and regulated by specific individual weapon qualification standards. Small arms include but are not limited to 9mm pistol, 12-gauge shotgun, and 7.62mm rifles. These exercises have occurred at Orote Point and Finegayan small arms ranges, and OPKD Range.
- *Expeditionary Raid.* An Expeditionary Raid (Assault) is an attack involving swift incursion into hostile territory for a specified purpose. The attack is then followed by a planned withdrawal of the raid forces. A raid force can consist of varying numbers of aviation, infantry, engineering, and fire support forces. Expeditionary Raids conducted in support to movement of operational forces are normally directed against objectives requiring specific outcomes not possible by other means. A key influence in every raid is the ability to insert, complete the assigned mission, and extract without providing the enemy force with opportunity to reinforce their forces or plan for counter measures. The expeditionary raid is the foundation for all MEU SOC operational missions and is structured based upon mission requirements, situational settings, and force structure. Reserve Craft Beach is capable of supporting a small Expeditionary Raid training event followed by a brief administrative buildup of forces ashore. In Fiscal Year (FY) 2003 up to 300 31st MEU personnel and pieces of equipment were moved ashore at Reserve Craft Beach via LCAC.
- *Hydrographic Surveys.* Hydrographic Reconnaissance is conducted to survey underwater terrain conditions and report findings to provide precise analysis typically in support of amphibious landings and precise ship and small craft movement through cleared routes (Q-Routes). Exercises involve the methodical reconnoitering of beaches and surf conditions during the day and night to find and clear underwater obstacles and to determine the feasibility of landing an amphibious force on a particular beach. Hydrographic Survey exercises have also occurred at Outer Apra Harbor and Tipalao Cove.

Mine Warfare (MIW) Training

- *Land Demolition.* Training activities using land demolition training are designed to develop and hone EOD detachment mission proficiency in location, excavation, identification, and neutralization of buried land mines. During the training, teams transit to the training site in trucks or other light-wheeled vehicles. A search is conducted to locate inert (nonexplosively filled) land mines or Improvised Explosive Devices (IEDs) and then designate the target for destruction. Buried land mines and Unexploded Ordnance (UXO) require the detachment to employ probing techniques and metal detectors for location phase. Use of hand tools and digging equipment is required to excavate. Once exposed and/or properly identified, the detachment neutralizes threats using simulated or live explosives. Land demolition training is actively conducted throughout the

MIRC. Explosive Ordnance Disposal Mobile Unit (EODMU)-5 is stationed at Main Base and EOD Detachment, Marianas (DET MARIANAS) is a small unit of EOD personnel who are permanently attached to COMNAVBASE MARIANAS and are actively involved in disposing of old munitions and UXO found throughout the MIRC. Land demolition training activities have occurred at Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point Airfield/Runway, OPCQC House, Ordnance Annex Breacher House, Ordnance Annex Emergency Detonation Site, NLNA, SLNA, and Barrigada Housing.

- *Underwater Demolition.* Underwater demolitions are designed to train personnel in the destruction of mines, obstacles, or other structures in an area to prevent interference with friendly or neutral forces and noncombatants. It provides NSW and EOD teams experience detonating underwater explosives. Outer Apra Harbor supports this training near the Glass Breakwater at a depth of 125 feet and with up to a 10-pound net explosive weight (NEW) charge. Piti and Agat Bay Floating Mine Neutralization areas also support this type of training, with up to a 20-pound NEW charge.

Logistics and Combat Services Support. Logistics and combat services support include the following training activities.

- *Combat Mission Area Training.* Special Forces and EOD units conduct mission area training that supports their own and other services combat service needs in both the water and on land. At Orote Point Airfield/Runway, this task includes providing patrolling, scouting, observation, imagery, and air control services and training.
- *Command and Control (C2.).* C2 training activities provide primary communications for command, control, and intelligence, providing critical interpretability and situation awareness information. EOD personnel have provided USMC C2 support at Reserve Craft Beach.

Combat Search and Rescue (CSAR). CSAR activities train rescue forces personnel in the tasks needed to be performed to affect the recovery of distressed personnel during war or military operations other than war. These training activities could include aircraft, surface ships, submarines, ground forces (NSW and USMC), and their associated personnel in the execution of training events. North Field on Tinian has supported night vision goggle (NVG) familiarization training for CSAR personnel.

Protect and Secure Area of Operations. The following training activities are included in this training category.

- *Embassy Reinforcement (Force Protection).* Force protection training increases the physical security of military personnel in the region to reduce their vulnerability to attacks. Force protection training includes moving forces and building barriers; detection and assessment of threats; delay or denial of access of the adversary to their target; appropriate response to threats and attack; and mitigation of effects of attack. Force protection includes employment of offensive as well as defensive measures. Base Naval Security Forces and Marine Support Squadrons frequently conduct force protection training throughout the Main Base, but all forces will participate in force protection training to some degree in multiple locations throughout the MIRC, including: Inner Apra Harbor, Kilo Wharf, Reserve Craft Beach, Orote Point Airfield/Runway, Orote Point Close Quarters Combat House, Orote Point Radio Tower, and Orote Point Triple Spot.

- *Anti-Terrorism (AT).* AT training activities concentrate on the deterrence of terrorism through active and passive measures, including the collection and dissemination of timely threat information, conducting information awareness programs, coordinated security plans, and personal training. The goal is to develop protective plans and procedures based upon likely threats and strike with a reasonable balance between physical protection, mission requirements, critical assets and facilities, and available resources to include manpower. AT training activities may involve units of Marines dedicated to defending both U.S. Navy and Marine Corps assets from terrorist attack. The units are designated as the Fleet Anti-Terrorism Security Team, or FAST. FAST Company Marines augment, assist, and train installation security when a threat condition is elevated beyond the ability of resident and auxiliary security forces. They are not designed to provide a permanent security force for the installation. They also ensure nuclear material on submarines is not compromised when vessels are docked. FAST Companies deploy only upon approval of the Chief of Naval Operations (CNO). USMC Security Force FAST Platoons stationed in Yokuska, Japan have conducted AT training with Base Naval Security, NSW, and EOD support in multiple locations within the MIRC, includin: Inner Apra Harbor, Polaris Point Site III, Ordnance Annex Breacher House, and Orote Annex Emergency Detonation Site.

Major Exercise — Training would also include either a joint expeditionary warfare exercise or a joint multi-strike group exercise. This exercise consists of combining the individual training activities described in the No Action Alternative in such a manner as to provide multi-Service and multi-national participation in realistic maritime and expeditionary training activity. This is designed to replicate the types of operations and challenges that could be faced during real-world contingency operations. Major exercises provide training for command elements, submarine, ship, aircraft, expeditionary, and special warfare forces in tactics, techniques, and procedures.

2.3.1.4 Air Force Training

Counter Land. Counter land is similar in nature and content to the Navy's BOMBEX (Land) training activity. These activities have occurred at FDM and utilize ATCAA 3.

Counter Air. Counter air is single to multiple aircraft engaged in advanced, simulated radar, infrared (IR), or visual air-to-air training. During this training, aircraft may dispense chaff and flares as part of missile defense training. Flares are high incendiary devices meant to decoy IR missiles. Burn time for flares usually lasts from 3 to 5 seconds. Chaff exercises train aircraft and/or shipboard personnel in the use of chaff to counter anti-ship and anti-aircraft missile threats. Chaff is a radar confusion reflector, consisting of thin, narrow metallic strips of various lengths and frequency responses, which are used to reflect echoes to deceive radars. During a chaff exercise, the chaff layer combines aircraft maneuvering with deployment of multiple rounds of chaff to confuse incoming missile threats. In an integrated Chaff Exercise scenario, ships/helicopters/fixed wing craft will deploy ship- and air-launched, rapid bloom offboard chaff in preestablished patterns designed to enhance missile defense. Chaff exercises have been conducted in W-517 and ATCAA 1 & 2.

Airlift. Airlift operations provide airlift support to combat forces. Airlift operations and training activity have occurred at Andersen Air Force Base and Northwest Field.

Air Expeditionary. This type of training provides air expeditionary operations support to forward deployed forces. Northwest Field on Andersen Air Force Base is used in support of forward/expeditionary training and is available as an alternate landing and laydown site for short field capable aircraft. Andersen South is utilized to support MOUT type training.

Force Protection. This type of training is to provide force protection to individuals, buildings, and specific areas of interest. Force protection training has occurred on Andersen Air Force Base at Northwest Field, Pati Pt. CATM Range, and Main Base.

2.3.1.5 Research, Development, Test, and Evaluation Activities

The Services may conduct RDT&E, engineering, and fleet support for command, control, and communications systems and ocean surveillance in the MIRC. These activities may include ocean engineering, missile firings, torpedo testing, manned and unmanned submersibles testing, UAV tests, EC, and other DoD weapons testing.

2.4 Alternative 1 — Current Training, Increased Training Supported by Modernization and Upgrades/Modifications to Existing Capabilities, Training Associated with ISR/Strike, and Multi-National and/or Joint Exercises

Alternative 1 is a proposal designed to meet the Services' current and foreseeable training requirements. If Alternative 1 were to be selected, in addition to accommodating the No Action Alternative, it would include increased training as a result of upgrades and modernization of existing capabilities, and include establishment of a permanent danger zone and restricted area around FDM (a 10-nm zone around FDM to be established in accordance with C.F.R. Title 33 Part 334; see Figure 2-3). Alternative 1 also includes training associated with ISR/Strike and other Andersen AFB initiatives. Training will also increase as a result of the acquisition and development of new Portable Underwater Tracking Range (PUTR) capabilities. PUTR trains personnel in undersea warfare including conducting TRACKEX and TORPEX activities. Helicopter, ship, and submarine sonar systems will use this capability. Small arms range capability improvements and MOUT training facility improvements would also increase training activities. Table 2-8 summarizes these increases in training activities. These increased capabilities will result in increased multi-national and/or joint exercises.

Alternative 1 meets the Proposed Action's purpose and need; however this Alternative does not optimize the training capabilities of the MIRC.

Major Exercise — Training would increase to include additional major exercises involving multiple strike groups and expeditionary task forces (see Table 2-7). Major exercises provide multi-Service and multi-national participation in realistic maritime and expeditionary training that is designed to replicate the types of operations and challenges that could be faced during real-world contingency operations. Major exercises provide training for command elements, submarine, ship, aircraft, expeditionary, and special warfare forces in tactics, techniques, and procedures.

(Note: the *Guam and CNMI Military Relocation EIS/OEIS* is being prepared for the relocation of Marine Corps forces from Okinawa to Guam. The Military Relocation EIS/OEIS examines the potential impact from activities associated with the Marine Corps units' relocation, including training activities and infrastructure changes on and off DoD lands. Since the MIRC EIS/OEIS covers DoD training on existing DoD land and training areas in and around Guam and the CNMI, there will be overlap between the two EIS/OEISs in the area of land usage. These documents are being closely coordinated to ensure consistency.)

ISR/Strike — The Air Force has established the ISR/Strike program at Andersen AFB, Guam. ISR/Strike will be implemented in phases over a planning horizon of FY2007–FY2016. ISR/Strike force structure consists of up to 48 fighter, 12 aerial refueling, six bomber, and six unmanned aircraft with associated support personnel and infrastructure. Aircraft operations and training out of Andersen AFB ultimately will increase by 45 percent over the current level (FY2006). Environmental impacts associated with ISR/Strike have been analyzed in the *2006 Establishment and Operation of an Intelligence, Surveillance* *and Reconnaissance/Strike, Andersen Air Force Base, EIS*. The anticipated 45 percent increase in aircraft operations and training out of and into Andersen AFB requires improved range infrastructure to accommodate this increased training tempo, newer aircraft, and weapon systems commensurate with ISR/Strike force structure. There will be increased activity on all the current training areas supporting Air Force training activities: W-517, ATCAAs, and FDM/R-7201. The ISR/Strike EIS analyzed environmental impacts related to the infrastructure improvements required. This EIS/OEIS analyzes the impacts of the increased training resulting from the ISR/Strike implementation.

FDM — Public access to FDM is strictly prohibited and there are no commercial or recreational activities on or near the island. During training exercises, marine vessels are restricted within a 3-nm (5-km) radius. Notice to Mariners (NOTMAR) and Notice to Airmen (NOTAM) are issued at least 72 hours in advance of potentially hazardous FDM range events and may advise restrictions beyond 3 to 30 nm (5-56 km) from FDM or greater for certain training events. These temporary advisory restrictions are used to maintain the safety of the military and the public during training sessions by providing public notice of potentially hazardous training activity and temporary danger zones and restriction areas.

As usage of FDM increases under implementation of either Alternative 1 or Alternative 2, a permanent danger zone and restricted area would be established to restrict all private and commercial vessels from entering the area to minimize danger from the hazardous activity in the area. Development of a 10-nm (18-km) permanent danger zone and restricted area would be an established restriction, supplemented by temporary advisory notices as required.

Modernization and Upgrades of Training Areas

Anti-Submarine Warfare (ASW) — ASW describes the entire spectrum of platforms, tactics, and weapon systems used to neutralize and defeat hostile submarine threats to combatant and non-combatant maritime forces. A critical component of ASW training is the Underwater Tracking Range (UTR). This is an instrumented range that allows near real-time tracking and feedback to all participants. The tracking range should provide for both a shallow water and deep water operating environment, with a variety of bottom slope and sound velocity profiles similar to potential contingency operating areas. Guam-homeported submarine crews, as well as crews of transient submarines, require ASW training events to maintain qualifications. A MIRC instrumented ASW PUTR, target support services, and assigned torpedo retriever craft would meet support requirements for TORPEX and TRACKEX activities in the MIRC in support of Fast Attack Submarine (SSN) and Ballistic Missile Submarine (SSBN) and other deployed forces.

Military Operations in Urban Terrain (MOUT) — MOUT training is conducted within a facility that replicates an urban area, to the extent practicable. The urban area includes a central urban infrastructure of buildings, blocks, and streets; an outlying suburban residential area; and outlying facilities. Suburban area structures should represent a local noncombatant populace and infrastructure. The MIRC will need to repair and upgrade the existing MOUT facilities to support training requirements of units stationed at or deployed to the MIRC.

2.5 ALTERNATIVE 2 — CURRENT TRAINING, INCREASED TRAINING, AND INCREASED MULTI-NATIONAL AND/OR JOINT EXERCISES; INCLUDING ADDITIONAL UNDERSEA EXERCISES

Implementation of Alternative 2 would include all the actions proposed for MIRC in Alternative 1 and increased training activity associated with major at-sea exercises (see Tables 2-7 and 2-8). Additional major at-sea exercises would provide additional ships and personnel maritime training including additional use of sonar that would improve the level of joint operating skill and teamwork between the

Navy, Joint Forces, and Partner Nations. Submarine, ship, and aircraft crews train in tactics, techniques, and procedures required in carrying out the primary mission areas of maritime forces. The additional maritime exercises would take place within the MIRC and would focus on carrier strike group training and ASW activities similar to training conducted in other Seventh Fleet locations, including a Fleet Strike Group Exercise, an Integrated ASW Exercise, and a Ship Squadron ASW Exercise.

Major Exercise — The Fleet Strike Group Exercise and an additional Integrated ASW exercise would be conducted in the MIRC by forward-deployed Navy Strike Groups to sustain or assess their proficiency in conducting tasking within the Seventh Fleet. Training would be focused on conducting Strike Warfare or ASW in the most realistic environment, against the level of threat expected in order to effect changes to both training and capabilities (e.g., equipment, tactics, and changes to size and composition) of the Navy Strike Group. Although these exercises would emphasize Strike or ASW, there is significant training value inherent in all at-sea exercises and the opportunity to exercise other mission areas. Each exercise would last a week or less.

The Ship Squadron ASW Exercise overall objective is to sustain and assess surface ship ASW readiness and effectiveness. The exercise typically involves multiple ships, submarines, and aircraft in several coordinated events over a period of a week or less. Maximizing opportunities to collect high-quality data to support quantitative analysis and assessment of training activities is an additional goal of this training.

Table 2-7: Major Exercises in the MIRC Study Area

MIRC EIS/OEIS		Major Exercises							
Exercise		Joint Expeditionary Exercise (CSG + ESG)	Joint Multi-strike Group Exercise (3 CSG + USAF)	Fleet Strike Group Exercise (CSG)	Integrated ASW Exercise (CSG)	Ship Squadron ASW Exercise (CRU DES)	MAGTF Exercise (STOM/ NEO)	SPMAGTF Exercise (HADR/ NEO)	Urban Warfare Exercise
Exercise Sponsor		US PACOM	US PACOM	C7F	C7F	C7F	III MEF	III MEF; MEU/UDP	III MEF; MEU/ UDP
Alternative: No Action		1 of the above		0	0	0	1	0	2
Alternative 1		1	1	0	0	0	4	2	5
Alternative 2		1	1	1	1	1	4	2	5
Primary Training Site		Tinian	MI Maritime >12 nm	MI Maritime >12 nm	MI Maritime >3 nm	MI Maritime >3 nm	Tinian	Guam	Guam
Secondary Training Sites		Nearshore to OTH: Guam: Rota; Saipan; FDM	FDM	FDM	FDM	N/A	Nearshore to OTH: Guam: Rota; Saipan; FDM	Tinian, Rota, Saipan	Tinian, Rota, Saipan
Exercise Footprint	Activity Days per Exercise	10	10	7	5	5	10	10	7-21
NAVY SHIPS	CVN	1	3	1	1	0	0	0	0
	CG	1	3	1	1	1	0	0	0
	FFG	2	3	1	1	1	1	0	0
	DDG	5	12	3	3	3	2	0	0
	LHD/ LHA	1	0	1	0	0	1	1	1
	LSD	2	0	0	0	0	2	1	1
	LPD	1	0	0	0	0	1	1	1
	TAOE	1	3	1	0	0	0	0	N/A
	SSN	1	5	1	1	1	0	0	N/A
	SSGN	1	0	0	0	0	1	0	0
	TR	N/A	N/A	0	0	0	N/A	N/A	N/A
Partner National Ships	CG	1	0	0	0	0	0	0	N/A
	DDG	2	0	0	0	0	0	0	N/A
	SS	1	1	0	0	0	0	0	N/A
FIXED WING	F/A-18	4 Squadrons	12 Squadrons	4 Squadrons	4 Squadrons	N/A	N/A	N/A	N/A
	EA-6B	1 Squadron	3 Squadrons	1 Squadron	1 Squadron	N/A	N/A	N/A	N/A
	E-2	1 Squadron	3 Squadrons	1 Squadron	1 Squadron	N/A	N/A	N/A	N/A
	MPA (P-3)	3	5	3	3	3	N/A	N/A	N/A
	AV-8B	1 Squadron	N/A	1 Squadron	N/A	N/A	N/A	N/A	N/A
	C-130	2	N/A	N/A	N/A	N/A	1	1	1
	USAF Bomber	N/A	1 Squadron	N/A	N/A	N/A	N/A	N/A	N/A
	F-15/16/22	N/A	1 Squadron	1 Squadron	N/A	N/A	N/A	N/A	N/A
	A-10	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	E-3	1	1	1	N/A	N/A	N/A	N/A	N/A
	KC-10/135/130	1	2	1	N/A	N/A	N/A	N/A	N/A

Table 2-7: Major Exercises in the MIRC Study Area (Continued)

MIRC EIS/OEIS		Major Exercises							
Exercise		Joint Expeditionary Exercise (CSG + ESG)	Joint Multi-strike Group Exercise (3 CSG + USAF)	Fleet Strike Group Exercise (CSG)	Integrated ASW Exercise (CSG)	Ship Squadron ASW Exercise (CRU DES)	MAGTF Exercise (STOM/ NEO)	SPMAGTF Exercise (HADR/ NEO)	Urban Warfare Exercise
ROTARY	MH-60R/S	4	12	4	4	4	2	N/A	N/A
	SH-60H	4	12	4	4	4	N/A	N/A	N/A
	HH-60H	4	12	4	4	N/A	N/A	N/A	N/A
	SH-60F	3	9	3	3	N/A	N/A	N/A	N/A
	CH-53	4	N/A	4	N/A	N/A	4	4	4
	CH-46	12	N/A	12	N/A	N/A	12	12	12
	AH-1	4	N/A	4	N/A	N/A	4	4	4
	UH-1	2	N/A	2	N/A	N/A	2	2	2
	MV-22 FY10 (replace CH-46)	10	N/A	10	N/A	N/A	10	10	10
UAS	Ship Based	2	3	1	1	0	1	0	0
	Ground Based	2	1	0	0	0	2	1	1
Landing Craft	LCAC	3-5	N/A	N/A	N/A	N/A	3-5	3	N/A
	LCU	1-2	N/A	N/A	N/A	N/A	1-2	1	N/A
	CRRC	18	N/A	N/A	N/A	N/A	18	18	0
GCE	AAV	14	N/A	N/A	N/A	N/A	14	3	3
	LAV	13	N/A	N/A	N/A	N/A	5	5	5
	HMMWV	78	N/A	N/A	N/A	N/A	78	16	16
	Ground Personnel	1200	N/A	N/A	N/A	N/A	1200	250	250
LCE	Trucks	36	N/A	N/A	N/A	N/A	36	8	8
	Dozer	2	N/A	N/A	N/A	N/A	2	1	1
	Forklift	6	N/A	N/A	N/A	N/A	6	2	2
	ROWPU	2	N/A	N/A	N/A	N/A	2	1	1
	RHIB	2	N/A	N/A	N/A	N/A	2	2	2
	Ground Personnel	300	N/A	N/A	N/A	N/A	300	60	60

Table 2-8: Annual Training Activities in the MIRC Study Area

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Anti-Submarine Warfare (ASW)						
ASW TRACKEX (SHIP)	CG/ DDG / FFG SUB/ MK-30/ EMATT	SQS-53C/D SQS-56	10	30	60	PRI: W-517 SEC: MI Maritime, >3 nm from land
ASW TRACKEX (SUB)	SSN; SSGN MK-30	BQQ	5	10	12	PRI: Guam Maritime, >3 nm from land SEC: W-517
ASW TRACKEX (HELO)	SH-60B, SH-60F SUB/ MK-30/ EMATT	AQS-22 DICASS	9	18	62	PRI: W-517 SEC: MI Maritime, >3 nm from land
ASW TRACKEX (MPA)	FIXED WING MPA SUB/ MK-30/ EMATT	DICASS EER/IEER/AEER	5	8	17	PRI: W-517 SEC: MI Maritime, >3 nm from land
ASW TORPEX (SUB)	SSN; SSGN MK-30 TRB / MH-60S	BQQ MK-48 EXTORP	5	10	12	PRI: Guam Maritime, >3 nm from land SEC: W-517
ASW TORPEX (SHIP)	CG/ DDG / FFG SUB/ MK-30/ EMATT TRB / MH-60S/ RHIB	SQS-53C/D SQS-56 REXTORP	0	3	6	PRI: Guam Maritime, >3 nm from land SEC: W-517
ASW TORPEX (MPA / HELO)	MPA / SH-60B/F, SUB/ MK-30/ EMATT TRB / MH-60S/ RHIB	AQS-22 / DICASS REXTORP	0	4	8	PRI: Guam Maritime, >3 nm from land SEC: W-517

Table 2-8: Annual Training Activities in the MIRC Study Area (Continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Mine Warfare (MIW)						
MINEX	B-1/ B-2/ B-52/ FA-18	MK-62 / MK-56	2	3	3	PRI: W-517 SEC: MI Maritime, >12 nm from land
Underwater Demolition	RHIB	Bottom/mid-moored mine shape 5 – 20 lb NEW	22	30	30	PRI: Agat Bay SEC: Apra Harbor (10lb max)
Floating Mine Neutralization	RHIB	Floating mine shape 5 – 20 lb NEW	8	20	20	PRI: Agat Bay SEC: Piti
Surface Warfare (SUW)						
SINKEX	Ship hulk or barge	HARM [2] SLAM-ER [4] HARPOON [5] 5" Rounds [400] HELLFIRE [2] MAVERICK [8] GBU-12 [10] GBU-10 [4] MK-48 [1] Underwater Demolitions [2 -100lb]	1	2	2	PRI: W-517 SEC: MI Maritime, >50 nm from land; ATCAAs
BOMBEX (Air to Surface)	FA-18; AV-8B; MPA (MK 58 Smoke tgt. or towed sled)	MK 82 I; BDU-45; MK 76 (Inert Rounds)	16 (48 rounds)	24 (72 rounds)	30 (90 rounds)	PRI: W-517 SEC: MI Maritime, >12 nm from land; ATCAAs
GUNEX Surface-to-Surface (Ship)	LHA, LHD, LSD, and LPD. Barrel, Inflatable tgt.	.50 cal MG	1 (2,400 rounds)	5 (12,000 rounds)	5 (12,000 rounds)	PRI: W-517 SEC: MI Maritime, >12 nm from land
		.25 mm MG	1 (1,600 rounds)	5 (8,000 rounds)	5 (8,000 rounds)	
	CG and DDG. Barrel or Inflatable tgt. or towed sled	5" gun	4 (160 rounds)	8 (320 rounds)	10 (400 rounds)	
	FFG. Barrel or Inflatable tgt. or towed sled	76 mm	2 (60 rounds)	4 (120 rounds)	5 (150 rounds)	

Table 2-8: Annual Training Activities in the MIRC Study Area (Continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Surface Warfare (SUW) (continued)						
GUNEX Surface-to-Surface (Small arms)	Ship, RHIB, small craft. Barrel or Inflatable tgt.	M-16, M-4, M-249 SAW, M-240G, .50 cal, M-203 (5.56 /7.62 mm/ .50 cal round/ 40mm TP)	24 (12,000 rounds)	32 (16,000 rounds)	40 (20,000 rounds)	PRI: MI Maritime, >3 nm from land SEC: W-517
GUNEX Air-to-Surface	SH-60; HH-60; MH-60R/S; UH-1; CH-53; FA-18; AH-1W; F-15; F16; F-22; AV-8B; A-10 (Barrel or MK-58 smoke tgt.)	7.62 mm MG	150 (30,000 rounds)	200 (40,000 rounds)	200 (40,000 rounds)	PRI: W-517 SEC: MI Maritime, >12 nm from land; ATCAAs
		.50 cal MG	10 (2,000 rounds)	20 (4,000 rounds)	20 (4,000 rounds)	
		20 mm cannon	50 (5,000 rounds)	100 (10,000 rounds)	100 (10,000 rounds)	
		25 mm cannon	10 (1,000 rounds)	40 (4,000 rounds)	40 (4,000 rounds)	
		30 mm cannon	0	15 (1,500 rounds)	15 (1,500 rounds)	
Visit, Board, Search and Seizure/Maritime Interception Operation (VBSS/MIO)	RHIB, Small Craft, Ship, H-60	n/a	3	6	8	PRI: Apra Harbor SEC: MI Maritime
Electronic Combat						
CHAFF Exercise	SH-60; MH-60; HH-60; MH-53	RR-144A/AL	12 sorties (360 rounds)	14 sorties (420 rounds)	14 sorties (420 rounds)	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs
	FA-18; EA-18; AV-8B; MPA; EA-6	RR-144A/AL	16 sorties (160 rounds)	32 sorties (320 rounds)	48 sorties (500 rounds)	
	F-15; F-16; C-130	RR-188	150 sorties (1,500 rounds)	500 sorties (5,000 rounds)	550 sorties (5,500 rounds)	
	CG, DDG, FFG, LHA, LHD, LPD, LSD	MK 214 (seduction); MK 216 (distraction)	12 (72 canisters)	16 (90 canisters)	20 (108 canisters)	

Table 2-8: Annual Training Activities in the MIRC Study Area (Continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Electronic Combat (EC) (continued)						
FLARE Exercise	SH-60; MH-60; HH-60; MH-53	MK 46 MOD 1C; MJU-8A/B; MJU-27A/B; MJU-32B; MJU-53B; SM-875/ALE	12 sorties (360 flares)	14 sorties (420 rounds)	14 sorties (420 rounds)	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs
	FA-18; EA-18; AV-8B; MPA; EA-6		16 sorties (160 rounds)	32 sorties (320 rounds)	48 sorties (500 rounds)	
	F-15; F-16; C-130	MJU-7; MJU-10; MJU-206	4 sorties (1,500 rounds)	500 sorties (5,000 rounds)	550 sorties (5,500 rounds)	
Strike Warfare (STW)						
BOMBEX (LAND)	FA-18; AV-8B; B-1; B-2; B-52; F-15; F-16; F-22; A-10	High Explosive Bombs ≤ 500 lbs	400 annually	500 annually	600 annually	FDM (R-7201)
		High Explosive Bombs: 750 / 1,000 lbs / 2,000 lbs	1,600 annually	1,650 annually	1,700 annually	
		Inert Bomb Training Rounds ≤ 2,000 lbs	1,800 annually	2,800 annually	3,000 annually	
		Total Sorties (1 aircraft per sortie):	1,000 sorties	1,300 sorties	1,400 sorties	
MISSILEX A-G	FA-18; AV-8B; F-15; F-16; F-22; A-10; MH-60R/S; SH-60B; HH-60H; AH-1	TOW; MAVERICK; HELLFIRE	30 annually	60 annually	70 annually	FDM (R-7201)
GUNEX A-G	FA-18; AV-8B; F-15; F-16; F-22; A-10; MH-60R/S; SH-60B; HH-60H; AH-1; AC-130	20 OR 25 MM CANNON	16,500 rounds	20,000 rounds	22,000 rounds	FDM (R-7201)
		30 MM CANNON (A-10)	0	1,500 rounds	1,500 rounds	
		40mm or 105mm CANNON (AC-130)	100 rounds	200 rounds	200 rounds	
Combat Search and Rescue (CSAR)	SH-60; MH-60; HH-60; MH-53; CH-53; C-17; C-130; V-22	NIGHT VISION	30 sorties	60 sorties	75 sorties	PRI: Tinian North Field: Guam Northwest Field SEC: Orote Point Airfield; Rota Airport
Air Warfare (AW)						
Air Combat Manuevers (ACM)	FA-18; AV-8B; F-15; F16.	Captive Air Training Missile (CATM) or Telemetry Pod	360 sorties of 2-4 aircraft per sortie	720 sorties of 2-4 aircraft per sortie	840 sorties 2-4 aircraft per sortie	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs
Air Intercept Control	FA-18; F-15	Search and Fire Control Radars	40 sorties (2-4 aircraft) 20 events	80 sorties (2-4 aircraft) 40 events	100 sorties (2-4 aircraft) 50 events	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs

Table 2-8: Annual Training Activities in the MIRC Study Area (Continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Air Warfare (AW) (continued)						
MISSILEX / GUNEX Air-to-Air	FA-18; EA-18; AV-8B. TALD tgt.	AIM-7 Sparrow (Non Explosive). 20mm or 25 mm cannon.	4 sorties (2-4 aircraft) (4 missiles; 1,000 rounds)	6 sorties (2-4 aircraft) (6 missiles; 1,500 rounds)	8 sorties (2-4 aircraft) (8 missiles; 2,000 rounds)	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs
		AIM-9 Sidewinder (HE)/AIM-120 (HE or Inert). 20mm or 25 mm cannon.	4 sorties (2-4 aircraft) (4 missiles; 1,000 rounds)	6 sorties (2-4 aircraft) (6 missiles; 1,500 rounds)	8 sorties (2-4 aircraft) (8 missiles; 2,000 rounds)	
MISSILEX Ship-to-Air	CVN, LHD, CG, DDG; BQM-74E.	RIM-7 Sea Sparrow RIM-116 RAM RIM-67 SM-II ER	1 (1 missile)	2 (2 missile)	2 (2 missile)	PRI: W-517 SEC: MI Maritime, >12nm from land; ATCAAs
Amphibious Warfare (AMW)						
FIREX (Land)	CG, DDG	5" Guns and (HE) shells	4 (400 rounds)	8 (800 rounds)	10 (1,000 rounds)	FDM (R-7201)
Amphibious Assault Marine Air Ground Task Force (MAGTF)	1 LHA or LHD, 1 LPD, 1 LSD, 1 CG or DDG, and 2 FFG.	4-14 AAV/EFV or LAV/LAR; 3-5 LCAC; 1-2 LCU; 4 H-53; 12 H-46 or 10 MV-22; 2 UH-1; 4 AH-1; 4 AV-8	1 event (assault, offload, backload)	5 events (assault, offload, backload)	5 events (assault, offload, backload)	PRI: Tinian Military Leased Area; Unai Chulu (beach) and Tinian Harbor; North Field. SEC: Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Sumay Cove and MWR Ramp
Amphibious Raid Special Purpose MAGTF	1 LHA or LHD, 1 LPD, and 1 LSD. Tailored MAGTF.	4-14 AAV/EFV or LAV/LAR; 0-5 LCAC; 0-2 LCU; 4 H-53; 12 H-46 or 10 MV-22; 2 UH-1; 4 AH-1; 4 AV-8	0	2 events (raid, offload, backload)	2 events (raid, offload, backload)	PRI: Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Field; Sumay Cove and MWR Marina Ramp SEC: Tinian Military Leased Area; Unai Chulu (beach) and Tinian Harbor; North Field.

Table 2-8: Annual Training Activities in the MIRC Study Area (Continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Expeditionary Warfare						
Military Operations in Theater (MOUT) Training	USMC Infantry Company: AH-1, UH-1; H-46 or MV-22; H-53; AAV, LAV, HMMWV, TRUCK	5.56 mm blanks/Simulations	2 events, 7-21 days/event	5 events of 7-21 days/event	5 events of 7-21 days/event	PRI: Guam; AAFB South; Finegayan Communication Annex; Barrigada Housing; Northwest Field SEC: Tinian; Rota; Saipan
	USAF RED HORSE SQUADRON: TRUCK, HMMWV; MH-53; H-60		2 events, 3-5 days/event	4 events, 3-5 days/event	4 events, 3-5 days/event	
	Navy NECC Company: HMWWV, TRUCK		2 events, 3-5 days/event	4 events, 3-5 days/event	4 events, 3-5 days/event	
	Army Reserve/GUARNG Company; HMWWV, TRUCK		2 events, 3-5 days/event	4 events, 3-5 days/event	4 events, 3-5 days/event	
Special Warfare						
Direct Action	SEAL Tactical Air Control Party (TAC-P); RHIB; Small Craft.	M-16, M-4, M-249 SAW, M-240G, .50 cal, M-203 (5.56 /7.62 mm/ .50 cal round/ 40mm HE)	2 (2,000 rounds)	3 (3,000 rounds)	3 (3,000 rounds)	FDM (R-7201)
	SEAL Platoon/Squad; NECC Platoon/Squad; USMC Platoon/Squad; ARMY Platoon/Squad; USAF Platoon/Squad	5.56 mm blanks/Simulations 9mm (Orote Pt. Combat Qualification Center - OPCQC) 1.5 lb NEW C4 (Navy Munitions Site Breaching House)	32 (12,500 9mm) (10.5 lb NEW C4)	40 (15,000 9mm) (15 lb NEW C4)	48 (17,500 9mm) (19.5 lb NEW C4)	PRI: OPCQC and Navy Munitions Site Breacher House SEC: Tarague Beach CQC and Navy Munitions Site Breacher House.

Table 2-8: Annual Training Activities in the MIRC Study Area (Continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Special Warfare (SW) (continued)						
Military Operations in Theater (MOUT) Training	SEAL Platoon/Squad; EOD Platoon/Squad; HMWWV; TRUCK	5.56 mm blanks/Simulations	6 events of 3-5 days/event	8 events of 3-5 days/event	10 events of 3-5 days/event	PRI: Guam; AAFB South; Finegayan Communication Annex; Barrigada Housing; Navy Munitions Site Breaching House SEC: Tinian; Rota; Saipan
Parachute Insertion	SEAL Platoon/Squad; EOD Platoon/Squad; ARMY Platoon/Squad USAF Platoon/Squad; C-130; CH-46; H-60	Square Rig or Static Line	6	12	12	PRI: Orote Pt. Airfield; Northwest Airfield; Orote Pt. Triple Spot SEC: Finegayan DZ; Apra Harbor; Navy Munitions Site Breacher House
Insertion/ Extraction	SEAL Platoon/Squad; EOD Platoon/Squad; ARMY Platoon/Squad; USMC Platoon/Squad; USAF Platoon/Squad: RHIB; Small Craft; CRRC; H-60; H-46 or MV-22	Square Rig or Static Line; Fastrope; Rappel; SCUBA	104	150	150	PRI: Orote Pt. Airfield; Northwest Field; Orote Pt. Triple Spot; Apra Harbor; Gab Gab Beach SEC: Orote Pt. CQC; Finegayan DZ; Haputo Beach; Munitions Site Breacher House; Polaris Pt. Field; Orote Pt. KD Range
Hydrographic Surveys	SEAL Platoon/Squad; EOD Platoon/Squad; USMC Platoon/Squad; Small Craft; RHIB; CRRC; H-60	SCUBA	3	6	6	PRI: FDM; Tinian; Tipalao Cove SEC: Haputo Beach; Gab Gab Beach; Dadi Beach
Breaching (Buildings, Doors)	SEAL Platoon/Squad; EOD Platoon/Squad; ARMY Platoon/Squad; USMC Platoon/Squad;	Breach House (1 lbs NEW C4 max/door)	10 (15 lbs NEW C4)	20 (30 lbs NEW C4)	20 (30 lbs NEW C4)	Navy Munitions Site Breacher House

Table 2-8: Annual Training Activities in the MIRC Study Area (Continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Special/Expeditionary Warfare						
Land Demolitions (IED Discovery/ Disposal)	NECC EOD Platoon/ Squad; USMC EOD Platoon/ Squad; USAF EOD Platoon/ Squad: HMWWV; TRUCK	IED Shapes	60	120	120	PRI: Guam, Orote Pt. Airfield; Orote Pt. CQC; Polaris Pt. Field; Andersen South; Northwest Field SEC: Northern/Southern Land Navigation Area; Munitions Site Breacher House; Tinian MLA
Land Demolitions (UXO Discovery/ Disposal)	NECC EOD Platoon/ Squad; USMC EOD Platoon/ Squad; USAF EOD Platoon/ Squad: HMWWV; TRUCK	UXO	100	200	200	PRI: Navy Munitions Site EOD Disposal Site (limit 3000 lbs NEW per UXO event) SEC: AAFB EOD Disposal Site (limit 100 lbs per event)
Seize Airfield	SEAL Company/ Platoon USMC Company/ Platoon ARMY Company/ Platoon USAF Squadron C-130; MH-53; H-60; HMWWV; TRUCK	5.56 mm blank/Simulations	2	12	12	PRI: Northwest Field SEC: Orote Pt. Airfield; Tinian North Field
Airfield Expeditionary	USAF RED HORSE Squadron. NECC SEABEE Company. USMC Combat Engineer Company USAR Engineer Dozer, Truck, Crane, Forklift, Earth Mover, HMMWV. C-130; H-53.	Expeditionary Airfield Repair and Operation	1	12	12	PRI: Northwest Field SEC: Orote Pt. Airfield; Tinian North Airfield

Table 2-8: Annual Training Activities in the MIRC Study Area (Continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Special/Expeditionary Warfare (continued)						
Intelligence, Surveillance, Reconnaissance (ISR)	SEAL Platoon/Squad; ARMY Platoon/Squad; USMC Platoon/Squad; USAF Platoon/Squad	Night Vision; Combat Camera; 5.56 mm blanks/Simunition	12	16	16	PRI: Guam; Northwest Field; Barrigada Housing; Finegayan Comm. Annex; Orote Pt. Airfield. SEC: Tinian, Rota, Saipan
Field Training Exercise (FTX)	ARMY Company/ Platoon NECC SEABEE Company/ Platoon	Tents; Trucks; HMMWV; Generators	100 events, 2-3 days per event	100 events, 2-3 days per event	100 events, 2-3 days per event	PRI: Guam, Northwest Field; Northern Land Navigation Area SEC: Orote Pt. Airfield; Polaris Pt. Field; Tinian North Field.
Non-Combatant Evacuation Operation (NEO)	Amphibious Shipping (1-LHD; 1-LPD; 1-LSD) USMC Special Purpose MAGTF	HMMWV; Trucks; Landing Craft (LCAC/ LCU); AAV/ LAV; H-46 or MV-22	1 event, 3-5 days	2	2	PRI: Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Northwest Field; Sumay Cove and MWR Marina Ramp SEC: Tinian Military Leased Area; Unai Chulu (beach) and Tinian Harbor; North Field.
MANEUVER (Convoy; Land Navigation)	USMC Company/Platoon Army Company/Platoon	Trucks; HMWWV;AAV/LAV	8	16	16	PRI: Northwest Field; AAFB South; Northern and Southern Land Navigation Area; Tinian MLA SEC: Finegayan Annex; Barrigada Annex; Orote Pt. Airfield;

Table 2-8: Annual Training Activities in the MIRC Study Area (Continued)

Range Activity	Platform	System or Ordnance	No Action Alternative	Alternative 1	Alternative 2	Location
Special/Expeditionary Warfare (continued)						
Humanitarian Assistance/ Disaster Relief Operation (HADR)	Amphibious Shipping (1-LHD; 1-LPD; 1-LSD) USMC Special Purpose MAGTF	HMMWV; Trucks; Landing Craft (LCAC/ LCU); AAV/ LAV; H-46 or MV-22	1 event, 3-5 days	2	2	PRI: Apra Harbor; Reserve Craft Beach; Polaris Point Beach (MWR) and Polaris Point Field; Orote Point Airfield; Northwest Field; Sumay Cove and MWR Marina Ramp SEC: Tinian Military Leased Area; Unai Chulu (beach) and Tinian Harbor; North Field.
Force Protection / Anti-Terrorism						
Embassy Reinforcement	SEAL Platoon ARMY Platoon USMC Company/ Platoon Trucks; HMMWV; C-130; H-60; H-53	5.56 mm blanks/Simulations	42 events, 1-2 days per event	50 events, 2-3 days per event	50 events, 2-3 days per event	PRI: Orote. Pt. Airfield Inner Apra Harbor; Northern and Southern Land Navigation Area SEC: Orote Pt. Triple Spot; Orote Pt. CQC; Kilo Wharf
Force Protection	USAF Squadron/ Platoon NECC SEABEE Company/ Platoon USAR Engineer Company/ Platoon Tents; Trucks; HMMWV; Generators	5.56 mm blanks/Simulations	60 events, 1-2 days per event	75 events, 1-2 days per event	75 events, 1-2 days per event	PRI: Guam, Northwest Field; Northern Land Navigation Area; Barrigada Annex SEC: Orote Pt. Airfield; Polaris Pt. Field; Tinian North Field.
Anti-Terrorism	Navy Base Security USAF Security Squadron USMC FAST Platoon Trucks; HMMWV; MH-60	5.56 mm blanks/Simulations	80 events, 1 day/event	80 events, 1 day/event	80 events, 1 day/event	PRI: Tarague Beach Shoot House and CATM Range; Polaris Pt.; Northwest Field. SEC: Kilo Wharf; Finegayan Comm. Annex; Navy Munitions Site; AAFB Munitions Site

Table 2-9: Summary of Ordnance Use by Training Area in the MIRC Study Area[1]

Training Area and Ordnance Type	Number of Rounds Per Year		
	No Action	Alternative 1	Alternative 2
FDM (R-7201)			
Bombs (HE) ≤ 500 lb	400	500	600
Bombs (HE) 750 / 1000 / 2000 lb	1,600	1,650	1,700
Inert Bomb Training Rounds ≤ 2000 lb	1,800	2,800	3,000
Missiles [Maverick; Hellfire; TOW]	30	60	70
Cannon Shells (20 or 25 mm)	16,500	20,000	22,000
Cannon Shells (30 mm)	0	1,500	1,500
AC-130 Cannon Shells (40mm or 105mm)	100	200	200
5-inch Gun Shells	400	800	1,000
Small Arms [5.56mm; 7.62mm; .50 cal; 40mm]	2,000	3,000	3,000
PRI: Guam Maritime > 3 nm from land SEC: W-517			
MK-48 EXTORP	20	40	48
MK-46 or MK-50 REXTORP	0	7	14
MK-84 SUS (Signal Under Surface Device, Electro-Acoustic)	20	40	48

Table 2-9: Summary of Ordnance Use by Training Area in the MIRC Study Area (Continued)

Training Area and Ordnance Type	Number of Rounds Per Year		
	No Action	Alternative 1	Alternative 2
PRI: W-517 SEC: Marianas Maritime > 12 nm; ATCAAs			
Air Deployed Mines [MK-62; MK-56]	320	480	480
Inert Bomb Training Rounds [MK-82 I; BDU-45; MK-76]	48	72	90
5-inch Gun Shells	160	320	400
76 mm Gun Shells	60	120	150
.50 cal MG	4,400	16,000	16,000
25 mm MG	1,600	8,000	8,000
7.62 mm MG	30,000	40,000	40,000
20 mm; 25 mm; 30 mm Cannon Shells	8,000	18,500	19,500
RR-144A/AL Chaff Canisters	520	740	920
RR-188 Chaff Canisters	1,500	5,000	5,500
MK-214; MK-216 Chaff Canisters	72	90	108
MK-46 MOD 1C; MJU-8A/B; MJU-27A/B; MJU-32B; MJU-53B; SM-875/ALE Flares	520	740	920
MJU-7; MJU-10; MJU-206 Flares	1,500	5,000	5,500
AIM-7 Sparrow	4	6	8
AIM-9 Sidewinder	4	6	8
AIM-120 AMRAAM	4	6	8
RIM-7 Sea Sparrow/ RIM-116 RAM / RIM-67 SM II ER	2	4	6
PRI: Marianas Maritime > 3 nm SEC: W-517			
EER/IEER/AEER	103	106	115
5.56 mm; 7.62 mm; .50 cal; 40 mm	12,000	16,000	20,000

Table 2-9: Summary of Ordnance Use by Training Area in the MIRC Study Area (Continued)

Training Area and Ordnance Type	Number of Rounds Per Year		
	No Action	Alternative 1	Alternative 2
PRI: W-517 SEC: Marianas Maritime > 50 nm; ATCAAs	**SINKEX**		
HARM	2	4	4
SLAM-ER	4	8	8
HARPOON	5	10	10
5-inch Gun Shells	400	800	800
HELLFIRE	2	4	4
MAVERICK	8	16	16
GBU-12	10	20	20
GBU-10	4	8	8
MK-48	1	2	2
Underwater Demolitions [100 lb NEW]	2	4	4
PRI: Agat Bay (20 lb NEW max) SEC: Apra Harbor (10 lb NEW max)	**Underwater Demolition**		
5 – 20 lb NEW	22	30	30
PRI: Agat Bay (20 lb NEW max) SEC: Piti (20 lb NEW max)	**Floating Mine Neutralization**		
5 – 20 lb NEW	8	20	20

[1.] Baseline ordnance expenditure estimates were made from review of FY2003-2007 Service records, databases, schedules, and estimates.

Table 2-10: Summary of Sonar Activity by Exercise Type in the MIRC Study Area

Exercise Type	No Action	Alternative 1	Alternative 2
Multi-Strike Group: One; [3] CSG; April – September; [10] Days	**Activity Guidelines Per CSG: [4] SQS-53C/D; [1] SQS-56 ; [2] Dips per hour; [16] DICASS per hour; Reset Time -12 hours**		
Events Per Year	0 or 1 (One Multi-Strike Group Exercise or One Joint Expeditionary Exercise)	1	1
SQS-53C/D	1705 hours	1705 hours	1705 hours
SQS-56	77 hours	77 hours	77 hours
AQS-22	288 dips	288 dips	288 dips
DICASS	1282	1282	1282
Sub BQQ	0	0	0
SINKEX : Two [2] Day Event	**Activity Guidelines: Sonar Hours in TRACKEX/TORPEX below**		
Events Per Year	1	2	2
DICASS	100	200	200
MK-48 (HE)	1	2	2
Joint Expeditionary: One [1] CSG + ESG; [10] Days	**Activity Guidelines: [3] SQS-53C/D; [1] SQS-56; Sonar Hours and Sonobuoys in TRACKEX/TORPEX below**		
Events Per Year	0 or 1 (One Multi-Strike Group Exercise or One Joint Expeditionary Exercise)	1	1
Fleet Strike Group: One [1] CSG; [7] Days	**Activity Guidelines: [4] SQS-53C/D; [1] SQS-56; Sonar Hours and Sonobuoys in TRACKEX/TORPEX below**		
Events Per Year	0	0	1
Integrated ASW: One [1] CSG; [5] Days	**Activity Guidelines: [4] SQS-53C/D; [1] SQS-56; Sonar Hours and Sonobuoys in TRACKEX/TORPEX below**		
Events Per Year	0	0	1

Table 2-10: Summary of Sonar Activity by Exercise Type in the MIRC Study Area (Continued)

Exercise Type	No Action	Alternative 1	Alternative 2
Ship Squadron ASW: One [1] DESRON; [5] Days	**Activity Guidelines: [4] SQS-53C/D; [1] SQS-56; Sonar Hours and Sonobuoys in TRACKEX/TORPEX below**		
Events Per Year	0	0	1
MAGTF Exercise (STOM/NEO)	**Activity Guidelines: [2] SQS-53C/D; [1] SQS-56; Sonar Hours and Sonobuoys in TRACKEX/TORPEX below**		
Events Per Year	1	4	4
ASW TRACKEX (SHIP): One [1] Reset, One [1] Day Event	**Activity Guidelines: [2] SQS-53C/D, [1] SQS-56; Reset Time - 8 hours (sub target), 4 hours (non-sub target); [3] 53C/D, ½ Time Active, [1] 56, ¼ Time Active**		
Events Per Year	10	30	60
SQS-53 C/D	120 hours	360 hours	720 hours
SQS-56	20 hours	60 hours	120 hours
ASW TRACKEX (HELO): One [1] Reset, One [1] Day Event	**Activity Guidelines: [2] SH-60B; [1] SH-60F 2 dips per hour; Reset Time - 8 hours (sub target), 4 hours (non-sub target)**		
Events Per Year	9	18	62
AQS-22	144 dips	288 dips	576 dips
DICASS	36	72	144
ASW TRACKEX (MPA): One [1] Reset, [1] Day Per Event	**Activity Guidelines: [1] MPA; Reset Time - 8 hours (sub target), 4 hours (non-sub target)**		
Events Per Year	5	8	17
DICASS	50	80	170
EER/IEER/AEER	5	8	17
ASW TORPEX (SUB): One [1] Reset, [1] Day Per Event; [1] EXTORP Per Event	**Activity Guidelines: [1] SSN or SSGN; Reset Time - 8 hours (sub target), 4 hours (non-sub target)**		
Events Per Year	5	10	12
Sub BQQ	6 hours	12 hours	15 hours
MK-48 EXTORP	20	40	48

Table 2-10: Summary of Sonar Activity by Exercise Type in the MIRC Study Area (Continued)

Exercise Type	No Action	Alternative 1	Alternative 2
ASW TORPEX (SHIP): One [1] Reset, [1] Day per Event; [1] REXTORP	**Activity Guidelines: [2] SQS-53C/D, [1] SQS-56; Reset Time - 8 hours (sub target), 4 hours (non-sub target); ½ Time Active**		
Events per Year	0	3	6
SQS-53 C/D	0	8 hours	16 hours
SQS-56	0	4 hours	8 hours
REXTORP	0	3	6
ASW TORPEX (MPA/HELO): One [1] Reset, One [1] Day Event; [1] REXTORP	**Activity Guidelines: [2] SH-60B; [1] SH-60F; [1] MPA; Reset Time - 8 hours (sub target), 4 hours (non-sub target)**		
Events per Year	0	4	8
AQS-22	0	16 dips	32 dips
DICASS	0	20	40
REXTORP	0	4	8

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CHAPTER 3

AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter describes existing environmental conditions for resources potentially affected by the Alternatives described in Chapter 2. This chapter also identifies and assesses the environmental consequences of the Alternatives. The affected environment and environmental consequences are described and analyzed according to categories of resources.

The Navy has embraced its stewardship responsibilities for the rich variety of natural resources at land and sea, managing them for multiple use, sustained yield, biodiversity, and ecosystem services. The Navy adopts an ecosystems management at land and sea, a management strategy based on the application of appropriate scientific methodologies focused on levels of biological organization which encompass the essential processes, functions and interactions among organisms and their environment. "Ecosystem" means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. Ecosystem management is a focus from sustaining the current viability of systems to one of sustaining the viability of systems now and into the future by bringing ecosystem capabilities, social, and economic needs into closer alignment. Therefore, the Navy recognizes that impacts to particular resource areas analyzed in this EIS/OEIS (listed below) can affect other resource areas within the ecosystem. For example, an effect on water quality may potentially impact fish populations by altering primary productivity. In other words, the Navy recognizes that impacts to one resource area can influence other ecological processes. Ecosystem management is only successful when management decisions reflect understanding and awareness of the principles that result in resource sustainability.

Through the consideration of local and global effects to the ecosystems within the MIRC, as well as interrelated impacts to individual resource areas, this EIS/OEIS is consistent with the ecosystems management approach in the environmental impact analysis process. The affected environment and environmental consequences are described and analyzed according to categories of resources. The categories of resources addressed in this EIS/OEIS are:

Resource	Section	Resource	Section
Geology, Soils, and Bathymetry	3.1	Hazardous Materials and Waste	3.2
Water Quality	3.3	Air Quality	3.4
Airborne Noise	3.5	Marine Communities	3.6
Marine Mammals	3.7	Sea Turtles	3.8
Fish and Essential Fish Habitat	3.9	Seabirds and Shorebirds	3.10
Terrestrial Species and Habitats	3.11	Land Use	3.12
Cultural Resources	3.13	Transportation	3.14
Demographics	3.15	Regional Economy	3.16
Recreation	3.17	Environmental Justice and Protection of Children	3.18
Public Health and Safety	3.19		

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3.1 GEOLOGY, SOILS, AND BATHYMETRY

This section addresses terrestrial earth resources: geologic formations, topography, soil resources, and geologic hazards (e.g., seismic activity, liquefaction) of the MIRC. A brief overview of marine geology and bathymetry of the MIRC Study Area is also provided.

The major earth resources of an area are its bedrock and soils. For the purpose of this EIS/OEIS, the terms soil and rock refer to unconsolidated and consolidated materials, respectively. Earth resources also include mineral deposits, significant landforms, tectonic features and paleontological remains (i.e., fossils). Geologic resources can have scientific, economic, and recreational value, and some can pose hazards to human endeavors. Because the location, extent and quality of paleontological resources in the MIRC are unknown[1] and the impacts of training, if any, on these resources can be mitigated, this resource will not be evaluated herein.

The bathymetry, sediments, and soils of an area are its general bottom features, soil, and sediments. These materials include sediments and rock outcroppings in the nearshore and open ocean underwater environment. Bathymetry is also referred to as seafloor topography.

3.1.1 Introduction and Methods

The assessment of geology, soils, and bathymetry in the MIRC was conducted by reviewing available literature including previously published NEPA documents for actions in the MIRC and surrounding area. A site-specific geotechnical investigation was not undertaken for this EIS/OEIS. Information on marine geology and bathymetry of the MIRC was taken from the Marine Resources Assessment (MRA) for the Marianas Operating Area (DoN 2005).

Potential geology and soils impacts are limited to elements of current and proposed activities that could affect onshore land forms or that could be affected by geologic hazards. Aircraft training activities are not expected to have substantial effects on geology and soils. Potential soil contamination issues are addressed in Section 3.2 (Hazardous Materials and Wastes). Potential bay and ocean sediment contamination issues are addressed in Section 3.3 (Water Quality).

Impacts on geology, soils, and bathymetry can be direct or indirect. Direct impacts result from physical soil disturbances or topographic alterations, while indirect impacts include risks to individuals from geologic hazards. Factors considered in determining whether an impact would be significant include the potential for substantial change in soil stability and physical effects on ocean bottom sediments and natural ocean processes (e.g., sedimentation and currents). An impact to geologic resources would be considered significant if the action would have the potential to disrupt geologic features, or if actions were to be affected by potential geologic hazards. Impacts would be considered significant if the action would have the potential to increase erosion as a result of disturbance of the ground surface by training activities.

[1] Although there are limited published accounts of fossil crabs and algae from Guam, and karsts on islands sometimes have fossil bird remains, information on paleontological resources is limited in the MIRC Study Area.

3.1.1.1 Regulatory Framework

3.1.1.1.1 Federal Laws and Regulations

There are no Federal laws or regulations applicable to geological resources and soils in the MIRC Study Area and to effects caused by the proposed training activities. To address geologic hazards, zoning considerations and local building codes aim to improve the seismic safety of existing buildings.

3.1.1.1.2 Territory and Commonwealth Laws and Regulations

The government of Guam has established a Soils and Water Conservation Program as defined in Chapter 26 of Title 17 of the Guam Code Annotated (GCA) as authorized by Public Law 28-179. The program is administered by the University of Guam. This regulation promotes the Territory of Guam's soil and water conservation policy in an effort to prevent erosion and water management problems; conserves and improves the use of the Territory's land and water resources; establishes Soil and Water Conservation Districts; and affirms the University of Guam's role as the Territory's lead soil conservation agency. Conservation programs are also administered by the Public Utility Agency of Guam and the Guam Environmental Protection Agency (GEPA).

The CNMI has Earthmoving and Erosion Control Regulations (CR) Vol. 15, No. 10, October 15, 1993) (CNMI Environmental Protection Act, Public Law 3-23, 2 Northern Mariana Islands Commonwealth Code [CMC] §§ 3101 to 3134, and 1 CMC §§ 2601 to 2605) that establish a permit process for construction activities, identify investigations and studies that are required prior to construction and design, and establish standards for grading, filling, and clearing.

3.1.1.2 Warfare Areas and Associated Environmental Stressors

Aspects of the proposed training likely to act as stressors to geological resources and soils were identified through analysis of the warfare training activities and specific activities included in the alternatives. This analysis is presented in Table 3.1-1. An impact analysis is provided in Section 3.1.3.

Table 3.1-1: Warfare Training and Potential Stressors to Geological Resources and Soils

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Geological Resources and Soils
Army Training			
Surveillance and Reconnaissance (S&R)/ Finegayan Communications Annex, Barrigada Communications Annex, Tinian EMUA and LBA		Vehicle Movements	Soil disturbance/suspension of soil/soil loss Localized erosion
Field Training Exercise (FTX) / Polaris Point Field, Orote Point Airfield/ Runway, Northern Land Navigation Area (NLNA), Northwest Field, Andersen South, Tinian Exclusive Military Use Area (EMUA)		Vehicle Movements	Soil disturbance/suspension of soil/soil loss Localized erosion
Live Fire/ Pati Point CATM Range		Weapons Firing	Soil disturbance/suspension of soil/soil loss Localized erosion
Parachute Insertions and Air Assault/ Orote Point Triple Spot, Polaris Point Field, Ordnance Annex Breacher House		Vehicle Movements	Soil disturbance/suspension of soil/soil loss Localized erosion
Military Operations in Urban Terrain (MOUT) / Orote Point Close Quarters Combat (CQC) Facility, Ordnance Annex Breacher House, Barrigada Communications Annex, Andersen South		Vehicle Movements Building Modification (repairs, maintenance and upgrades)	Soil disturbance/suspension of soil/soil loss Localized erosion
Marine Corps Training			
Ship to Objective Maneuver (STOM) / Tinian EMUA		Vehicle Movements	Soil disturbance/suspension of soil/soil loss Localized erosion
Operational Maneuver/ NLNA, Southern Land Navigation Area (SLNA)		Vehicle Movements	Soil disturbance/suspension of soil/soil loss Localized erosion
Noncombatant Evacuation Order (NEO) / Tinian EMUA		Vehicle Movement	Soil disturbance/suspension of soil/soil loss Localized erosion
Assault Support (AS) / Polaris Point Field, Orote Point Small Arms Range/Known Distance Range, Tinian EMUA		Vehicle Movements	Soil disturbance/suspension of soil/soil loss Localized erosion
Reconnaissance and Surveillance (R&S) / Tinian EMUA		Vehicle Movements	Soil disturbance/suspension of soil/soil loss Localized erosion
MOUT / Ordnance Annex Breacher House, Orote Point CQC		Vehicle Movements Building Modification	Soil disturbance/suspension of soil/soil loss Localized erosion
Direct Fires/ FDM, Orote Point Known Distance (KD) Range, ATCAA 3A		Weapons Firing	Soil disturbance/suspension of soil/soil loss Localized erosion

Table 3.1-1: Warfare Training and Potential Stressors to Geological Resources and Soils (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Geological Resources and Soils
Marine Corps Training (continued)			
Protect the Force/ Northwest Field		Vehicle Movements	Soil disturbance/suspension of soil/soil loss Localized erosion
Navy Training			
Anti-Submarine Warfare (ASW) / Open Ocean		Aircraft Movements Use of Torpedoes	Torpedo fragments landing on ocean floor
Air Warfare (AW) / W-517, R-7201		Non-recovery of fired missiles	Disturbance of bottom sediments
Surface Warfare (SUW)/ FDM, W-517	Surface-to-Surface Gunnery Exercise (GUNEX)	None	None
	Air-to-Surface GUNEX	None	None
	Visit Board Search and Seizure (VBSS)	None	None
	Sink Exercise (SINKEX)		
Strike Warfare (STW) / FDM	Air-to-Ground Bombing Exercises (Land)(BOMBEX-Land)	Land Detonations	Soil disturbance/suspension of soil/soil loss
	Air-to-Ground Missile Exercises (MISSILEX)	Land Detonations	Soil disturbance/suspension of soil/soil loss

Table 3.1-1: Warfare Training and Potential Stressors to Geological Resources and Soils (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Geological Resources and Soils
Navy Training (continued)			
Naval Special Warfare (NSW) / Orote Point Training Areas, Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field, Apra Harbor, Reserve Craft Beach, Polaris Point Field, Dan Dan Drop Zone	Naval Special Warfare Operations (NSW OPS)	Vehicle Movements Amphibious Landings Weapons Firing	Soil disturbance/suspension of soil/soil loss Beach erosion, siltation and formation of sediment plumes
	Airfield Seizure	Aircraft Movements Vehicle Movements	Soil disturbance/suspension of soil/soil loss Beach erosion, siltation and formation of sediment plumes
	Insertion/ Extraction	Aircraft Movements Amphibious Landings	Soil disturbance/suspension of soil/soil loss Beach erosion, siltation and formation of sediment plumes
	Direct Action	Aircraft Movements Amphibious Landings Weapons Firing	Soil disturbance/suspension of soil/soil loss Beach erosion, siltation and formation of sediment plumes
	Military Operations in Urban Terrain (MOUT)	Vehicle Movements	Soil disturbance/suspension of soil/soil loss
	Over the Beach (OTB)	Aircraft Movements Amphibious Landings	Soil disturbance/suspension of soil/soil loss Beach erosion, siltation and formation of sediment plumes
	Breaching	Explosive Ordnance (use of small explosives)	Soil disturbance/suspension of soil/soil loss
Amphibious Warfare (AMW) / FDM, Orote Point and Finegayan Small Arms Ranges, Orote Point KD Range, Reserve Craft Beach, Outer Apra Harbor, Tipalao Cove, Tinian EMUA	Naval Surface Fire Support (FIREX Land)	Land Detonations	Soil disturbance/suspension of soil/soil loss
	Marksmanship	Weapons Firing	Soil disturbance/suspension of soil/soil loss
	Expeditionary Raid	Amphibious Landings Vehicle Movement	Beach erosion, siltation and formation of sediment plumes Soil disturbance/suspension of soil/soil loss
	Hydrographic Surveys	Amphibious Landings	Beach erosion, siltation and formation of sediment plumes Soil disturbance/suspension of soil/soil loss

Table 3.1-1: Warfare Training and Potential Stressors to Geological Resources and Soils (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Geological Resources and Soils
Navy Training (continued)			
Mine Warfare (MIW) Training/ Agat Bay, Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point Airfield/Runway, OPCQC, Ordnance Annex Breacher House, Ordnance Annex Emergency Detonation Site, NLNA, SLNA, Barrigada Housing, Piti and Agat Bay Floating Mine Neutralization Areas	Land Demolition	Vehicle Movements Land Detonations	Soil disturbance/suspension of soil/soil loss
	Underwater Demolition	None	None
Logistics and Combat Services Support/ Orote Point Airfield/ Runway, Reserve Craft Beach	Combat Mission Area	Vehicle Movements Amphibious Landings	Soil disturbance/suspension of soil/soil loss Beach erosion, siltation and formation of sediment plumes
	Command and Control (C2)	None	None
Combat Search and Rescue (CSAR) / Tinian North Field (for NVG)	Embassy Reinforcement	Vehicle Movements Building Modification	Soil disturbance/suspension of soil/soil loss
	Anti-Terrorism (AT)	Vehicle Movements	Soil disturbance/suspension of soil/soil loss
Protect and Secure Area of Operations/ Navy Main Base, Inner Apra Harbor, Kilo Wharf, Reserve Craft Beach, Orote Point Training Areas, Polaris Point Site III, Ordnance Annex Breacher House, Orote Annex Emergency Detonation Site	Embassy Reinforcement (Force Protection)	Vehicle Movements Building Modification	Soil disturbance/suspension of soil/soil loss
	Anti-Terrorism	None	None

Table 3.1-1: Warfare Training and Potential Stressors to Geological Resources and Soils (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Geological Resources and Soils
Air Force Training			
Counter Land / FDM, ATCAA 3		Land Detonations	Soil disturbance/suspension of soil/soil loss
Counter Air (Chaff)/ W-517, ATCAAs 1 and 2		None	None
Airlift / Northwest Field		Aircraft Movements Vehicle Movements	Soil disturbance/suspension of soil/soil loss
Air Expeditionary / Northwest Field		Aircraft Movements Vehicle Movements	Soil disturbance/suspension of soil/soil loss
Force Protection / Northwest Field		Vehicle Movements	Soil disturbance/suspension of soil/soil loss
ISR/Strike Capability / R-7201, FDM, Andersen AFB	Air-to-Ground Training	Aircraft Movements Land Detonations	Soil disturbance/suspension of soil/soil loss

3.1.2 Affected Environment

The Mariana Islands are stratovolcanoes created by subduction of the Pacific Plate beneath the Philippine Plate. The islands are located west and parallel of the Mariana Trench, which reaches a depth of nearly 36,000 ft, (approximately 10,970 m) in the western Pacific (WestPac) (COMNAVMARIANAS 2003).

The geology of the individual islands is largely dependent on the degree of recent volcanism. The older southern islands (Guam, Rota, Tinian, Agrigan, Saipan, and FDM) generally consist of a volcanic core that is covered by coralline limestone in layers up to several hundred meters thick. In general, the original volcanoes subsided beneath the ocean surface, allowing the coral formations to grow, which ultimately formed the limestone caps on these southern islands. Alternating sea level heights and wave action formed the limestone plateaus at various elevations. Uplifting of the Philippine Plate resulted in the limestone caps being pushed several hundred meters above sea level. The volcanic core is exposed in some areas through either recent volcanic activities or erosion.

The northern islands (north of FDM) are generally younger and have not experienced periods of submergence; therefore, they lack thick limestone caps. Sarigan has no known historical eruptions. Three earthquakes of magnitude greater than 6.5 on the Richter scale occurred in the Mariana Islands within the past 15 years: (1) an earthquake of magnitude 7.4 on the Richter scale occurred in 2007 approximately 175 miles (mi) northwest of Farallon de Pajaros, (2) an earthquake of magnitude 7.1 on the Richter scale occurred in the Mariana Islands in 2002, and (3) an earthquake of magnitude 7.8 on the Richter scale occurred south of Guam in 1993 (U.S. Geological Survey [USGS] 2008). Anatahan was volcanically active in 2003. Guguan had a single historic eruption in 1883. Alamagan is suspected to have had two historic eruptions in 1864 and 1887. Pagan has had 19 historic eruptions, the most recent in 1993. Agrigan has had a single known historic eruption in 1917. Asuncion is considered volcanically active with the most recent eruption in 1906. Maug is comprised of three small islands that are the rim of a submerged summit crater; however, there are no historic eruptions. Farallon de Pajaros, also called Uracas, is the northernmost island of CNMI and most recently erupted in 1967 (COMNAVMARIANAS 2003).

All of the islands in the archipelago have some nearshore coral reef development. Some islands have only a narrow fringing reef system, while others such as Saipan have extensive reef flats extending seaward for hundreds of meters. The islands in the chain are not at high risk for tsunami due to the absence of a shoal for seismic waves to crest upon. Earthquakes of low magnitude occur throughout the year in the Mariana Islands as two sections of the ocean floor collide and one slides beneath the other at the nearby Mariana Trench.

The MIRC Study Area for geological resources for the Proposed Action analyzed in this EIS/OEIS extends 12 nm (19 km) from the coastline of any U.S. Territory as defined by Presidential Proclamation 5928. Portions of potentially affected inner sea range within these boundaries are also subject to analysis under NEPA.

The Mariana Islands are volcanic islands developed west of the Mariana Trench, an active subduction zone where one section of the ocean crust is pushed beneath another. Coralline limestone covers much of each island, in some cases in a layer several hundred meters thick. Soils developed on volcanic rock tend to be poorly drained clays, while soils developed on limestone are usually shallow and highly porous. Surface water bodies and streams can only exist in regions with enough clay to prevent water from draining through to the porous rock below (PACOM 1999).

Marine Geology and Bathymetry. The MIRC Study Area is located at the intersection of the Philippine and Pacific crustal plates, atop what is believed to be the oldest seafloor on the planet dating to the Jurassic era. The collision of the two plates has resulted in the subduction of the Pacific Plate beneath the Philippine Plate forming the Mariana Trench (Figure 3.1-1)[2]. The Mariana Trench is over 1,410 mi (2,269 km) long and 71 mi (114 km) wide (Figure 3.1-2). The deepest point in the trench and on Earth, Challenger Deep, is found 338 mi (544 km) southwest of Guam in the southwestern extremity of the trench (COMPACFLT 2005).

Thermocline. The water column in the MIRC Study Area contains a well-mixed surface layer ranging from approximately 300 to 410 ft (90 to 125 meters [m]). Immediately below the mixed layer is a rapid decline in temperature to the cold deeper waters. Unlike more temperate climates, the thermocline is relatively stable, rarely turning over and mixing the more nutrient waters of the deeper ocean in to the surface layer. This constitutes what has been defined as a “significant” surface duct (a mixed layer of constant water temperature extending from the sea surface to 100 ft [30 m] or more), which influences the transmission of sound in the water. This factor has been included in the acoustic exposure modeling analysis for marine mammals, discussed in detail in Section 3.7 (Marine Mammals).

[2] The asthenosphere is a weak part of earth's mantle: a weak zone in the upper part of the Earth's mantle where rock can be deformed in response to stress, resulting in movement of the overlying crust.

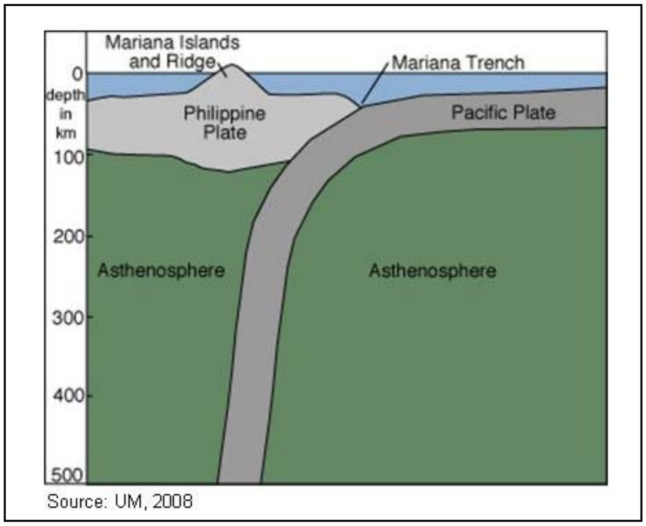
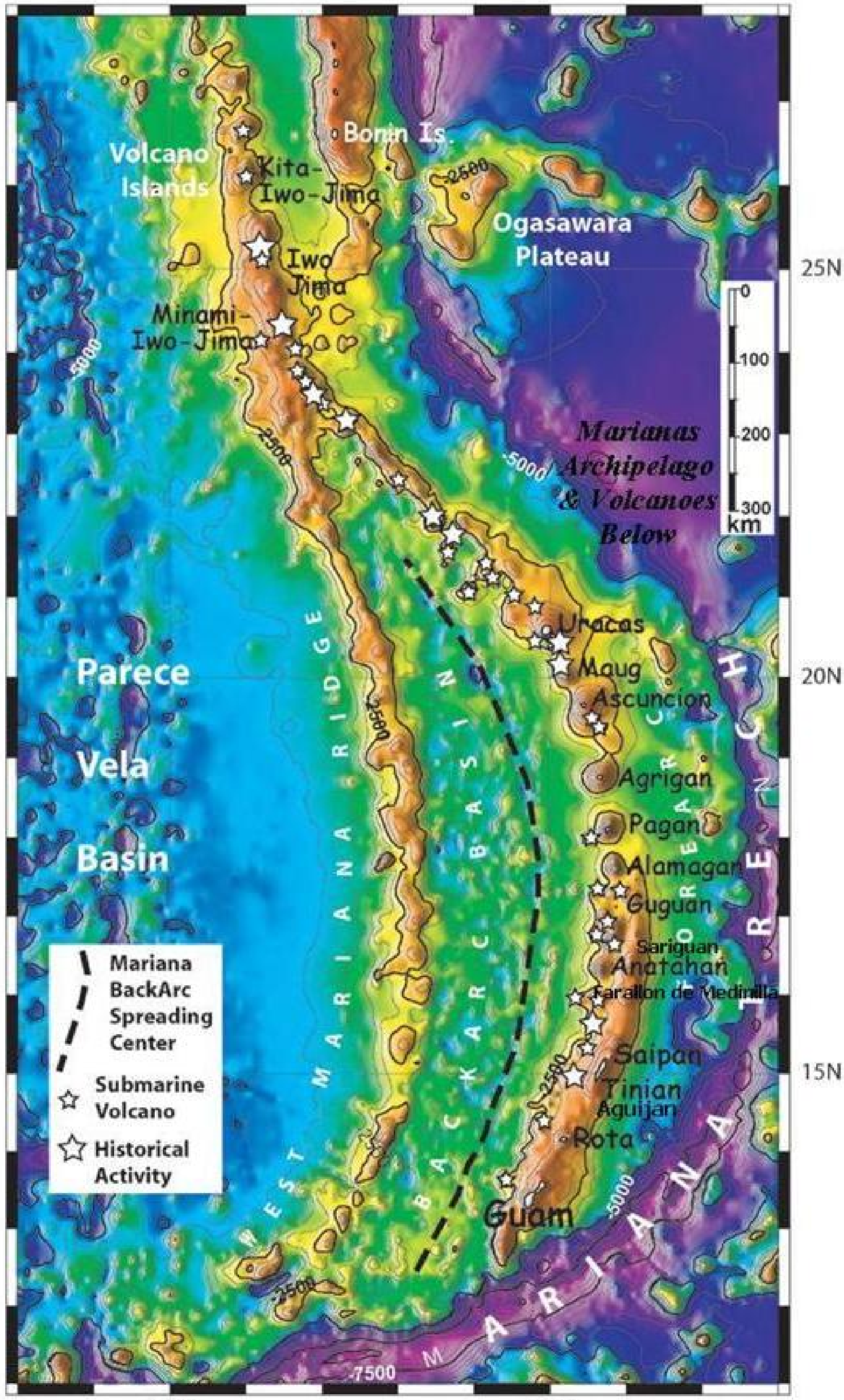


Figure 3.1-1: Subduction of Pacific Plate

The seafloor of the MIRC Study Area region is characterized by the Mariana Trench, the Mariana Trough, ridges, numerous seamounts, hydrothermal vents, and volcanic activity. Two volcanic arcs, the West Mariana Ridge (a remnant volcanic arc) and the Mariana Ridge (an active volcanic arc) are separated by the Mariana Trough. The Mariana Trough formed when the oceanic crust in this region began to spread between the ridges four million years ago. The Mariana Trough is spreading at a rate of less than 0.4 inch [in.] (1 centimeter [cm]) per year in the northern region and at rates up to 1.2 in (3 cm) per year in the center of the trough. The Mariana archipelago is located on the Mariana Ridge, 99 to 124 mi (159 to 200 km) west of the Mariana Trench subduction zone. The Mariana archipelago comprises 15 volcanic islands: Guam, Rota, Tinian, Saipan, FDM, Aguijan, Anatahan, Sarigan, Guguan, Alamagan, Pagan, Agrigan, Asuncion, Maug, and Farallon de Pajaros. Approximately 497 mi (795 km) separate Guam from Farallon de Pajaros (COMPACFLT 2005).



Source: NOAA, 2008

Figure 3.1-2: Seafloor Beneath the Mariana Islands

The islands north of FDM are located on an active volcanic arc ridge axis and were formed between 1.3 and 10 million years ago. The six southern islands (Guam to FDM) are on the old Mariana fore-arc ridge axis and formed about 43 million years ago (Eocene). The young volcanic active ridge axis is offset 16 to 22 mi (26 to 35 km) west of the southern arc ridge axis. The islands on the southern ridge consist of a volcanic core covered by thick coralline limestone (up to several hundreds of meters). The subsidence of the original volcanoes in the southern islands allowed for the capping of the volcanoes by limestone. Limestone covers the northern half of Guam (limestone plateau height: 295 to 590 ft (90 to 180 m) above mean sea level [MSL]) while volcanic rock and clay are exposed on the southern half of the island. Tinian consists of rocky shoreline cliffs and limestone plateaus with no apparent volcanic rock. Similar to Tinian, the uplifted limestone substrate of FDM is bordered by steep cliffs. (COMPACFLT 2005).

In contrast, volcanoes north of FDM have not subsided below sea level, do not have limestone caps, and remain active with the latest major known eruption on Anatahan occurring in July 2005 when ash reached an elevation in excess of 40,000 ft (12,000 m). Guguan, Alamagan, Pagan (two active volcanoes), Agrigan, Asuncion, and Farallon de Pajaros have documented volcanic activity spanning from 1883 to 1967. Ruby Volcano and Esmeralda Bank are submarine volcanoes found east of Saipan and Tinian. Ruby Volcano erupted in 1966 and then again in 1995 as the surrounding area experienced submarine explosions, fish kills, a sulfurous odor, bubbling water, and volcanic tremors (COMPACFLT 2005). Ruby Volcano, also known as Ruby Seamount, is 25 mi (40 km) northwest of Saipan and estimated to be approximately 200 ft (60 m) below sea level (UND 2008). The summits of the Esmeralda Bank are from 141 to 459 ft (43 to 140 m) beneath the sea surface (Smithsonian Institution 2008).

The MIRC Study Area experiences numerous shallow to intermediate depth (< 186 mi [299 km]) normal-fault events indicative of a region that is stretching, resulting in low magnitude earthquakes. Further, the subduction of the Pacific Plate under the Philippine Plate causes abundant seismic activity in the area, with occasional intense and destructive earthquakes (magnitudes greater than 7 on the Richter scale) (COMPACFLT 2005).

As the Pacific Plate descends into the interior of the Earth, fluids driven off lower the melting temperature of the mantle permitting partial melting of the mantle. This material is less dense and rises to the surface to form seamounts. Seamounts in the MIRC Study Area are of two distinct varieties: volcanoes and mud volcanoes. Volcanoes are formed along the spreading axis in the Mariana Trough in which molten rock from the interior of the Earth rises to the surface in the form of magma to construct the seamount conical structure. These seamounts are often associated with hydrothermal communities. An example of a volcanic seamount in the MIRC Study Area is Ruby Volcano, last believed to have erupted in May 1995. Mud volcanoes are formed in a band behind the axis of the Mariana Trench. They are formed when water generated by the dehydration of the subducting Pacific plate (due to increased pressure and temperature) ascends to the mantle of the overlying crust and creates low-density rock capable of rising and extruding to the seafloor. Mud volcanoes tend to have a central conduit that feeds serpentinite mud which comprises the bulk of the seamount structure (COMPACFLT 2005).

3.1.2.1 Guam

Guam is located at the eastern edge of the Philippine Plate at the subduction boundary of the Pacific Plate. The Mariana Trench is located approximately 6 mi (9.6 km) below the ocean surface in the subduction boundary east of Guam. Due to movement of lithospheric plates, Guam is prone to earthquakes. Between 1849 and 1911, four earthquakes with a magnitude of 7.0 or greater on the Richter Scale occurred in the vicinity of Guam. The most recent large-magnitude earthquake was recorded in 1993 and measured 8.1 on the Richter scale (USAF 2006).

Guam is divided into four geophysical regions: (1) the volcanic remnants of south Guam; (2) the deformed beds of the Alutom formation of central Guam composed of well-defined, fine- to coarse-grained gray, green, and brown tuffaceous shale and sandstone; (3) the limestone formations of the northern plateau; and (4) coastal lowlands (USAF 2006).

A limestone plateau covers the northern half of Guam. The plateau elevation ranges from 295 to 590 ft (90 to 180 m) above MSL and drops to the shoreline in steep cliffs. In the southern portion of Guam, bedrock is mostly volcanic rock with clay soils on top. Streams have carved this half of the island into a rugged mountainous region; its highest peak is Mount Lamlam (1,335 ft [400 m] above MSL) near the southwest coast. No significant groundwater aquifer has been identified here. The two halves of the island are joined by a transition region of hilly terrain and mixed limestone and volcanic rock (PACOM 1999).

Andersen AFB lies on the limestone formations of the northern plateau. A narrow coastal lowland terrace is located at the bottom of steep cliffs that surround the plateau on the north, east, and west. This coastal zone is between 300 to 900 ft (90 to 270 m) wide from the base of the cliff to the shore. Massive limestone formations from the Miocene-age (approximately 23.3 to 6.7 million years old) to the Pleistocene-age (about 5.2 to 3.4 million years old) underlie Andersen AFB. These formations were exposed by tectonic uplift and sea level fluctuations. The underlying limestone subtypes range from brittle to well cemented (USAF 2006).

The northern area of Guam is karst terrain that exhibits solution cavities and caves within the porous limestone bedrock. Collapses of these subterranean cavities form sinkholes, which are prominent topographic features of the limestone. The area is dominated by subsurface drainage instead of well-integrated surface drainage systems with principal stream valleys and tributaries. Rainwater easily percolates through the limestone to recharge the Northern Guam Lens aquifer, which is Guam's only drinking water aquifer (USAF 2006).

The southern half of the island is predominately volcanic in origin and is underlain by highly weathered basalt and tuff-derived sedimentary rocks. The island has two major fault zones, the Adelup and the Talofofo faults. The topography, surface drainage, distribution of bedrock and soils, groundwater storage and discharge, landslide potential, and coastal formation of the island is strongly affected by the numerous smaller faults, vertical joints, and local fractures (COMNAVMARIANAS 2001).

Geologically, the Main Base at the Apra Harbor Naval Complex is more closely aligned with the northern structural province. The underlying rocks are composed of coral limestone. Orote Peninsula is a raised limestone plateau reaching 190 ft (57 m) in elevation above MSL. The plateau slopes eastward to near sea level. Much of the land has been substantially altered by shaping, dredging, and filling. The Dry Dock Island Peninsula, Polaris Point, and sections of the shoreline are the result of dredging and filling. The coastline is composed of a relatively narrow margin of beach interspersed with basalt or limestone rock formations. Beach deposits consist of beach sand and gravel, beach rock in the intertidal zone, and patches of recently emerged detrital limestone. A fringing reef extends around the coastline to approximately 200 ft (60 m) offshore. The reef complex begins near shore as a relatively flat back-channel or moat (from 16 to 33 ft [5 to 10 m] deep) that consists of large areas of flat hard pavement with encrusting corals. This deeper channel becomes shallower as it rises to the reef crest on the seaward side, which is formed by terraced algal pools. The reef complex is transected at various points by cracks or fissures (called "spur-and-groove" zones) that create shallow to slightly deeper pools in the back reef. These grooves run roughly parallel to the shoreline and may merge with the reef crest where they create deeper pools protected by the reef crest but well washed with waves. These are areas of highest coral diversity on the reef flat. Natural cuts in the reef, such as Tarague Cut in the north, and Mamaon in the south, are dangerous areas where water constrained by the fringing reefs is funneled back out to sea. The ocean bottom drops off abruptly just past the reef. Apra Harbor, the only deep-water harbor on the island with its 900 ft (270 m) entrance and depths of between 30 and 160 ft (9 and 48 m), is protected to the north by low-lying Cabras and Luminao Reef, to the east by the inland mountain ranges and to the south by the Orote Peninsula (COMNAVMARIANAS 2001).

Communications Annex, Finegayan and Communications Annex, Barrigada lie in the northern limestone structural province. Elevations at the top of the plateau range from 500 to 600 ft (150 to 180 m) above MSL. At the edge of the plateau to the north, west, and east, steep cliffs drop down to an intermittent narrow coastal lowland terrace. The coastal areas range from 200 to 900 ft (60 to 270 m) wide, stretching from the base of the cliffs to the shore. The substrate comprises a heterogeneous mixture of limestone subtypes ranging from highly friable to well-cemented depending on the depositional source. Numerous solution cavities and caves exist within the porous limestone bedrock; collapses of these subterranean cavities form sinkholes, which are prominent topographic features of the limestone. There are no perennial streams in either of these annexes (COMNAVMARIANAS 2001).

Ordnance Annex is located in the southern structural provinces of Guam. The western boundary of Ordnance Annex coincides with a range of low mountains orientated on a north to south axis. This range includes Mount Alifan, Mount Almagosa, Mount Lamlam, which attains a height of 1,335 ft (400 m) above sea level, and Mount Humuyong. This range lies on the Bolanos structural block, which consists of rock from the Miocene-aged Umatac Formation. The Umatac Formation is composed of east-dipping (5-10 degrees) volcanic rocks, including flow basalts (Dandan Member) and tuff breccia or tuff-derived conglomerate, sandstone, and shale (Bolanos Member). The tuff is consolidated volcanic ash that was marine deposited and uplifted. Breccia refers to the angular fragments of the conglomerate. Portions of the range have alternated between periods of submergence and emergence as evidenced from the presence of Alifan Limestone (COMNAVMARIANAS 2001).

The drainage pattern within the southern structural province is the result of the numerous faults. The range of low mountains forms the majority of the topographic divide of the catchment area. A total of nine major perennial stream courses exist within Ordnance Annex. Four (Imong, Sadog Gago, Almagosa River, and Maulap) of the perennial streams have relatively steep gradients and flow into Fena Reservoir, which was formed with the construction of a dam. Three of the perennial streams (Bonya, Talisay, and Maemong) converge with the Maagas River before meeting the Talofofo River. The Maagas River is also known as the Lost River because it disappears underground and resurfaces again. The Mahlac, Bonya, Talisay, Maemong, and Maagas Rivers have more gentle gradients, which results in broad river basins (COMNAVMARIANAS 2001).

Five major soil types are found in Guam, including laterite (volcanic), riverine mud, coral rock, coral sand, and argillaceous (mixtures of coral and laterite soil). Guam soil is classified into three categories: bottomland, volcanic upland, and limestone upland. Soil at Andersen AFB is classified as limestone upland. This soil exhibits moderately rapid permeability and low water capacity. A thin layer (between 4 to 10 in [10 to 25 cm]) of Guam cobbley clay soil overlies the northern limestone substrate, contributing to a shallow vegetation root structure at the Andersen AFB (USAF 2006). A map of soil types found on Guam is provided on Figure 3.1-3.

The Main Base at Andersen AFB is dominated by shallow, well-drained limestone soils; however, areas of soils formed on bottomlands and soils formed on volcanic plateaus are also present in specific areas. Large areas of Orote Peninsula Annex has highly disturbed soils classified as urban, and extensive areas along Apra Harbor consists of coastal fill and are covered by roads, buildings, and parking lots. Coastal and depressional areas often include poorly drained soils formed from a variety of sources (limestone, volcanic, and beach deposits). Upland soils are dominated by highly weathered shallow, well-drained volcanic soils. The landscape of Ordnance Annex is more complex than the other Annexes, and includes soils formed on bottomland, volcanic plateaus, and limestone plateaus. The soils found at the higher elevations along the mountain range from Mount Alifan to Mount Lamlam consist of shallow, well-drained limestone soils. Extensive areas of highly weathered volcanic soils are present in the central and southern portions of Ordnance Annex. Soils along the broad river bottoms tend to be poorly drained soils formed sediment eroded from the upland limestone and volcanic soils (COMNAVMARIANAS 2001).

The majority of the soils at Communication Annex, Finegayan are shallow, well-drained soils on the limestone plateaus. The cliff line areas are primarily rock outcrops and very shallow and well drained coralline limestone soils. The soils at Communication Annex, Barrigada are similar to Communication Annex, Finegayan except for areas consisting of shallow well drained soils formed from argillaceous limestone, which contain clay soil particles (COMNAVMARIANAS 2001).

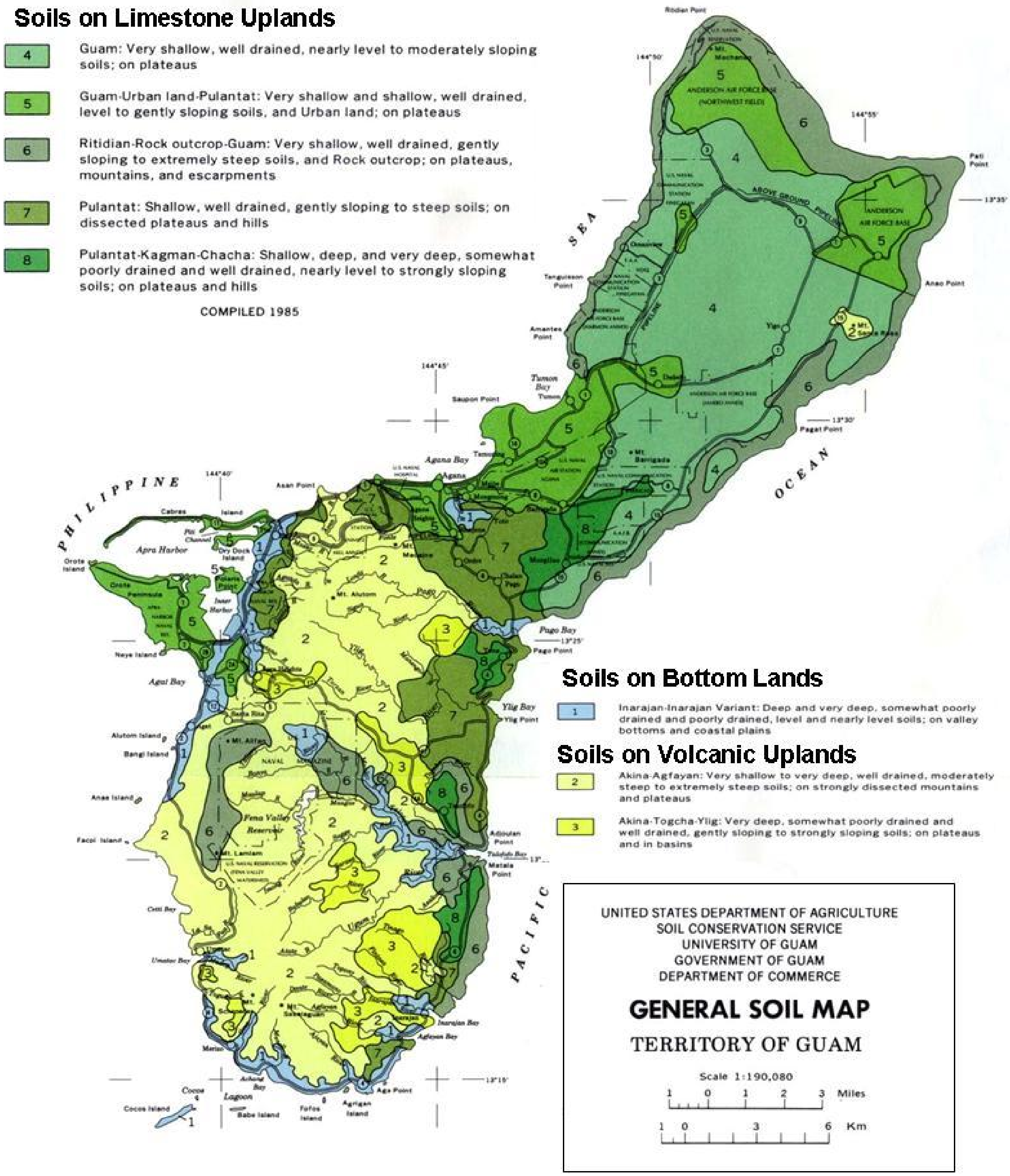
Radon, a radioactive gas that seeps out of rocks and soil, is known to occur on Guam. Radon can enter buildings through cracks in the foundation floors, walls or other openings. High concentration of this gas is a potential health concern for enclosed buildings on Guam, where surveys indicate that approximately 27 percent of homes on island have elevated levels of radon (GEPA 2008).

3.1.2.2 Tinian

Tinian is composed of permeable limestone overlaying a relatively impermeable volcanic foundation (COMNAVMARIANAS 2003). Almost no volcanic rock is exposed on Tinian; its topography consists of a series of limestone plateaus and rocky shoreline cliffs (PACOM 1999). Most of the shoreline consists of low to high limestone cliffs with sea-level caverns, cuts, notches and slumped border, commonly bordered by intertidal benches. Beach deposits consist mainly of medium- to coarse-grain calcareous sands, gravel and rubble interspersed in exposed limestone rock. The north, east and south coasts have very limited fringing or apron reef development. Submarine topography is characterized by limestone pavement with interspersed coral colonies and occasional zones of submerged boulders. Coral reef development is more prevalent at various west coast locations (PACOM 1999).

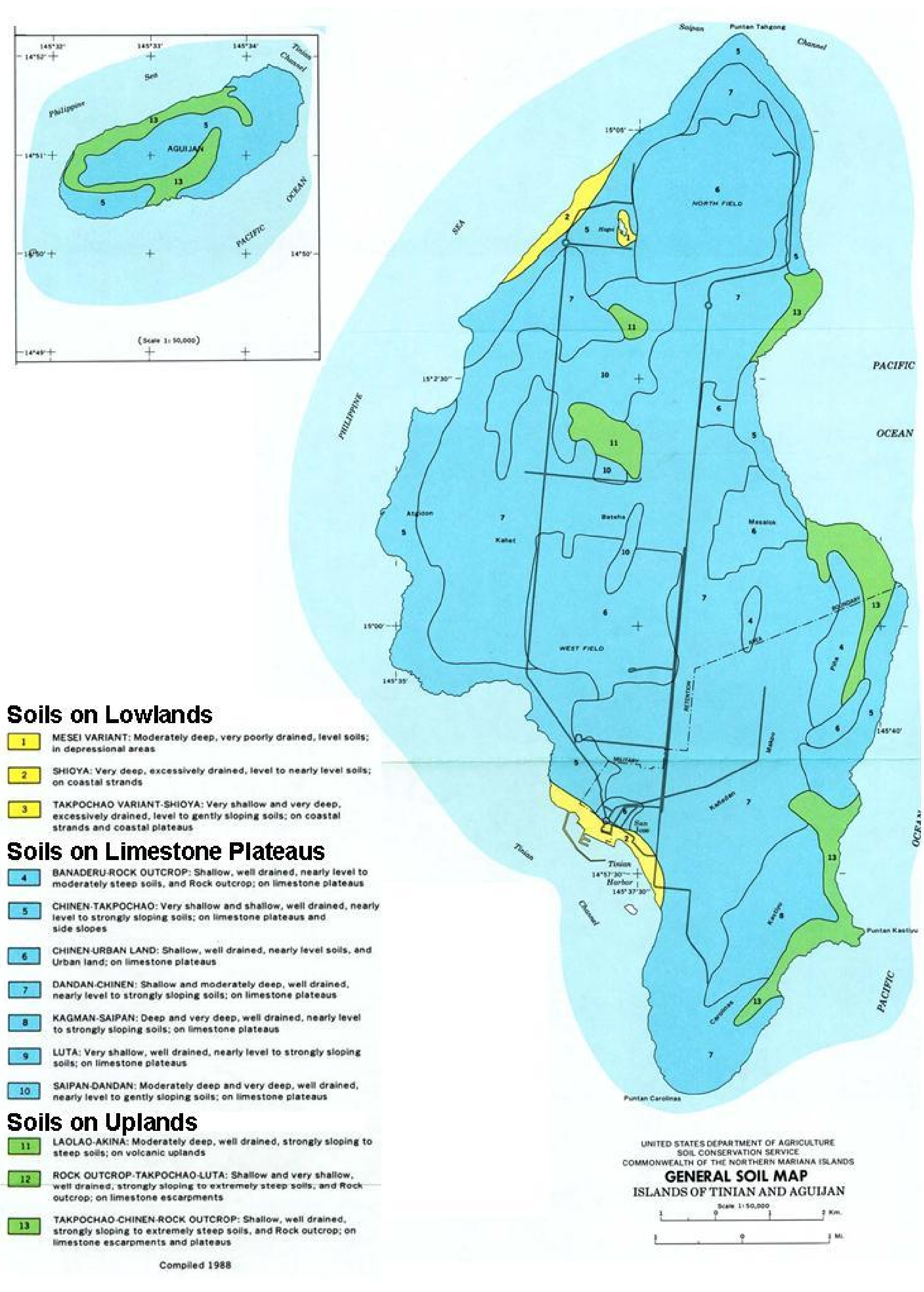
Unai Dankulo (Long Beach) is the largest beach on Tinian, extending approximately 492 ft (150 m) between limestone cliffs that extend to the water line. The Dankulo beaches are composed of white calcareous sands that gently slope into a shallow reef flat separated from the open ocean by a reef crest that is emergent at low tide. The reef crest is continuous across the entire run of the beach. Strong wave action from typhoons in the late 1990s severely damaged the shallow coral reef formation and resulted in deposition of cobble and rubble in channels along the ocean floor (PACOM 1999).

A map of soil types found on Tinian is provided on Figure 3.1-4. Surface runoff is practically non-existent due to rapid percolation through the soils. There are no springs or perennial streams (COMNAVMARIANAS 2003). Tinian has only a few small surface water bodies. The island has an aquifer of fresh water in the older limestone unit in the south-central portion of the island and may have a smaller aquifer in the north (PACOM 1999).



Source: UTA 2008

Figure 3.1-3: Soil Map of Guam



Source: UTA 2008

Figure 3.1-4: Soil Map of Tinian and Aguigan

3.1.2.3 Farallon de Medinilla (FDM)

There are no published United States Geological Survey (USGS) or National Resource Conservation Service reports that specifically describe soil or geologic conditions at FDM. The island is likely related to Saipan and other Marianas chain islands, and likely has a volcanic core. The island is composed predominantly of limestone formations with a thin layer of related porous soils. FDM is suspected to contain many faults and is subject to cave and sinkhole formation, as limestone is susceptible to erosion by rainwater dissolution, wave action, and biological breakdown processes. Substantial erosion has been observed on the island, particularly on the cliffs near the central isthmus where large sections of rock have fallen into the ocean (DoN 2008). The beaches are composed of very coarse carbonate sand and small rubble/cobble fragments (COMNAVMARIANAS 2003). Because FDM has no surface water bodies, it is suspected to be completely covered by limestone and related porous soils. The existence or extent of any freshwater aquifer is unknown (PACOM 1999).

Two generic types of soils have been identified on FDM: a red, highly plastic clay, and a black humus most likely composed of decomposing vegetation and bird guano. Detonation of air-to-surface munitions on the land surface results in the formation of craters up to 6 ft (1.8 m) in depth and 20 ft (6 m) in diameter. Exposed soil and rock are susceptible to wind and water erosion, though the vegetation present on the island, which typically reestablishes quickly, may limit erosion on the flatter portions of the island. Clear evidence of ordnance impacts exists on cliff tops and faces on certain sections of the island that may contribute to erosion, runoff, and sediment pluming (DoN 2008).

Shore bombardment of barren cliffs on the west side of the island may have weakened the exposed limestone and contributed to erosion of the cliffside. The eastern cliffs near Zone 2 (land bridge) are avoided during shore bombardment activities (DoN 2008).

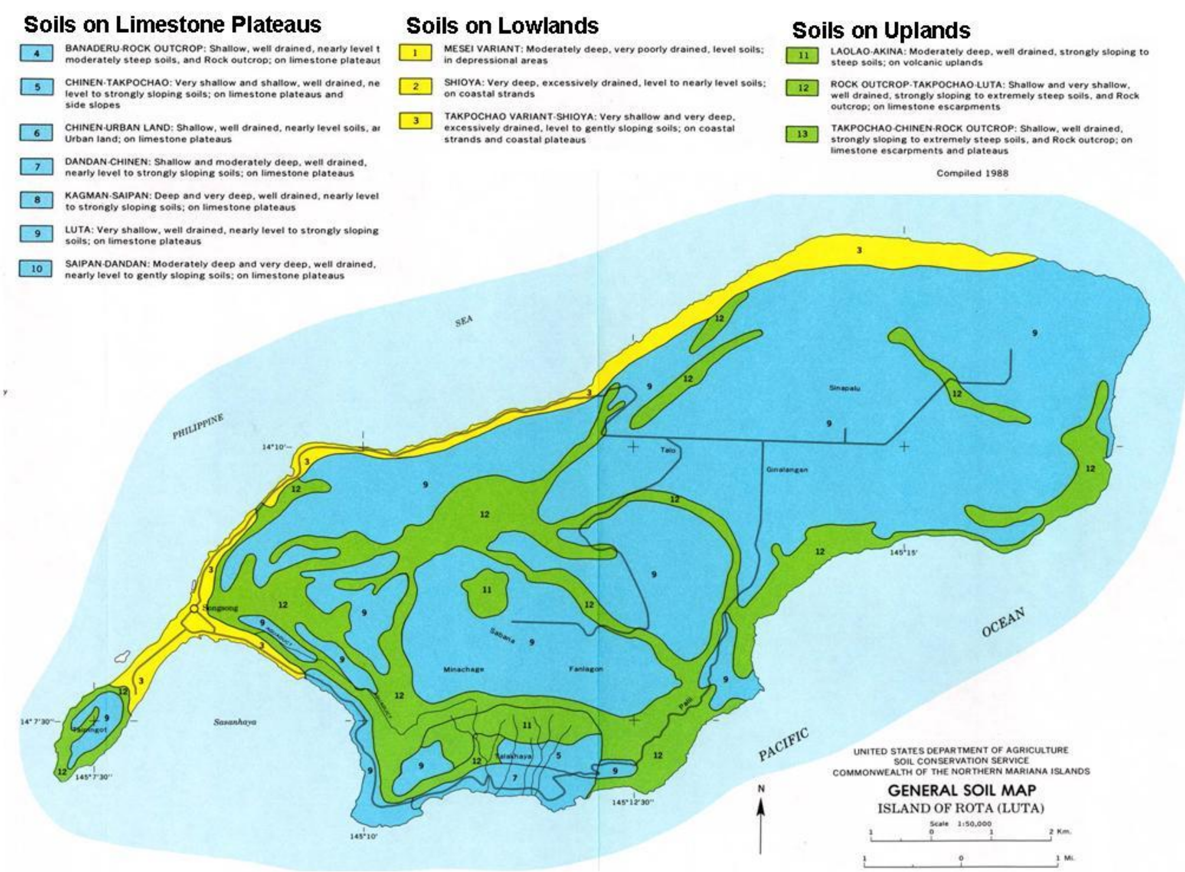
Cyclones are a natural threat to geologic formations on FDM, because they can produce extremely strong winds, torrential rain, high waves, and storm surges, which in turn can cause extensive flooding. Weathering of soils and coastal formations on FDM has resulted from cyclones. The northern two-thirds of the island are nearly separated from the southern third where the island narrows dramatically (Oceandots 2008).

3.1.2.4 Rota

Rota is best depicted as a series of limestone terraces surrounding a volcanic core that protrudes slightly above the top terrace as Mount Manira (1,627 ft [488 m] above MSL). Volcanic rock is also exposed along the south and southeast slopes of the island in an area known as the Talakhaya, where all the surface drainageways are located. A perched aquifer under the Talakhaya gives rise to Rota's two main water sources, the Matanhanom and As Onaan springs. A basal lens of fresh to brackish water is also known to exist on the central north coast (PACOM 1999). A map of soil types found on Rota is provided in Figure 3.1-5.

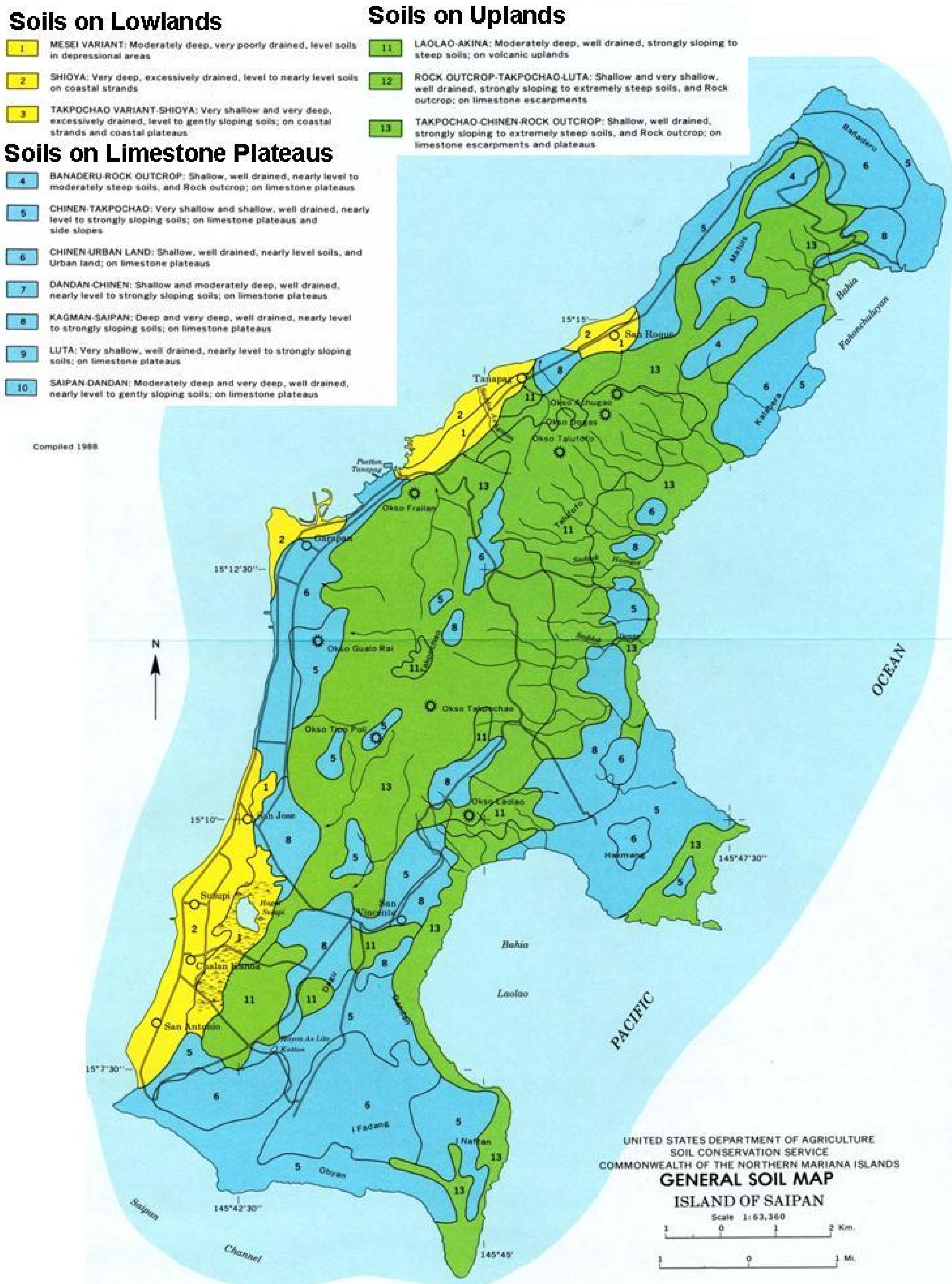
3.1.2.5 Saipan

Saipan is a subareal peak on the Mariana Island arc and consists of a volcanic core overlain by younger limestones. Limestones and calcareous deposits dominate the surface lithology, comprising about 90 percent of the surface exposures. Volcanic rocks are exposed on the remaining 10 percent of the land surface. Primary and secondary porosity of the limestones usually result in high permeability (conducive to faster groundwater flow), whereas poor sorting and alteration in the volcanic rocks usually result in low permeability (conducive to slower groundwater flow). A map of soil types found on Saipan is provided in Figure 3.1-6. Faults transect the island in a north-northeast direction, complicating the sequence and permeabilities of the rock units (Carruth 2003).



Source: UTA 2008

Figure 3.1-5: Soil Map of Rota



Source: UTA 2008

Figure 3.1-6: Soil Map of Saipan

3.1.2.6 Current Protective Measures

The following measures are current protective measures for activities that could impact geology and soils in the Study Area:

- Locate ground-disturbing training activities on previously disturbed sites whenever possible.
- Ensure that all training areas, including transit routes necessary to reach training areas, are clearly identified or marked. Restrict vehicular activities to designated/previously identified areas.
- Ensure that protective measures are developed for amphibious landings and other training activities at Unai Dankulo on Tinian. The detailed training constraints map for Unai Dankulo will be modified to incorporate any exclusion areas required for beach training activities (per the Marianas Training Handbook, COMNAVMARIANAS Instruction 3500.4).
- Continue to control erosion through the Site Approval Process, whereby the Navy reviews each proposed project for its erosion potential, and involves the designated installation Natural Resource Specialist in the process.
- Continue to manage erosion in accordance with the applicable storm water pollution prevention plan (SWPPP) at each training location.
- Prohibit off-road vehicle use except in designated off-road areas or on established trails.
- Monitor erosion and drainage at select locations, particularly at Unai Dankulo.
- Implement protective measures for terrestrial biological resources (to reduce impacts from loss of ground cover) and cultural resources (to ensure avoidance of restricted areas).
- Comply with existing policies and management activities to conserve soils, including requirements and restrictions outlined in the Marianas Training Handbook (COMNAVMARIANAS Instruction 3500.4).

3.1.3 Environmental Consequences

3.1.3.1 No Action Alternative

Training in the MIRC encompasses the land, air, ocean surface, and subsurface. The No Action Alternative would result in continued multi-Service training activities at Andersen AFB, Naval Station Guam and its offshore areas, FDM, Tinian, and Saipan. Under the No Action Alternative, the Navy would continue its existing training and Research, Development, Test, and Evaluation (RDT&E) programs and ongoing base training. Ongoing training activities in the MIRC that interface with the geologic environment include the following: Army surveillance and reconnaissance; FTX; live-fire training; MOUT; Protect the Force activities; mine warfare training; Strike Warfare training including BOMBEX and MISSILEX; NSW OPS; Over-the-Beach (OTB) exercises; AMW training including FIREX Land, marksmanship, expeditionary raids and hydrographic surveys; and Explosive Ordnance Disposal (EOD) activities such as land demolitions and underwater demolitions.

Effects on Marine Geology and Bathymetry. No geologic resources in offshore submerged locations would be impacted by existing training. Effects of offshore training activities on geologic resources are limited to training expendables (e.g., targets, sonobuoys, inert bombs, missiles, and other ordnance) that would fall into the ocean, sink to the bottom, and settle on submerged resources. These effects on submerged geologic resources are negligible because no change to existing conditions would result. The settling of small amounts of debris on submerged geologic formations would have no more adverse effect than the gradual accumulation of natural sediments. Marine geologic resources are not affected by surface vessels, by the transit of submarines, or by deposition of expended training materials.

Marine sediments can become contaminated as a result of unrecovered sonobuoys, torpedo components, Acoustic Device Countermeasures (ADCs), and expendable mobile Expendable Mobile ASW Training Targets (EMATTs) used in training activities. Contamination of sediments would not result in adverse effects. Accumulation of expended materials from unrecovered sonobuoys, torpedo components, ADCs, and EMATTs would not result in adverse effects on marine geology or bathymetry as discussed below.

Underwater Detonations. Mine warfare training is an EOD event that involves the use of underwater detonation devices by Navy divers. Ongoing training occurs in designated areas where existing marine geologic features have been degraded from past use. The detonation of explosives and mines in water results in dispersion of marine sediments, which is a repetitive activity limited to the designated activity zone. Geologic resources have been affected by past training activities and would continue to be affected under the No Action Alternative.

Deepwater Mine Countermeasure training is conducted at Outer Apra Harbor using 10-pound (lb) (4.5-kilogram [kg]) charges at 125 ft (38 m) and where the marine geology consists of a sandy substrate that is devoid of living coral. Impact to marine geology consists of the temporary suspension of sandy sediments until they settle back to the bottom.

Shallow-water demolition training occurs near the Glass Breakwater at Outer Apra Harbor using 1-lb charges to clear obstacles for amphibious landings. With the exception of debris from cleared obstacles settling to the bottom, this type of training does not impact marine geology since only small charges are used near the surface.

Floating mine neutralization training is restricted to Agat Bay and the Piti Mine Neutralization Area in the open ocean. This type of training occurs near the surface where a 10-lb charge is used to “neutralize” a floating mine or cut its mooring cable. There is little to no impact to the marine geology of the immediate area.

Sonobuoys. Training and RDT&E activities involving sonobuoys would occur in the MIRC Study Area. A sonobuoy is an expendable device used for the detection of underwater acoustical energy and for conducting vertical water column temperature measurements. Residual metals associated with scuttled sonobuoys on the ocean floor represent a potential source of contamination to sediments. Sediments act as a reservoir for metals that are attracted to particulate organic carbon and, as such, may be available as a source of chronic stress to the benthic community.

During operation, a sonobuoy’s seawater batteries may release copper, silver, lithium, or other metals to the surrounding marine environment, depending upon the type of battery used. They also may release fluorocarbons. The maximum life of seawater batteries is about 8 hours. The batteries cease operating when their chemical constituents have been consumed. Once expended and scuttled, the sonobuoys sink to the ocean floor. Scuttled sonobuoy seawater batteries on the ocean floor would have negligible adverse effects on sediments because electrodes are largely exhausted during training exercises and residual constituent dissolution will occur more slowly than releases from the activated seawater batteries. Corrosion and colonization of encrusting marine organisms on the sonobuoy housing would reduce leaching rates.

Torpedoes. Torpedo components deposited into sediment would include nonhazardous launch accessories (e.g., nose cap, suspension bands, air stabilizer, sway brace pad, arming wire, release wire, propeller baffle, fahnstock clip), the guidance wire and flexible hose, fuel combustion byproducts, and lead ballast weights used for recovering a torpedo. Fuel combustion byproducts would be diluted and dispersed in the water column; lead ballasts (jacketed in steel) would be buried in the sediments. No lead would be exposed or ionized within the sediments.

Acoustic Device Countermeasures (ADCs). Lithium sulfur dioxide battery cells power ADCs. The chemical reactions of the lithium sulfur dioxide batteries would be highly localized and short-lived, and the ocean currents would greatly diffuse concentrations of the chemicals leached by the batteries. Due to the rapid dilution of the chemical releases, accumulation of chemicals in sediments is not likely.

Expendable Mobile ASW Training Targets (EMATTs). Lithium sulfur dioxide battery cells also power EMATTs. The chemical reactions of the lithium sulfur dioxide batteries would be highly localized and short-lived, and the ocean currents would greatly diffuse concentrations of the chemicals leached by the batteries. Due to the rapid dilution of the chemical releases, accumulation of chemicals in sediments is not likely.

At-sea training exercises would not affect ocean bottom topography or natural ocean processes. Some training activities could slightly increase local turbidity or create shallow depressions in bottom sediments; however, these are temporary effects that disappear over time under the influence of natural ocean circulation and sediment transport.

Over the entire period of military training at the MIRC, expended material would accumulate in ocean bottom sediments. These materials would sink to the ocean floor throughout the entire MIRC Study Area and eventually be covered with sediments. Expended material would be spread over a relatively large area. These training items are small and of low density, so that they would not affect sediment stability on the ocean bottom when deposited on the ocean floor.

Effects on Land and Soils. Ongoing military training activities on land surfaces during the individual training exercises identified in Section 2.2.3 have resulted in localized disturbances to topographic features and localized erosion. Training activities are conducted in previously disturbed areas in accordance with established procedures and site-specific constraints, including protective measures to prevent effects such as erosion or loss of topsoil. The nature of the exercises would not change as a result of the No Action Alternative, and incorporation of protective measures would continue. The execution of training activities in the MIRC would have minimal effects on geological resources and soils.

Field training exercises (FTX) occur on Tinian and Guam in established training locations. MOUT training is conducted primarily in existing structures such as the Orote Point CQC House, Barrigada Housing, and Andersen South. Marine Corps Protect the Force training activities occur at Northwest Field on Andersen AFB. The continued use of these locations in accordance with established procedures and protective measures would not result in loss of geologic resources.

The Tarague Beach Small Arms Range has been used as a live-fire training location for many years. The integrity of geologic resources at this location has been severely degraded due to human activity. Geologic resources outside the Tarague Beach Small Arms Range could have been affected by past training activities and may continue being affected under the No Action Alternative.

Strike warfare activities such as BOMBEX (Land) and MISSILEX involve the use of inert training munitions as well as live munitions by aircrews that practice on ground targets. Missile launches by air-to-ground exercises would also use munitions upon ground targets. These warfare training activities occur on the FDM land mass and are limited to the designated impact zones along the central corridor of the island. Training activities may contribute to ongoing soil disturbance and erosion from natural causes on FDM. The live-fire and inert bombing range on FDM is leased by DoD for exclusive use for military training and does not support other land uses.

NSW training mostly occurs in well-defined, well-used areas, although the range of training activities can occur in a variety of terrain. Special warfare training would be conducted in maritime, littoral, and riverine environments. OTB exercises involve the movement of NSW personnel from the sea across a beach onto land. Similarly, AMW training on FDM, marksmanship training on the small arms ranges on Orote Point and Finegayan, expeditionary raids at Reserve Craft Beach in the Outer Apra Harbor Complex, and hydrographic surveys at FDM and Tinian would result in disturbance to land surfaces as well as reef flat zones. Disturbance to some sandy beaches would continue; these effects would be similar to that from normal wave action during stormy conditions. Such activities may result in localized disturbance of soils and beach substrates in the event that any previously undisturbed areas are utilized for training. Amphibious landings and personnel activities on the beach would result in a continuation of disturbance to some sandy beaches; these effects would be similar to that from normal wave action during stormy conditions. Most of the existing locations have soil conditions that are degraded from ongoing military use. The moderate to highly weathered limestone bedrock overlain by a thin layer of soil on FDM would continue to be susceptible to wind and water erosion and the impacts from ordnance use on cliff tops and faces. These effects would continue to contribute to the ongoing erosion, runoff, and sediment pluming. Erosion of the barren cliffs on the west side of the island would continue to weaken the exposed limestone, while eastern cliffs near the land bridge would continue to be avoided during shore bombardment activities.

EOD training occurs in the Main Base at Andersen AFB, Apra Harbor and other locations in response to the identification of unexploded ordnance (UXO). Disposal actions are individually reviewed for safety risk. Personnel safety is the primary concern. Within these constraints and because EOD activities are limited by ground sensitivity concerns, effects on geological resources would be limited. Land and underwater demolitions have resulted in localized disturbance to existing geologic features.

Based on the analysis presented above, the No Action Alternative would result in minimal to no impact on geological resources in most areas of the MIRC. Existing training areas are already disturbed from ongoing military training. The geologic hazards associated with earthquakes, active volcanoes, and collapse of subterranean cavities in limestone formation have not resulted in any impact on existing training activities. Radon gas would not be considered a geologic hazard because outdoor concentrations would be below U.S. Environmental Protection Agency (USEPA) action levels and indoor training would be conducted with proper ventilation. Localized disruption of soils may result from live-fire activities and detonations in portions of the MIRC where no previous training activities have occurred. With adherence to established protective measures, impacts to geologic resources would not be considered significant.

3.1.3.2 Alternative 1

Alternative 1 would include all of the training activities under the No Action Alternative, with the addition of increased training activities as a result of upgrades and modernization of the existing ranges and training areas. Under Alternative 1, the number of Navy training events at all training locations would increase. No new construction would be required, although some facilities would be improved.

Aerial, surface, and subsurface training activities would not affect marine geologic resources. Alternative 1 would not result in direct loss of geologic resources because no new construction would be required. Any physical improvements to facilities or infrastructure that includes ground disturbance could result in potential impacts to geological resources and soils. Ground disturbance for facility improvements would be conducted in accordance with standard construction protective measures and associated permit conditions including applicable SWPPPs.

Impacts on geological resources would be similar to those described under the No Action Alternative. The nature of the training activities would not change substantially, with the exception of the number of exercises to be conducted at each location. Erosion would continue to occur from training activities that involve land detonations on FDM. Training activities would continue to be conducted in accordance with policies and restrictions to conserve soils as outlined in the Marianas Training Handbook (COMNAVMARIANAS Instruction 3500.4). An estimated 45 percent increase in aircraft associated with the proposed Intelligence, Surveillance, and Reconnaisance (ISR)/Strike program at Andersen AFB would result in increased range and training capabilities at various locations. Use of existing training locations and ranges would intensify as a result of the increase in range capability and modernization would include enhanced activities in ASW, mine warfare, MOUT, combined arms warfare, and airspace and electronic combat. Shore bombardment training activities and mine warfare training using underwater detonation devices by Navy divers would continue with the use of a heavier explosive device (20 lb NEW) than that authorized in 1999 (10 lb NEW). Restrictions on use of this explosive would remain the same as outlined in the Marianas Training Handbook. With the increase in training exercises at each location, specific protective measures to protect geologic resources will require evaluation for adequacy and applicability in consideration of the increase in multi-Service personnel that will have joint participation in major exercises.

3.1.3.3 Alternative 2

Alternative 2 would include all of the training activities under Alternative 1, with the addition of more major exercises. Under Alternative 2, the number of Navy training events at all training locations would increase above the level projected for Alternative 1. No new construction would be required. The nature of the training activities would not change substantially, with the exception of the number of exercises to be conducted at each location. Specific protective measures to protect geologic resources will require evaluation for adequacy and applicability in consideration of the increase in multi-Service personnel that will have joint participation in major exercises. Impacts on geological resources would not differ substantially from those described under Alternative 1.

3.1.4 Unavoidable Adverse Environmental Effects

Scientific factors considered in determining the residual (i.e., unavoidable) environmental effects of the Proposed Action on soils include the net deposition rate of training materials and the degree to which erosion processes would be accelerated.

The Proposed Action would have no unavoidable adverse environmental effects on soil erosion because erosion control measures, structures, and procedures could, if appropriately implemented, minimize or offset increases in erosion from training activities.

The Proposed Action would unavoidably and gradually increase the concentrations of expended training materials on beaches and in intertidal zones within the MIRC. These effects are unavoidable because some residues from detonations of live ordnance and some corrosion and degradation products of materials left on the range for extended periods would be too small to readily distinguish from native materials, and no cost-effective technology exists for removal of these materials. A gradual increase in the quantities of these materials is expected because the processes of degradation, dissolution, and dispersal into the larger environment are very slow relative to the anticipated rate of deposition. Aside from the potential effects of hazardous substances (addressed in Section 3.2), however, a buildup of expended training materials would be an aesthetic concern. Depending on the amount of additional expended material added to the soil matrix and the sizes of such materials, an increase over time in the amount of the expended materials in the soil matrix could affect vegetation growth, change movements of particles, or provide habitat.

3.1.5 Summary of Environmental Effects

Table 3.1-2 summarizes the effects of the No Action Alternative, Alternative 1, and Alternative 2 on geology, soils, and bathymetry.

Table 3.1-2: Summary of Impacts on Geology, Soils, and Bathymetry

Alternative	NEPA (Land and U.S. Territorial Waters, <12 nm)	EO 12114 (Non-U.S. Territorial Waters, >12 nm)
No Action Alternative	Localized disturbance to topography and localized erosion. Continuation of ongoing erosion would occur; however, topographic and surface soil changes would be minimal and would be managed in accordance with established protective measures. Continuation of dispersion and suspension of marine sediments as a result of detonation of underwater mines and EOD demolition. Continuation of disturbance to some sandy beaches; these effects would be similar to that from normal wave action during stormy conditions.	Expendable training materials would continue to be deposited on the ocean floor or submerged geologic resources. No adverse effects on marine geology or bathymetry.
Alternative 1	Impacts would be similar to those described for the No Action Alternative. Intensity of impacts to geologic resources and soils would be greater than the No Action Alternative.	Impacts would be similar to those described for the No Action Alternative.
Alternative 2	Impacts would be similar to those described for the No Action Alternative. Intensity of impacts to geologic resources and soils would be greater than Alternative 1.	Impacts would be similar to those described for the No Action Alternative.

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3.2 HAZARDOUS MATERIALS AND WASTE

3.2.1 Introduction and Methods

Hazardous materials addressed in this EIS/OEIS are broadly defined as substances that pose a substantial hazard to human health or the environment by virtue of their chemical or biological properties. The purpose of evaluating hazardous materials and hazardous wastes is to determine whether they pose a direct hazard to individuals or the environment; whether fresh or marine surface waters, soils, or groundwater would be contaminated; and whether waste generation would exceed regional capacity of hazardous waste management facilities.

In general, the degree of hazard posed by these materials is related to their quantity, concentration, bioavailability, or physical state. 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. Hazardous materials also are required for maintenance and operation of equipment used by the Navy in training activities. These materials include petroleum products, coolants, paints, adhesives, solvents, corrosion inhibitors, cleaning compounds, photographic materials and chemicals, and batteries.

A solid waste is a hazardous waste if it is not excluded from regulation as a hazardous waste or if it exhibits any ignitable, corrosive, reactive, or toxic characteristics (40 Code of Federal Regulations [C.F.R.] Part 261). A hazardous waste may be a solid, liquid, semi-solid, or contained gaseous material that alone or in combination may (1) cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness; or (2) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Hazardous wastes are managed under the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. §§ 6901 6992k).

For purposes of 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. These materials include hazardous substances, hazardous wastes, and marine pollutants.

Because hazardous constituents comprise only a portion of the materials entering the MIRC, this section also addresses nonhazardous expended materials. Nonhazardous expended material is defined as parts of a device that are made of nonreactive materials, including parts made of steel or aluminum, polymers (*e.g.*, nylon, rubber, vinyl, and various other plastics), glass fiber, and concrete. 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; however, they may pose a physical hazard to biological resources wherever they are deposited.

3.2.1.1 Regulatory Framework

The geographic footprint of the MIRC includes land on Guam and the CNMI and vast open areas in the Pacific Ocean. For the most part, existing environmental laws and regulations applicable to hazardous materials and wastes that are presented in succeeding paragraphs are applicable to land-based facilities and activities and are not applicable to Navy activities at sea beyond three nm from shore. Certain international treaties may apply to at-sea training activities.

3.2.1.1.1 International Treaties

The international treaty for regulating disposal of wastes generated by operation of vessels is the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78). Although naval ships are exempt from MARPOL 73/78, the U.S. Congress required compliance by the U.S. Navy with Annex V of the treaty in the *Marine Plastic Pollution Research and Control Act of 1987* as modified by the *National Defense Authorization Act for Fiscal Year 1994*.

Annex V covers nonfood marine pollution solid waste. Under Annex V, the nonfood solid waste materials that are controlled include paper and cardboard, metal, glass (including crockery and similar materials), and plastics. None of these materials may be discharged overboard in Special Areas and plastics may not be discharged in the ocean anywhere. Special Areas are areas where more stringent discharge standards are applicable. The Pacific Ocean is not designated a Special Area at this time.

3.2.1.1.2 Federal Laws and Regulations

Hazardous materials and wastes are regulated by several Federal laws and regulations. The relevant laws include RCRA; the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 U.S.C. § 9601 – 9675); the Toxic Substances Control Act (TSCA) (15 U.S.C. § 2601 *et seq.*), the Hazardous Materials Transport Act; the Emergency Planning and Community Right to Know Act (EPCRA) (42 U.S.C. § 11002 *et seq.*); the Pollution Prevention Act (PPA) (42 U.S.C. § 13101 – 13109), and the Oil Pollution Act (OPA) (33 U.S.C. § 2701 *et seq.*). Together, the regulations adopted to implement these laws govern the storage, use, and transportation of hazardous materials and wastes from their origin to their ultimate disposal. The recovery and cleanup of environmental contamination resulting from accidental releases of these materials also are addressed in the regulations. Laws and regulations of the Territory of Guam and the Commonwealth of the Northern Mariana Islands (CNMI) generally implement Federal requirements.

Resource Conservation and Recovery Act (RCRA). Hazardous wastes are defined by the Solid Waste Disposal Act, as amended by the RCRA, which was further amended by the Hazardous and Solid Waste Amendments. The RCRA specifically defines a hazardous waste as a solid waste (or combination of wastes) that, due to its quantity, concentration, or physical, chemical, or infectious characteristics, can cause or significantly contribute to an increase in mortality. The RCRA further defines a hazardous waste as one that can increase serious, irreversible, or incapacitating reversible illness or pose a hazard to human health or the environment when improperly treated, stored, disposed of, or otherwise managed. A solid waste is a hazardous waste only if it is a "listed waste" or if it meets one of the four criteria (ignitable, corrosive, reactive, or toxic) for hazardous waste (40 C.F.R. Part 261).

In 1997, the U.S. Environmental Protection Agency (USEPA) published its Final Military Munitions Rule (MMR) (40 C.F.R. 266.200.206). The MMR identifies when conventional and chemical military munitions become hazardous wastes under the RCRA, and provides for their safe storage and transport. Under the MMR, military munitions include, but are not limited to, the following items:

- Confined gaseous, liquid, and solid propellants,
- Explosives,
- Pyrotechnics,
- Chemical and riot agents, and
- Smoke canisters.

The MMR defines training; Research, Development, Test, and Evaluation (RDT&E); and clearance of unexploded ordnance (UXO) and munitions fragments on active or inactive ranges as normal uses of the product. When military munitions are used for their intended purpose, they are not considered to be a solid waste for regulatory purposes. Under the MMR, wholly inert items and nonmunitions training materials are not defined as military munitions. These materials must meet the criteria for hazardous waste to be regulated as hazardous wastes under the RCRA.

Under the RCRA, hazardous materials are considered solid wastes – and thus fall under the definition of hazardous wastes – if they are used in a manner constituting disposal rather than for their intended purpose. Military munitions become subject to the RCRA when transported off-range for storage; reclaimed and/or treated for disposal; buried or landfilled on- or off-range; or they land off-range and are not immediately rendered safe or retrieved. Transportation, storage, and disposal of these items are governed by the RCRA.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Under CERCLA, as amended by the Superfund Amendments and Reauthorization Act, a hazardous substance is defined 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.

Andersen AFB is an active National Priorities List site and a cleanup program is underway. Training activities at Andersen AFB are conducted so as not to interfere with the progress of cleanup activities.

Toxic Substances Control Act (TSCA). The TSCA requires that, prior to manufacturing a new substance which is to become an article of commerce; a facility must file a Pre-Manufacture Notice with the USEPA characterizing the toxicity of the substance. The TSCA also regulates the disposal of polychlorinated biphenyls.

Emergency Planning and Community Right to Know Act (EPCRA). The EPCRA requires Federal, state, and local governments and industry to report on their use of hazardous and toxic chemicals. Access to this information contributes to improvements in chemical safety and protection of local communities.

Oil Pollution Act (OPA). The OPA of 1990 requires oil storage facilities and vessels to submit plans to the Federal government describing how they will respond to large, unplanned releases. In 2002, the Oil Pollution Prevention regulations were amended by the Oil Pollution Prevention and Response; Non-Transportation-Related Onshore and Offshore Facilities; Final Rule (40 C.F.R. 112). This rule requires Spill Prevention, Control, and Countermeasure (SPCC) Plans and Facility Response Plans (FRPs). These plans outline the requirements to plan for and respond to oil and hazardous substance releases. Oil and hazardous releases would be reported and remediated in accordance with current DoD policy.

Pollution Prevention Act (PPA). The PPA of 1990 focuses on source reduction, reducing pollution through changes in production, and use of raw materials. PPA also addresses other practices that increase efficiency in the use of natural resources or that protects natural resources through conservation.

3.2.1.1.3 State and Local Laws and Regulations

The Services comply with applicable state regulations in accordance with EO 12088, Federal Compliance with Pollution Control Standards. Statutory hazardous waste authorities for the Territory of Guam and the CNMI are contained in the following agencies and regulations.

The Guam Environmental Protection Agency (GEPA) Hazardous Waste Management Program was created in December 1998 under Public Law 24-304 and is codified in Title 10 Guam Code Annotated (GCA) Chapter 51 (Solid Waste Management and Litter Control Act) and Chapter 76 (Underground Storage of Hazardous Substance Act). The program is responsible for permitting hazardous waste collection; treatment, storage, and disposal facilities; and inspection, compliance monitoring, enforcement, and corrective action on all hazardous waste-related activities. Guam has authority to enforce RCRA and Hazardous and Solid Waste Act regulations and has adopted 56 percent of the USEPA's corresponding rules. To date, Guam has not adopted the MMR; munitions on Guam are currently covered under the definition of solid waste.

The CNMI Department of Environmental Quality (DEQ) Hazardous and Solid Waste Management Branch regulates hazardous waste generated within the CNMI. In 1984, the CNMI DEQ adopted the Federal hazardous waste regulations under RCRA and the Hazardous and Solid Waste Act (HSWA) and is currently working to update those regulations in order to adopt the most recent USEPA regulations. The CNMI does not have any hazardous waste regulations that are more stringent than the USEPA regulations and has not adopted the MMR.

The OPA of 1990 preserves state authority to establish laws governing oil spill prevention, response, and periodic drills and exercises. Statutory petroleum, oils, and lubricants (POL) management authorities for Guam and the CNMI within the MIRC are contained in the following agencies and regulations.

- The GEPA's Water Pollution Control Program administers the FRP/SPCC Plan requirements under the OPA for affected facilities under 40 C.F.R. 112.
- The CNMI DEQ Above & Underground Storage Tanks and Pesticide Management (AUPM) Branch is responsible for regulating storage tanks, SPCC, and used oil and pesticides. The AUPM branch regulates SPCC based on the CNMI DEQ's Memorandum of Understanding (MOU) with USEPA Region 9. The MOU provides for DEQ to take the lead when conducting and enforcing FRP/SPCC requirements and to provide to the USEPA on a quarterly basis findings and recommendations as appropriate.

3.2.1.2 Assessment Methods and Data Used

3.2.1.2.1 General Approach to Analysis

To address potential impacts, the approach to analysis includes 1) characterizing the hazardous training materials used, their hazardous constituents, the hazardous wastes generated from them, and their nonhazardous expended components; and 2) understanding how these are managed to prevent contaminating the environment and to comply with applicable Federal and state regulations.

Hazardous materials addressed in this document are chemical substances that pose a substantial hazard to human health or the environment. The definition of "hazardous materials" includes extremely hazardous substances and toxic chemicals. In general, these materials pose hazards because of their quantity, concentration, or physical, chemical, or infectious characteristics. Hazardous materials are often used in high technology weapons, ordnance, and targets because they are strong, lightweight, reliable, long-lasting, or low cost.

A hazardous waste may be a solid, liquid, semi-solid, or contained gaseous material that, alone or in combination with other substances, may (a) cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness; or (b) pose a substantial present or potential hazard to human or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Hazardous wastes are managed in accordance with the RCRA.

Some training materials, including gun ammunition, bombs, missiles, targets, chaff, and flares, are expended on the range and not recovered. Items expended on the water, and fragments that are not recognizable as expended material (*e.g.*, flare residue or candle mix), typically are not recovered. A small percentage of training items containing military explosives fail to function properly, and, if not recovered, remain on the range as UXO.

3.2.1.2.2 Data Sources

Available reference materials, including Navy instructions and prior Environmental Assessments (EA) and EISs were reviewed. In particular, the Marianas Training Handbook (MTH) or COMNAVMARIANAS Instruction 3500.4 (COMNAVMARIANAS 2000) was the source for restrictions regarding the use of hazardous materials while training in the MIRC. The 1999 Military Training in the Marianas EIS (PACOM 1999) was also consulted extensively. Information on existing range conditions at FDM and the Ordnance Annex Emergency Detonation Site was taken from the Final Range Condition Assessment, Marianas Land-Based Operational Range Complex Decision Point 1 Recommendations Report (DoN 2008).

3.2.1.2.3 Warfare Areas and Environmental Stressors

Aspects of the proposed training likely to act as environmental stressors from hazardous materials use and hazardous waste generation were identified by conducting an analysis of the warfare areas and specific activities included in the alternatives. This analysis is presented in Table 3.2-1. Impact analysis is presented in Section 3.2.3, Environmental Consequences.

Table 3.2-1: Warfare Training and Potential Environmental Stressors from Hazardous Materials Use and Hazardous Waste Generation

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect
Army Training			
Field Training Exercise (FTX)/ Polaris Point Field, Orote Point Airfield & Runway, NLNA, Northwest Field, Andersen South, Tinian EMUA		Vehicle Use	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
Live Fire/ Pati Point CATM Range		Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.
Parachute Insertions and Air Assault/ Orote Point Triple Spot, Polaris Point Field, Ordnance Annex Breacher House		Vehicle Use	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
Military Operations in Urban Terrain (MOUT)/ Orote Point CQC House, Ordnance Annex Breacher House, Barrigada Housing, Andersen South		Vehicle Use	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
		Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.
		Use of Structures	Potential release of lead-based paint, asbestos-containing materials, and ozone-depleting substances (refrigerant in air conditioning systems) from structures.

Table 3.2-1: Warfare Training and Potential Environmental Stressors from Hazardous Materials Use and Hazardous Waste Generation (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect
Marine Corps Training			
Ship to Objective Maneuver (STOM)/ Tinian EMUA		LCAC/AAV Use	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
Operational Maneuver/ NLNA, SLNA		Vehicle Use	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
Noncombatant Evacuation Order (NEO)/Tinian EMUA		Vehicle Use	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
		Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.
Assault Support (AS)/ Polaris Point Field, Orote Point KD Range, Tinian EMUA		Vehicle Use	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
		Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.
Reconnaissance and Surveillance (R&S)/ Tinian EMUA		Vehicle Use	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
		Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.
MOUT/Ordnance Annex Breacher House, Orote Point CQC		Vehicle Use	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
		Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.
		Use of Structures	Potential release of lead-based paint, asbestos-containing materials, and ozone-depleting substances (refrigerant in air conditioning systems) from structures.
Direct Fires/FDM, Orote Point KD Range, ATCAA 3A		Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.
Exercise Command and Control (C2)/ Andersen AFB		None	
Protect the Force/ Northwest Field		Vehicle Use	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
		Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.

Table 3.2-1: Warfare Training and Potential Environmental Stressors from Hazardous Materials Use and Hazardous Waste Generation (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect
Navy Training			
Anti-Submarine Warfare (ASW)/ Open Ocean		Weapons Firing	Release of hazardous materials such as metals into the ocean from sonobuoys.
Mine Warfare (MIW)/ Agat Bay, Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point Airfield/Runway, OPCQC, Ordnance Annex Breacher House, Ordnance Annex Emergency Detonation Site, NLNA, SLNA, Barrigada Housing, Piti and Agat Bay Floating Mine Neutralization Areas		Explosives detonations	Release of hazardous materials from explosives detonations.
		Vehicle Use	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
		Land Detonations	Release of hazardous materials from expended training materials. Deposition of UXO.
Air Warfare (AW)/ W-517, R-7201		Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.
Surface Warfare (SUW)/FDM, W-517,	Surface to Surface Gunnery Exercise (GUNEX)	Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.
	Air to Surface GUNEX	Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.
	Visit Board Search and Seizure (VBSS)	None	
Strike Warfare (STW)/FDM	Air to Ground Bombing Exercises (Land)(BOMBEX-Land)	Land Detonations	Release of hazardous materials from expended training materials . Deposition of UXO.
	Air to Ground Missile Exercises (MISSILEX)	Land Detonations	Release of hazardous materials from expended training materials. Deposition of UXO..

Table 3.2-1: Warfare Training and Potential Environmental Stressors from Hazardous Materials Use and Hazardous Waste Generation (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect
Navy Training			
Naval Special Warfare (NSW)/Orote Point Training Areas, Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field, Reserve Craft Beach, Polaris Point Field, Dan Dan Drop Zone	Naval Special Warfare s (NSW OPS)	Vehicle Use	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
		Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.
	Insertion/Extraction	Amphibious Landings	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
		Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.
	Direct Action	Amphibious Landings	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
		Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.
	MOUT	Vehicle Use	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
		Use of Structures	Potential release of lead-based paint, asbestos-containing materials, and ozone depleting substances (refrigerant in air conditioning systems) from structures.

Table 3.2-1: Warfare Training and Potential Environmental Stressors from Hazardous Materials Use and Hazardous Waste Generation (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect
Amphibious Warfare (AMW)/FDM, Orote Point Small Arms Range and Finegayan Small Arms Ranges, Orote Point KD Range, Reserve Craft Beach, Outer Apra Harbor, Tipalao Cove, Tinian EMUA	Airfield Seizure	None	
	Over the Beach (OTB)	Amphibious Landings	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
		Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.
	Breaching	Explosive Ordnance	Release of hazardous materials from expended training materials.
	Naval Surface Fire Support (FIREX Land)	Land Detonations	Release of hazardous materials from expended training materials. Deposition of UXO.
	Marksmanship	Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO
	Expeditionary Raid	Amphibious Landings	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
		Vehicle Use	Release of hazardous materials from expended training materials.
	Hydrographic Surveys	Amphibious Landings	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.

Table 3.2-1: Warfare Training and Potential Environmental Stressors from Hazardous Materials Use and Hazardous Waste Generation (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect
	Underwater Demolition/ Outer Apra Harbor, Piti Floating Mine Neutralization Area, Agat Bay	Underwater Detonations	Release of hazardous materials from expended training materials.
Logistics and Combat Services Support/Orote Point Airfield/ Runway, Reserve Craft Beach	Combat Mission Area	Vehicle Use, Amphibious Landings	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
	Command and Control (C2)	None	
Combat Search and Rescue (CSAR)/Tinian North Field (for NVG)		Vehicle Use	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
		Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.
Air Force Training			
Counter Land/ FDM, ATCAA 3		Land Detonations	Release of hazardous materials from expended training materials. Deposition of UXO.
Counter Air (Chaff)/ W-517, ATCAAs 1 and 2		None	
Airlift/ Northwest Field		Vehicle Use	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
		Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.
Air Expeditionary/ Northwest Field		Vehicle Use	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
		Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.
Force Protection/ Northwest Field		Vehicle Use	Unintentional leaks/spills of petroleum products such as fuels, lubricants, hydraulic fluids, etc.
		Weapons Firing	Release of hazardous materials from expended training materials. Deposition of UXO.

3.2.2 Affected Environment

The MIRC is located in the Western Pacific (WestPac), centered around the Territory of Guam and the CNMI. The MIRC consists of DoD-controlled training areas on Guam and the island of Farallon de Medinilla (FDM), leased areas on Tinian, and port facilities in the CNMI. Training areas and activities are as listed in Table 2-7.

3.2.2.1 Hazardous Materials and Hazardous Waste Management

In support of training activities in the MIRC, the MTH (COMNAVMARIANAS 2000) was developed to provide information, instructions, and procedures governing the use of training areas in the MIRC. Chapter 4 of the MTH presents a notional Environmental Protection Plan to be developed for a major training exercise at the MIRC. Appendix C of the MTH presents the Hazardous Wastes and Solid Waste Management Plan.

Chapter 4 of the MTH lists general requirements and restrictions categorized for air, maritime, and shore training as well as specific requirements and restrictions pertaining to air/air support training, naval ships training, land training, amphibious training, and underwater demolitions. General requirements and restrictions relating to hazardous materials and hazardous waste include:

- No washdown activity on Tinian (air training).
- No hazardous material or substance allowed in trash containers or dumpsters (shore).
- No discharge allowed at sea (maritime training).
- Report spills in water immediately (maritime training).
- Report spills immediately (shore training).

Specific requirements and restrictions relating to hazardous materials and hazardous waste include:

- Maintain airfield Crash-Fire-Rescue equipment and crews at North Field for the duration of the exercise (Tinian – Fixed Wing Aircraft/Airborne, Airmobile, Container Delivery System [CDS]).
- Do not use live cluster weapons, live scatterable munitions, fuel air explosives, incendiaries, or bombs greater than 2,000 lb (FDM – Live and Inert Bombing, Live Fire Guns, Naval Surface Fire Support).
- Emergency fuel release may only be conducted in designated aircraft emergency fuel release areas. If designated emergency fuel release areas are unavailable, fuel may be released as directed at locations at least 12 nm from any land, sea mound or island, in depths greater than or equal to 1,000 fathoms (6,000 ft) of water and at an altitude safe for flight or as directed to ensure complete evaporation of the fuel.
- Ordnance may be jettisoned in designated emergency jettison areas only. If designated emergency jettison areas are unavailable, ordnance may be jettisoned at locations at least 12 nm from any land, sea mound or island, in depths greater than or equal to 1,000 fathoms (6,000 ft) of water and at an altitude safe for flight or as directed.
- Use approved oil-spill and cleanup equipment (Guam and Tinian – Craft and Amphibious Assault Vehicle [AAV] refueling).
- Set up fuel bladders within berms with impervious liner or double wall protection, preferably over existing pavement rather than open ground. Spill kit and spill response capability must be readily available. (Guam and Tinian – Fuel Bladders).

- No live fire or tracer rounds will be used on Tinian. Use of pyrotechnics, flares, blank fire, and other potential fire-starting activities must be conducted on existing cleared runways and in accordance with the Fire Prevention Plan. (Tinian – Field Maneuvers and Simulated POW Camps).
- Collect and haul away all expended brass, clips, and lead rounds (Guam and Tinian – TRUE Training).
- For underwater demolitions, the maximum size of the charge will be 10 lb Net Explosive Weight (NEW) (Deepwater Mine Countermeasures).
- Dispose oily waste and bilge water at disposal facilities on Guam and/or Saipan.

Appendix C of the MTH or the Hazardous Wastes and Solid Waste Management Plan provides further guidance to ensure that hazardous materials and solid wastes are handled in an environmentally responsible and sustainable manner. The plan covers, but is not limited to, the following:

- Reduction in hazardous materials usage.
- Establishment of hazardous materials storage facilities away from catch basins, storm drains, and waterways. Storage of liquid hazardous materials in containers/facilities with an impervious lining.
- Use of hazardous chemical warning labels on all hazardous materials. Material Safety Data Sheets for each hazardous material to be carried by deploying unit.
- Availability of spill containment and cleanup equipment.
- Availability of trained spill response teams.
- Designated collection points for segregation, packaging, and labeling of hazardous wastes for disposal.
- Availability of packaging materials for hazardous materials and hazardous waste.
- Segregation of hazardous waste from general refuse.

In addition to compliance with the requirements of the MTH, Navy shore installations, ships, and air detachments comply with the hazardous materials and hazardous waste management requirements of OPNAVINST 5090.1C (DoN 2007).

All military installations on Guam also implement rigorous programs for hazardous materials and hazardous waste management, including SPCC Plans and FRPs for the management of fuels (*e.g.* gasoline, diesel, jet fuel) and petroleum, oil, and lubricants (POLs); Lead-Based Management Plans; Asbestos Management Plans; Ozone Depleting Substances Management Plans; and others. The last three plans are specific to the management of materials on buildings, including structures used for training, particularly those used for MOUT.

3.2.2.2 Hazardous Materials

Expended training material can leak or leach small amounts of toxic substances as they degrade and decompose. Table 3.2-2 lists the hazardous constituents of common training munitions. These items decompose very slowly, so the volume of expended material that decomposes within the training areas, and the amounts of toxic substances being released to the environment, gradually increase over the period of military use. Concentrations of some substances in sediments surrounding the expended material increase over time. In ocean waters, sediment transport via currents can eventually disperse these contaminants outside training areas where they will be present at very low concentrations and, thus, have no effect on the open ocean environment.

Table 3.2-2: Hazardous Constituents of Training Materials

Training Application/ Munitions Element	Hazardous Constituent
Pyrotechnics **Tracers** **Spotting Charges**	Barium chromate Potassium perchlorate
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

Training materials containing hazardous materials are described as follows:

3.2.2.2.1 Missiles

Missiles would be fired by ships, aircraft, and Naval Special Warfare (NSW) operatives at a variety of airborne and surface targets on the MIRC. The single largest hazardous constituent of missiles is solid propellant, primarily composed of rubber (polybutadiene) mixed with ammonium perchlorate, but numerous hazardous constituents are used in igniters, explosive bolts, batteries (potassium hydroxide and lithium chloride), and warheads (*i.e.*, PBX-N high explosive components; PBXN-106 explosive; and PBX [AF]-108 explosive). In the event of an ignition failure, or other launch mishap, the rocket motor or portions of the unburned propellant may impact the environment. Most of the missiles fired carry inert warheads that contain no hazardous constituents. Exterior surfaces may be coated, however, with anti-corrosion compounds containing chromium or cadmium.

Live missiles fired in training would have an explosive warhead or telemetry warhead. The only training missiles that do not use rocket motors are missiles that do not leave the rail, such as a captive AIM-9 Sidewinder. Practice missiles use rocket motors that contain potentially hazardous rocket fuel. The main environmental impact would be the physical structure of the missile itself entering the water, as the rocket fuel would be combusted prior to entering the water.

Exploding warheads used in air-to-air missile exercises detonate upon impact with the aerial target, disintegrate, and then fall into the ocean. Live missiles used in air-to-surface exercises explode near the water surface.

3.2.2.2.2 Bombs

Bombing exercises at the MIRC involve one or more aircraft bombing a target simulating a hostile surface vessel at sea and a variety of targets on FDM simulating buildings, convoys, and missile sites. Live and inert bombs are used on FDM.

Bomb bodies are steel and the bomb fins are either steel or aluminum. Based upon the American Society for Testing and Materials (ASTM) standards specified for bomb construction, each of the iron bomb bodies or steel fins may also contain small percentages (typically less than one percent) of any of the following: carbon, manganese, phosphorus, sulfur, copper, nickel, chromium, molybdenum, vanadium, columbium, or titanium. The aluminum fins, in addition to the aluminum, may also contain zinc, magnesium, copper, chromium, manganese, silicon, or titanium.

Practice bombs, also called bomb dummy units (BDU), are bomb bodies filled with an inert material such as concrete and configured with either low-drag conical tail fins or high-drag tail fins for retarded weapon delivery. A BDU has the same weight, size, center of gravity, and ballistics as a live bomb. Practice bombs may contain spotting charges/signal cartridges that produce a visual indication of impact. Authorized spotting charges include the M1A1 (contains 3 lb of black powder), M3 (contains 2.33 lb of dark smoke filler and 425 grains of black powder), and the M5 (a 2.54-lb charge assembly consisting of a glass bottle filled with sulfuric oxide [FS] smoke mixture).

Practice bombs which are much smaller in size and weight than the service bombs they simulate are called subscale practice bombs. There are two types of subcaliber practice bombs – the MK 76 Mod 5 and the BDU-48/B. The MK-76 Mod 5 is designed for impact firing only and the BDU-48/B simulates retarded weapon delivery (http://www.ordnance.org/practice.htm 2008).

Hazardous energetic materials in unrecovered bombs will eventually leach out as the metal bomb casing continues to corrode. Impact to the marine environment from the leaching of hazardous bomb material would be minimal due to dilution factors from the vast ocean and the failure of bombs to detonate.

Bombs that strike FDM would release a small percentage of munition constituents that are not consumed in the detonation and ensuing explosion. This amount would be further reduced by wind transporting some of the munition constituents to the southwest away from the island and rapidly mixing with the surrounding air before being deposited into the ocean. Munition constituents deposited on land are eventually carried out to the ocean by percolating surface water through the limestone formations. For this reason, the impact of hazardous materials in bombs on FDM would also be minimal.

The *Final Range Condition Assessment (RCA), Marianas Land-Based Operational Range Complex Decision Point 1 Recommendations Report* (DoN 2008) indicates that the entire land area on FDM is considered a munitions constituent source, as bombing of the entire island was conducted for a 28-year period prior to the establishment of designated impact areas in 1999. The majority of munitions constituent released to the environment originates from munitions that only partially detonate or do not detonate (UXOs). Munitions constituents in UXO are contained within the munition itself and release of munitions constituents due to corrosion of the casing may take a long time to occur, although salt spray and humidity may accelerate deterioration of the casing. UXO clearance is not conducted at FDM, although an operational range clearance plan is under development (DoN 2008). Testing for the presence of munitions constituents and modeling to predict transport or transformation of munitions constituents has not yet been conducted for FDM (DoN 2008). The RCA concludes that for FDM, no further analysis is required to assess the risk of off-range release of munitions constituents because FDM is an uninhabited isolated island with no risk of exposure to human receptors.

3.2.2.2.3 Aerial and Surface Targets

Aerial targets are used for testing and training purposes. Most air targets contain jet fuels, oils, hydraulic fluid, batteries, and explosive cartridges as part of their operating systems. Fuel is shut off by an electronic signal, the engine stops, and the target begins to descend. A parachute is activated and the target descends to the ocean surface where range personnel retrieve it. Some targets are actually hit by missiles and fall into the range.

Surface targets are made environmentally clean and are discussed further in Section 3.2.2.3.3.

3.2.2.2.4 Sonobuoys

Sonobuoys are electro-mechanical devices used for a variety of ocean sensing and monitoring tasks. Sonobuoys contain lead solder, lead weights, and copper anodes. Sonobuoys also may contain fluorocarbons and lithium sulfur dioxide, lithium, or thermal batteries. They consist of expendable metal cylinders having two 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.

Regardless of type, each sonobuoy contains a seawater battery housed in the upper, floating portion and which supplies power to the sonobuoy. The seawater battery contains about 300 grams of lead, in addition to battery electrodes composed of lead chloride, cuprous thiocyanide, or silver chloride (Green *et al*. 1996). Silver chloride, lithium, or lithium iron disulfide thermal batteries are used to power subsurface units. The lithium-sulfur batteries used typically contain lithium sulfur dioxide and lithium bromide, but may also contain lithium carbon monofluoroxide, lithium manganese dioxide, sulfur 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.

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 with 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.

For explosive sonobuoys such as the SSQ-110A, the sonobuoy is composed of two sections, an active – explosive – section and a passive section. The explosive section consists of two explosive payloads of Class A explosive weighing 4.2 lbs (1.9 kg) each. 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, with a small amount dissolving in the water column.

Various types of sonobuoys are used, so the exact amounts of waste materials that are generated are not known. Table 3.2-3 provides sonobuoy hazardous constituents, based on the types of sonobuoys in use on San Clemente Island and likely to be used in the MIRC.

Table 3.2-3: Sonobuoy Hazardous Constituents

Constituent	Weight (lb) per Sonobuoy
Copper thiocyanate	1.59
Fluorocarbons	0.02
Copper	0.34
Lead	0.94
Steel, tin/lead plated	0.06
TOTAL	2.95

Source: U.S. Department of the Navy, San Clemente Island Ordnance Database [No Date]

3.2.2.2.5 Torpedoes

MK-46, MK-54, and MK-48 torpedoes contain potentially hazardous or harmful (non-propulsion related) components and materials. Only very small quantities of these materials, however, are contained in each torpedo.

The MK-48 torpedo would be used during active sonar activities. A guidance wire consisting of a thin-gauge copper-cadmium core with a polyolefin coating is attached to the torpedo. At the end of a torpedo run, the guidance wire is released and sinks to the sea floor. A flexible hose protects the guidance wire and prevents it from forming loops as it leaves the tube.

During training exercises, the torpedo is recovered at the end of a run; therefore, none of the potentially hazardous or harmful materials would be released to the marine environment. Because the guidance system of the torpedo is programmed for target and bottom avoidance, potentially hazardous or harmful materials are not released on impact with a target or the sea floor. For these reasons, the chance of an accidental release is remote. Further, since the amounts of potentially hazardous and harmful materials contained in each torpedo are very small, upon accidental release the materials would rapidly diffuse in the marine environment.

During service weapons tests, if the torpedo does not function as designed, then the torpedo will sink upon completion of the run cycle, implode at depth, and the debris (including the explosive warhead) will settle to the bottom. Potentially hazardous components and materials would rapidly diffuse in the marine environment.

An exercise torpedo that actually “runs” is referred to as an “EXTORP.” The remaining shots are nonrunning, recoverable “dummy” torpedo shapes called “REXTORPs.” Upon completion of an MK-46 EXTORP, two steel-jacketed lead ballast weights are released to lighten the torpedo, allowing it to rise to the surface. Each ballast weighs 37 lb (16.8 kg) and sinks rapidly to the bottom. MK-46 REXTORPs must also be ballasted for safety purposes. Ballast weights for REXTORPs are similarly released to allow for torpedo recovery. Ballasting the MK-46 REXTORP for maritime patrol aircraft use requires six ballasts, totaling 180 lb (82 kg) of lead.

Torpedoes are powered with Otto Fuel II. The fuel is combusted in the torpedo engine and the combustion byproducts are exhausted into the torpedo wake, which is extremely turbulent and causes rapid mixing and diffusion. Combustion byproducts include hydrogen cyanide (HCN), which is highly soluble in seawater and readily diluted.

HCN does not normally occur in seawater and, at high enough concentrations, could pose a risk to both humans and marine biota. The USEPA acute and chronic national recommendation for cyanide in marine waters is 1.0 microgram per liter (µg/L), or approximately one part per billion (ppb) (DoN 1996). HCN concentrations of 280 ppb would be discharged by MK-46 torpedoes and HCN concentrations ranging from 140 to 150 ppb would be discharged from MK-48 torpedoes (DoN 1996a, 1996b). These initial concentrations are well above the USEPA recommendations for cyanide. Because it is very soluble in seawater, however, HCN would be diluted to less than 1 µg/L at 17.7 ft (5.4 m) from the center of the torpedo’s path, and thus should pose no threat to marine organisms.

3.2.2.2.6 Explosives

Explosives in modern military ordnance are generally solid-cast explosive fills formed by melting the constituents and pouring them into steel or aluminum casings. Most new military formulations contain plastic-bonded explosives that use plastic or other polymer binders to increase their stability (Janes 2005, 2006). Royal Demolition Explosive (RDX)/High Melting Explosive (HMX) blends have generally replaced trinitrotoluene (TNT) in plastic-bonded formulations.

Munitions constituents of concern include nitroaromatics—principally TNT, its degradation products, and related compounds; and cyclonitramines, including RDX, HMX, and their degradation products. TNT degrades to dinitrotoluene (DNT) and subsequent degradation products from exposure to sunlight (photolysis) or bacteria (biodegradation). RDX also is subject to photolysis and biodegradation once exposed to the environment. As a group, military-grade explosives have low water solubility (see Table 3.2-4), and are relatively immobile in water. The physical structure and composition of blended explosives containing multiple chemical compounds, often with additional binding agents, may further slow the degradation and dissolution of these materials (see Table 3.2-5).

Explosive byproducts generated when ordnance functions as designed (high-order detonation), or experiences a low-order detonation, also generate constituents of concern. The major explosive byproducts of organic nitrated compounds such as TNT and RDX include water, carbon dioxide, carbon monoxide, and nitrogen (Brinkley and Wilson 1943; John 1941, 1943; Renner and Short 1980; Cook and Spillman 2000). High-order detonations result in almost complete conversion of explosives (99.997 percent or more [USACE 2003]) into such inorganic compounds, whereas low-order detonations result in incomplete conversion (*i.e.*, a mixture of the original explosive and its byproducts). For example, Table 3.2-6 lists the calculated chemical byproducts of high-order underwater detonation of TNT, RDX, and related materials.

The RCA (DoN 2008) also reported on the condition of the Ordnance Annex Emergency Detonation Site. The concern relates to the potential for contamination of the Fena Reservoir with munitions constituents from explosives use at this range. While surface water level screening analysis indicated that the potential exists for munitions constituents to reach the Fena Reservoir, the concentration of munitions constituents are not released into the reservoir at levels of health concern. Subsequently, confirmation sampling and analysis of soil and water samples indicated that munitions constituents are not migrating from the range and entering the Fena Reservoir at levels exceeding screening values based on USEPA Region IX Preliminary Remediation Goals (DoN 2008). The report recommends conducting another RCA in 5 years.

Table 3.2-4: Water Solubility of Common Explosives and Degradation Products

Compound	Water Solubility, mg/L (at 20°C)
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
PETN	43
RDX	38
HMX	7
white phosphorus	4

Source: USEPA 2006. mg/L – milligrams per liter

Table 3.2-5: Explosive Components of Munitions

Name	Composition	Use
Composition A	91% RDX	grenades, projectiles
Composition B	60% RDX, 39% TNT	projectiles, grenades, shells, bombs
Composition C-4	91% RDX, 9% plasticizer	demolition explosive
Explosive D	picric acid, ammonium picrate	bombs, projectiles
Octol	70-75% HMX, 25-30% TNT	shaped and bursting charges
TNT	Not Applicable	projectiles, shells
Tritonal	80% TNT, 20% aluminum	bombs, projectiles
H6	80% Comp B, 20% aluminum	bombs, projectiles

Source: USEPA 2006.

Table 3.2-6: Chemical Byproducts of Underwater Detonations

Byproduct	Percent by Weight, by Explosive Compound			
	TNT	RDX	Composition B	PBX
nitrogen	18.2	37.0	29.3	33.2
carbon dioxide	27.0	24.9	34.3	32.0
water	5.0	16.4	8.4	13.2
carbon monoxide	31.3	18.4	17.5	7.1
carbon (elemental)	10.6	-	2.3	3.2
ethane	5.2	1.6	5.4	7.1
hydrogen	0.2	0.3	0.1	0.1
propane	1.6	0.2	1.8	2.8
ammonia	0.3	0.9	0.6	1
methane	0.2	0.2	0.2	0.1
hydrogen cyanide	<0.0	<0.0	<0.0	<0.0
methyl alcohol	<0.0	<0.0	-	-
formaldehyde	<0.0	<0.0	<0.0	<0.0
other compounds	<0.0	<0.0	<0.0	<0.0

Source: Renner and Short 1980

3.2.2.2.7 Other Ordnance

Munitions constituents, in particular heavy metals (lead, nickel, chromium, cadmium, and copper), tend to accumulate in surface soils because of their generally low solubility and their elemental nature. They may oxidize or otherwise react with natural substances, but do not break down in the manner of organic compounds.

Other ordnance constituents of concern include pyrotechnic (illumination and smoke) compounds, propellants, primers, and metals (*e.g.*, iron, manganese, copper, lead, zinc, antimony, mercury). Nitrocellulose, nitroglycerin, perchlorate, nitroguanidine, and pentaerythritol tetranitrate (PETN) are commonly used in artillery, mortar, and rocket propellants. Common primers include lead azide, lead styphnate, and mercury fulminate. PETN is a major component of detonation cord and blasting caps. Phosphorus, potassium perchlorate, and metal nitrates are common ingredients of pyrotechnics, flares, and smokes.

Debris from flares, smoke grenades, and other pyrotechnic devices that fall in the water may release small amounts of toxic substances as they degrade and decompose. Solid flare and pyrotechnic residues may contain, depending on their purpose and color, aluminum, magnesium, zinc, strontium, barium, cadmium, nickel, and perchlorates. Although pyrotechnic residues typically include hazardous constituents, most of them are present in small amounts or low concentrations, and are bound up in relatively insoluble compounds. As inert, incombustible solids with low concentrations of leachable metals, these materials typically do not meet the criteria for characteristic hazardous wastes. The perchlorate compounds present in the residues are relatively soluble. Sediment movements in response to tidal surge and currents, and sediment disturbance from ship traffic and other sources, would eventually disperse contaminants outside of the training areas. The items degrade very slowly, so the volume of training debris within the training areas and the amounts of toxic substances being released to the environment gradually increases over the period of military use. Concentrations of some substances in sediments surrounding the disposed items would increase over time.

3.2.2.3 Expended Training Materials

Various types of training items are shot, thrown, dropped, or placed within the training areas. Items that are expended on the water, and fragments that are not recognizable as training debris (*e.g.*, flare residue or candle mix) are not collected. Some nonhazardous expended training materials that remain as floating debris can constitute marine litter, hazards to navigation, and potential hazards to marine life. Plastics and other nonbiodegradable items pose slightly more significant problems as seabed litter than items such as metals, and could also result in floating and coastal litter. However, since they are nonhazardous, minimal in volume due to infrequent training activities in the open ocean, and dispersed over a vast ocean training area, the impact is not considered significant.

3.2.2.3.1 Missiles

Missiles used in most aviation exercises are inert versions that do not explode upon contact with the target or sea surface. The principal source of potential impacts to water and sediment quality from missiles would be unburned solid propellant residue and batteries. Solid propellant fragments would sink to the ocean floor and undergo changes in the presence of seawater. The concentration decreases over time as the leaching rate decreases and further dilution occurs. The aluminum remains in the propellant binder and is eventually oxidized by seawater to aluminum oxide. The remaining binder material and aluminum oxide pose no threat to the marine environment.

3.2.2.3.2 Bombs

Detonated bomb debris, practice bombs, and unrecovered bombs that enter the water would settle to the ocean floor and the solid metal bomb components would corrode slowly in seawater. Over time, natural encrustation of exposed metal surfaces would occur, reducing the rate at which subsequent corrosion occurs. Rates of deterioration would vary, depending on the material and conditions in the immediate marine and benthic environment.

3.2.2.3.3 Aerial and Surface Targets

Surface targets are used during MISSILEX and BOMBEX. Surface targets include stationary targets such as a MK-42 Floating At Sea Target (FAST) or MK-58 marker (smoke) buoys. Surface targets are stripped of unnecessary hazardous constituents, and made environmentally clean.

A Sinking Exercise (SINKEX) uses an excess vessel hulk as a target that is eventually sunk during the course of the exercise. The target is an empty, cleaned, and environmentally remediated target vessel that is towed to a designated location where various ships, submarines, or aircraft use multiple types of weapons to fire shots at the target vessel. The vessels used as targets are selected from a list of CNO-approved vessels that have been cleaned in accordance with USEPA guidelines. Weapons can include missiles, precision and nonprecision bombs, gunfire, and torpedoes. If none of the shots sink the target vessel, either a submarine shot or placed explosive charges are used to sink the ship. Charges ranging from 100 to 200 lb, depending on the size of the ship, are placed on or in the target vessel if sunk by explosives.

The USEPA granted 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 C.F.R. 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 ft) deep and at least 50 nm from land.”

Target fragments and expended material would sink to the ocean floor, gradually degrade, be overgrown with marine life, and/or be incorporated into the sediments. Floating nonhazardous expended material may be lost and would either degrade over time or wash ashore as flotsam. Nonhazardous expended materials are defined as all parts of a device made of nonreactive materials, including parts made of steel or aluminum, polymers (*e.g.*, nylon, rubber, vinyl, and various other plastics), glass fiber, and concrete. 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.

3.2.2.3.4 Torpedoes

Expended training materials from torpedoes (guidance wire, flexible hose, launch accessories [nose cap, suspension bands, air stabilizer, release wire, propeller baffle, sway brace pad, arming wire, and fahnstock clip]) will be spread over a relatively large ocean area. These expended training materials will settle to the ocean bottom and will be covered by sediments over time.

Lead in the ballast weights is unlikely to mobilize into the sediment or water as lead ion for three reasons. First, the lead is jacketed with steel, which means that the lead surface would not be exposed directly to seawater. Second, even if the lead were exposed, general ocean bottom conditions are slightly basic with low oxygen content which would prohibit the lead from ionizing. In addition, lead is only slightly soluble in seawater. Finally, in softbottom areas, the lead weights would be buried due to the velocity of their impact.

3.2.2.3.5 Sonobuoys

In addition to the sonobuoy’s metal case and expended 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. Over time, these materials will sink to the ocean floor. The outside metal case will slowly corrode and can become encrusted from seawater processes and marine organisms, thus further slowing the rate of corrosion.

3.2.2.3.6 Chaff

Radio frequency chaff (chaff) is an electronic countermeasure designed to reflect radar waves and obscure aircraft, ships, and other equipment from radar tracking sources. Chaff is nonhazardous and consists of aluminum-coated glass fibers (about 60 percent silica and 40 percent aluminum by weight) ranging in lengths of 0.3 to 3 inches (in) (0.8 to 7.6 centimeters [cm]) with a diameter of about 0.0016 in (40 micrometers [µm]). Chaff is released or dispensed from military vehicles in cartridges or projectiles that contain millions of chaff fibers, forming a diffuse cloud of fibers that is undetectable to the human eye. Chaff is a very light material that can remain suspended in air anywhere from 10 minutes to 10 hours and can travel considerable distances from its release point, depending on prevailing atmospheric conditions.

Based on the dispersion characteristics of chaff, large areas of open water within the MIRC would be exposed to chaff; however, the chaff concentrations would be low. The fine, neutrally buoyant chaff streamers act like particulates in water, temporarily increasing the turbidity of the ocean's surface, but are quickly dispersed. The Air Force has studied chaff and has determined that it has no adverse environmental impacts (U.S. Air Force 1997).

For each chaff cartridge used, a plastic end cap and a Plexiglas piston are released into the environment in addition to the chaff fibers. The end cap and the piston are both round and are 1.3 in (3.3 cm) in diameter and 0.13 in (0.33 cm) thick. The end caps and piston would sink. Although highly unlikely, some may remain at or near the surface if it were to fall directly on floating materials. The expended material could also be transported long distances before becoming incorporated into the bottom sediments.

3.2.2.3.7 Other Ordnance

Other ordnance includes gunnery rounds. Most of this ordnance is inert (nonexplosive) and consists of nonhazardous constituents. Inert ordnance includes steel shapes or replicas containing concrete, vermiculite (clay), or other nonhazardous constituents similar in appearance, size, and weight to explosive ordnance used in wartime. These inert rounds will accumulate over time. If dropped in the water, they will sink to the ocean floor and eventually be covered with sediments.

3.2.3 Environmental Consequences

3.2.3.1 Approach to Analysis

The significance of potential impacts associated with hazardous materials, constituents, substances, and wastes is based primarily on their characteristics, distribution, transportation, storage, and disposal. Factors used to assess significance include the extent or degree to which implementation of an alternative would substantially increase the human health risk or environmental exposure resulting from the storage, use, transportation, and disposal of these materials and substances. A second measure of significance is whether the use, transportation, storage, and disposal of hazardous items are consistent with the various Federal and state laws regulating these materials.

3.2.3.2 No Action Alternative

Under the No Action Alternative, the current training activities and level of activity in the MIRC would remain the same. Current training activities would continue to be conducted in accordance with applicable Federal regulations, OPNAVINST 5090.1C requirements for hazardous materials and hazardous waste management afloat and ashore, the GEPA Hazardous Waste Management Program, the CNMI DEQ Hazardous and Solid Waste Management regulations, the MTH, and Air Force Instruction (AFI) 32-7086, *Hazardous Materials Management,* and AFI 32-7042, *Hazardous Waste Management,* for training activities on Andersen AFB.

There would be no increase in human health risk or environmental exposure from the storage, use, transportation, and disposal of hazardous substances associated with current training activities.

Nonhazardous expended training materials will continue to be deposited on the training areas at current levels. On land ranges, nonhazardous expended training materials will continue to be collected for appropriate disposal or reuse options. Those expended on the water are not collected and will accumulate over time. Although unlikely because of the vast expanse of ocean area where expended training materials may be deposited, over time, they may become physical hazards to marine life or to navigation.

Hazardous materials on structures (*e.g.*, lead-based paint, asbestos, ozone depleting substances) used for MOUT training will continue to be managed in accordance with applicable management plans to preclude their release to the environment or the exposure of military personnel while conducting training. MOUT training facilities at the MIRC consist of relatively old structures at Andersen South, Barrigada (Housing), Ordnance Annex and Orote Point CQC House that are likely to contain hazardous construction materials.

3.2.3.3 Alternative 1

Under Alternative 1, the number of training exercises in the MIRC would increase; however, the nature of the training activities would not change substantially. This alternative also takes into consideration the addition of major exercises and the Air Force's ISR/Strike and other initiatives at Andersen AFB. Modernization and upgrade of existing ranges, training facilities, and training areas, as described in Section 2.4, are proposed under this alternative which would result in increased and enhanced training in ASW and MOUT.

Training activities would continue to be conducted in accordance with applicable Federal, Guam and CNMI regulations, the MTH, and applicable Service instructions.

Because training activities are conducted in areas and facilities where access by the public is not allowed, human health risk from the increased storage, use, transportation, and disposal of hazardous substances associated with training activities will remain the same. However, risk of exposure of the environment to hazardous substances may increase. Compliance with applicable regulations and implementation of associated management plans should reduce the increased risk of environmental exposure.

Hazardous materials on structures (*e.g.*, lead-based paint, asbestos, ozone depleting substances) used for MOUT training will continue to be managed in accordance with applicable management plans to preclude their release to the environment or the exposure of military personnel while conducting training. MOUT training facilities at the MIRC consist of relatively old structures at Andersen South, Barrigada (Housing), Ordnance Annex and Orote Point CQC House that are likely to contain hazardous construction materials.

The rate of deposition of nonhazardous expended training materials on training areas will increase with increased training tempo. Environmental effects will be similar to those under the No Action Alternative.

3.2.3.4 Alternative 2

Under Alternative 2, the number of training exercises in the MIRC would slightly increase in comparison to Alternative 1; however, the nature of the training activities would not change substantially. In addition to upgrades and modernization of some existing ranges and training areas proposed under Alternative 1, additional major exercises would be included.

Training activities would continue to be conducted in accordance with applicable Federal, Guam and CNMI regulations, the MTH, and applicable Service instructions.

Environmental impacts would be similar to that of Alternative 1. Hazardous material usage, hazardous waste generation, and deposition of nonhazardous expended training materials will increase over that of Alternative 1. Compliance with applicable regulations and implementation of associated management plans should reduce the increased risk of environmental exposure.

3.2.4 Unavoidable Significant Environmental Effects

The quantities of hazardous substances (in expended training materials) in the soils, sands, and sediments of the MIRC training areas would gradually accumulate over time. However, the concentrations of these substances are not expected to reach a concentration that could affect human health since military personnel exposure is limited and public access to training areas is restricted. For land ranges, hazardous substances are deposited on the surface of the soil and confined within the perimeter of the range. Ranges would be cleaned up when they are no longer needed.

The volume of hazardous wastes generated by training activities at MIRC and transported back to disposal facilities in the Continental United States (CONUS) would increase. CONUS-based facilities are adequate to contain minimal quantities of wastes generated from training at the MIRC.

3.2.5 Summary of Environmental Effects

Table 3.2-7 presents a summary of effects and mitigation measures for the No Action Alternative, Alternative 1, and Alternative 2.

Table 3.2-7: Summary of Hazardous Materials and Waste Effects

Alternative	NEPA (Land and U.S. Territorial Waters, <12 nm)	EO 12114 (Non-U.S. Territorial Waters, >12 nm)
No Action Alternative	Use of expendable training materials will deposit training debris on the ranges. Most of the degradation products of these materials are nonhazardous inorganic materials. Existing hazardous material and waste management systems are sufficient for handling of wastes generated by the No Action Alternative.	Use of expendable training materials will deposit training debris on the ranges. Most of the degradation products of these materials are nonhazardous inorganic materials. Existing hazardous materials and waste management systems are sufficient for handling of wastes generated by the No Action Alternative.
Alternative 1	Impacts on MIRC would be similar to those of the No Action Alternative. Overall volume of training debris would increase slightly. Existing hazardous materials and waste management systems are sufficient for handling of wastes generated by Alternative 1.	Impacts on MIRC would be similar to those of the No Action Alternative. Overall volume of training debris would increase slightly. Existing hazardous materials and waste management systems are sufficient for handling of wastes generated under Alternative 1.
Alternative 2	Impacts on MIRC would be similar to those of the No Action Alternative and Alternative 1. Overall volume of training debris would increase over Alternative 1. Existing hazardous materials and waste management systems are sufficient for handling of wastes generated by Alternative 2..	Impacts on MIRC would be similar to those of the No Action Alternative and Alternative 1. Overall volume of training debris would increase over Alternative 1. Existing hazardous materials and waste management system are sufficient for handling of wastes generated by Alternative 2.

3.3 WATER QUALITY

Water quality consists of the chemical and physical composition of groundwater and surface waters. Potentially affected water bodies include Pacific Ocean waters surrounding Guam and the CNMI, and rivers, lakes, streams, wetlands, and groundwater within or affected by actions on the subject onshore and offshore ranges.

3.3.1 Introduction and Methods

The assessment of water quality in the MIRC was conducted by reviewing available literature including previously published NEPA documents for actions in the MIRC and surrounding area.

Potential water quality impacts are limited to elements of current and proposed activities that could affect ocean, groundwater and surface water. With the exception of air-to-ground warfare training, aircraft activities and training activities in airspace are not expected to have adverse effects on water quality.

Factors considered in evaluating impacts on marine water quality include the extent or degree to which:

- Concentrations of water pollutants from the proposed activity would exceed applicable standards;
- Proposed activities would violate laws or regulations adopted to protect or manage the water resource system; or
- Proposed activities would affect existing or future beneficial uses.

Current and proposed activities that could affect non-marine water resources are limited to deposition of constituents of training and testing materials on surface soils in the MIRC. Deposition on soils could indirectly affect surface freshwater resources.

3.3.1.1 Regulatory Framework

The study area for water quality extends 12 nm from the coastline of any U.S. Territory as defined by Presidential Proclamation 5928. Portions of the potentially affected inner sea range within these boundaries are subject to analysis under NEPA.

The study area for this action extends outside the U.S. territorial sea or beyond 12 nm (22 km) of the shore as it relates to training and RDT&E activities in the MIRC. The open ocean training areas are subject to analysis under EO 12114.

3.3.1.1.1 Federal Laws and Regulations

The United States Environmental Protection Agency (USEPA) and National Oceanic and Atmospheric Administration (NOAA) are the federal agencies primarily responsible for water quality and ocean resources. Federal laws regulating water quality include the Clean Water Act (CWA) (33 USC 1251 *et seq.*) and the Safe Drinking Water Act (SDWA) (42 USC 300f *et seq.*). The CWA was enacted by Congress to restore and maintain the chemical, physical, and biological integrity of United States (U.S.) waters. The CWA requires each state to establish water quality standards for its surface waters based on designated uses. For impaired water bodies, the CWA directs each state to develop Total Maximum Daily Loads (TMDL), the amounts of pollutants that can be assimilated by a body of water without exceeding water quality standards. Based on the developed TMDLs, the state or USEPA can limit any discharge of pollutants to a level sufficient to ensure compliance with state water quality standards.

As required under the CWA, the USEPA has established National Ambient Water Quality Criteria (NAWQC) (USEPA, 1996). The criteria are maximum concentration levels for specific contaminants in discharges to surface waters necessary to protect ecological and human health. The criteria are not rules, and have no regulatory effect. However, they can be used to develop regulatory requirements, based on concentrations that will have an adverse effect on the qualities necessary to sustain beneficial uses of U.S. waters. Table 3.3-1 shows the NAWQC standards for saltwater.

The CWA prohibits the discharge of oil or hazardous substances into the territorial waters of the U.S. (*i.e.*, up to 12 nm [19 km]) in quantities harmful to the public health or welfare, or to the environment. Oil and hazardous substance spills are addressed under the National Contingency Plan. USEPA has proposed Uniform National Discharge Standards for military vessels. Table 3.3-2 summarizes current Navy pollution control discharge restrictions in the coastal zone.

Table 3.3-1: National Ambient Water Quality Criteria Standards For Saltwater

Contaminant	NAWQS (µg/L)	
	Acute (1-hr average)	Chronic (4-day average)
Metals		
Nickel	75.0	8.30
Lead	140.0	5.60
Cadmium	43.0	9.30
Copper	2.9	2.90
Mercury	5.6	0.25
Polycyclic Aromatic Hydrocarbons		
Naphthalene	2,350	none
Acenaphthene	970	710
µg/L - micrograms per liter; hr - hour		
SOURCE: USEPA, 1996		

3.3.1.1.2 Territory and Commonwealth Laws and Regulations

Statutory water quality authorities and regulations for Guam and the CNMI are described herein. The USEPA Region 9 Water Division implements programs that prevent, reduce, and regulate surface and groundwater contamination. The 1986 amendments to the SDWA and the 1987 amendments to the CWA established authority for USEPA water programs.

A Memorandum of Agreement (MOA) with the USEPA provides the authority for the Guam Environmental Protection Agency (GEPA) Water Programs Division to enforce portions of federal statutes (such as portions of the CWA and the SDWA) and regulations not covered by local statutes. GEPA's Water Programs Division is responsible for the management and protection of Guam's drinking, surface, and marine water resources. This agency is responsible for three programs:

- Safe Drinking Water Program
- Water Pollution Control Program
- Water Resource Management Program

The main objectives of the Safe Drinking Water Program are to undertake planning activities, and develop, implement, and enforce Guam's Primary and Secondary Safe Drinking Water Regulations, as authorized by the Guam SDWA (10 Guam Annotated Code [GCA] Chapter 53) and the 1986 and 1996 SDWA, as amended. The primary goal of this program is to ensure that potable water on Guam meets local and national standards by implementing the Water and Wastewater Operator's Mandatory Certification Act (10 GCA Chapter 52) and the Guam Lead Ban Act (10 GCA Chapter 53A). The mandatory operators' certification program ensures that all operators who supervise water and wastewater utilities are qualified and adequately trained to operate the system in a manner that ensures the water treatment systems meet criteria for safety and quality. The Guam Lead Ban Act is implemented and enforced to minimize the public's exposure to lead contamination attributed to plumbing materials, fittings and fixtures. The eleven permitted Public Water Supply Systems (PWSS) on Guam are regulated under this program through an Operating Permit. The Navy and the Air Force PWSS are currently permitted (COMPACFLT, 2007).

Table 3.3-2: Summary of Navy Pollution Control Discharge Restrictions (Coastal Zone)

Area	Type of Waste	
	Sewage ("Black Water")	**Gray water**
0-3 nm	No discharge.	If no pierside collection capability exists, direct discharge permitted
3-12 nm	Direct discharge permitted.	Direct discharge permitted
12-25 nm	Direct discharge permitted.	Direct discharge permitted
Area	**Oily Waste**	**Garbage (Non-plastics)**
0-3 nm	No sheen. If equipped with Oil Content Monitor (OCM), discharge ≤ 15 ppm oil. (If operating properly, oil/water separator (OWS) or bilge water processing tank (BWPS) will routinely be less than 15 ppm)	No discharge
3-12 nm	Same as 0-3 nm.	Pulped garbage may be discharged
12-25 nm	If equipped with OCM, discharge < 15 ppm oil. Ships with Oil/Water Separator but no OCM must process all bilge water through the oil-water separator.	Direct discharge permitted
Area	**Garbage (Non-Plastics)**	**Garbage (Plastics)**
0-3 nm	No discharge.	No discharge
3-12 nm	Pulped or comminuted food and pulped paper and cardboard waste may be discharged > 3 nm.	No discharge
12-25 nm	Bagged shredded glass and metal waste may be discharged > 12 nm. Submarines may discharge compacted, sinkable garbage between 12 nm and 25 nm provided that the depth of water is greater than 1,000 fathoms	No discharge. Submarines may discharge compacted, sinkable garbage between 12 nm and 25 nm provided that the depth of water is greater than 1,000 fathoms
Area	**Hazardous Materials**	**Medical Wastes (Infectious & Sharps)**
0-3 nm	No discharge.	Steam sterilize, store, and transfer ashore. No discharges
3-12 nm	No discharge.	Steam sterilize, store, and transfer ashore. No discharges
12-25 nm	No discharge except as permitted by Navy authorized disposal methods for shipboard hazardous materials.	Steam sterilize, store, and transfer ashore. No discharges
Source: DoN, 2007		

The GEPA Water Pollution Control Program, comprised of the Community Wastewater and Individual Wastewater Sections, is responsible for protecting public health, the sole source of Guam's drinking water (the Northern Aquifer), and Guam's waters from point and non-point sources of water pollution. The Community Wastewater Section is responsible for providing sewage treatment and related facilities, while the Individual Wastewater Section is responsible for controlling pollution from domestic wastewater through a permit system requiring all buildings on Guam have a safe and adequate sewage disposal system. The program is also responsible for the administration of the National Pollutant Discharge Elimination System (NPDES) Program, Spill Prevention, Control and Countermeasure Program, the Nonpoint Source Management Program, Federal Sewer Construction Grants Program, Guam Water Quality Standards, Soil Erosion and Sediment Control Regulations, Feedlot Waste Management Regulations, and Connection to Public Sewer Regulations (http://www. guamepa.govguam.net/programs/water/poll.html).

The GEPA Water Resources Management Program is responsible for implementing Guam's Water Resources Conservation Act (10 GCA Chapter 46) by managing and protecting Guam's principal source aquifer from pollution and over pumping and by implementing the Water Resources Development and Operating Regulations, the Underground Injection Control Regulations, and the Wellhead Protection and Water Quality Standards. Data on groundwater lens characteristics are continuously collected and used to determine how the groundwater resource has been affected and to what extent future development can or should occur. The data are also used to determine whether changes or modifications to the current management are necessary (http://www.guamepa.govguam.net/programs/water/res.html).

The CNMI Department of Environmental Quality (DEQ) has developed its own Water Quality Standards, which are promulgated in accordance with the Federal CWA, the Commonwealth Environmental Protection Act, the Commonwealth Environmental Amendments Act, and the Commonwealth Groundwater Management and Protection Act (COMPACFLT, 2007).

3.3.1.2 Warfare Areas and Associated Environmental Stressors

Aspects of the proposed training likely to act as stressors to water quality were identified through analysis of the warfare training and specific activities included in the alternatives. Environmental stressors are limited to those locations where surface, ground and ocean water resources could potentially be affected by training activities. This analysis is presented in Table 3.3-3. An impact analysis is provided in Subchapter 3.3.3.

Table 3.3-3: Warfare Training and Potential Stressors to Water Quality

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Water Quality
Army Training			
Field Training Exercise (FTX) / Polaris Point Field, Orote Point Airfield & Runway, NLNA, Northwest Field, Andersen South, Tinian EMUA		Vehicle Movements Foot Traffic	Contamination of surface drainage areas from runoff; Contaminant accumulation in waters from leaks or spills of hazardous substances.
Live Fire / Pati Point CATM Range		Weapons Firing	Contamination of surface drainage areas from runoff; Contaminant accumulation in waters from leaks or spills of hazardous substances.
Marine Corps Training			
Direct Fires / FDM, Orote Point KD Range, ATCAA 3A		Weapons Firing	Contamination of surface drainage areas from runoff; Contaminant accumulation in waters from leaks or spills of hazardous substances.
Protect the Force / Northwest Field		Vehicle Movements Foot Traffic	Contamination of surface drainage areas from runoff; Contaminant accumulation in waters from leaks or spills of hazardous substances.
Navy Training			
Mine Warfare (MIW) Training / Agat Bay, Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point Airfield/ Runway, OPCQC, Ordnance Annex Breacher House, Ordnance Annex Emergency Detonation Site, NLNA, SLNA, Barrigada Housing, Piti and Agat Bay Floating Mine Neutralization Areas	Underwater detonations Land demolitions	Detonation of underwater mine Vehicle Movements Foot Traffic Land Detonations	Suspension of bottom sediments; Accumulation of contaminants in ocean bottom sediments; Increase in turbidity, organic and toxic loads in affected waters; Formation of craters in bottom sediments Contamination of surface drainage areas from runoff; Contaminant accumulation in waters from leaks or spills of hazardous substances; Siltation and formation of sediment plumes
Strike Warfare (STW)/ FDM	Air to Ground Bombing Exercises (Land)(BOMBEX-Land)	Land Detonations	Contamination of surface drainage areas from runoff; Contaminant accumulation in waters from leaks or spills of hazardous substances. Siltation and formation of sediment plumes
	Air to Ground Missile Exercises (MISSELEX)	Land Detonations	Contamination of surface drainage areas from runoff; Contaminant accumulation in waters from leaks or spills of hazardous substances. Siltation and formation of sediment plumes

Table 3.3-3: Warfare Training and Potential Stressors to Water Quality (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Water Quality
Navy Training (Continued)			
Naval Special Warfare (NSW) / Orote Point Training Areas, Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field, Reserve Craft Beach, Polaris Point Field, Dan Dan Drop Zone	Naval Special Warfare Operations (NSW OPS)	Vehicle Movements Foot Traffic Amphibious Warfare Exercises, Land Demolitions including use of explosives during breaching training, Weapons Firing	Contamination of surface drainage areas from runoff; Contaminant accumulation in waters from leaks or spills of hazardous substances; Siltation and formation of sediment plumes
	Over the Beach (OTB)	Aircraft Movements Amphibious Landings Foot Traffic	Contamination of surface drainage areas from runoff; Contaminant accumulation in waters from leaks or spills of hazardous substances; Siltation and formation of sediment plumes
Amphibious Warfare (AMW) Training / FDM, Orote Point and Finegayan Small Arms Ranges, Orote Point KD Range, Reserve Craft Beach, Outer Apra Harbor, Tipalao Cove, Tinian EMUA	Naval Surface Fire Support (FIREX Land)	Land Detonations	Contamination of surface drainage areas from runoff; Contaminant accumulation in waters from leaks or spills of hazardous substances. Siltation and formation of sediment plumes
	Hydrographic Surveys	Amphibious Landings Foot Traffic	Contamination of surface drainage areas from runoff; Contaminant accumulation in waters from leaks or spills of hazardous substances; Siltation and formation of sediment plumes
Logistics and Combat Services Support / Orote Point Airfield/ Runway, Reserve Craft Beach	Combat Mission Area Training	Vehicle Movements Foot Traffic Amphibious Landings	Contamination of surface drainage areas from runoff; Contaminant accumulation in waters from leaks or spills of hazardous substances; Siltation and formation of sediment plumes

Table 3.3-3: Warfare Training and Potential Stressors to Water Quality (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Water Quality
Air Force Training			
Counter Land / FDM, ATCAA 3		Land Detonations	Contamination of surface drainage areas from runoff; Contaminant accumulation in waters from leaks or spills of hazardous substances; Siltation and formation of sediment plumes
Intelligence, Surveillance, Reconnaissance (ISR) and Strike Capability / R-7201, FDM, Andersen AFB	Air-to-Ground Training	Increased Personnel	Contamination of surface drainage areas from runoff; increase in water withdrawal from aquifers due to increase in population.

3.3.2 Affected Environment

The study area is comprised of marine, surface, and groundwater associated with the islands of Guam, Tinian, Saipan, Rota and FDM.

Marine Water. Water quality in the marine environment is determined by a complex set of interactions between chemical and physical processes operating continuously in the ocean system. This dynamic equilibrium is expressed by a variety of indicators, including temperature, salinity, dissolved oxygen, and nutrient levels. Nutrients are chemicals or elements necessary to produce organic matter. 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. Water pollutants alter the basic chemistry of sea water in various ways.

The marine environment has a high buffering capacity (i.e., the pH of seawater is relatively stable) 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 equilibrium reaction of dissolved carbon dioxide (CO_2) and water. This CO_2-carbonate equilibrium system is the major buffering system in seawater, maintaining a hydrogen ion concentration (pH) between 7.5 and 8.5.

The vast expanse of the off-shore waters combined with their distance from the shore and the mixing and transport effects of the currents, work together to maintain a generally high quality of water. The major chemical parameters of marine water quality include pH, dissolved oxygen, and nutrient concentrations. The major ions present in seawater are sodium, chloride, potassium, calcium, magnesium, and sulfate.

The quality of coastal ocean waters is strongly affected by human activities with urban runoff as a primary source of contamination. Runoff may contain bacterial contamination, inorganic nutrients, various organic compounds, and metals. Sediment toxicity can be severe in port and marina areas within bays, harbors, and river mouths.

Water pollutants associated with Navy training activities are released into the ocean; however, their release is regulated in accordance with appropriate regulatory permits. Navy training activities require the use of a variety of solid and liquid hazardous materials. Hazardous materials required on the open ocean ranges can be broadly classified as either shipboard materials, necessary for normal training and maintenance, such as fuel and paint, and training materials. Training materials include both live and practice munitions (considered to contain military expended material constituent [MEMC] because they contain explosives or propellants), and non-munition training materials.

Commercial, recreational, and institutional vessels discharge water pollutants into the ocean. 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: (a) Liquids: "black water" (sewage); "gray water" (i.e., water from deck drains, showers, dishwashers, and laundries); and oily wastes (oil water mixtures); and (b) Solids (garbage).

Marine water quality around the Mariana Islands is good. Various locations in Tinian Harbor are tested monthly for fecal coliform. There were three incidents of coliform violations due to fishing boat discharges into the harbor in 1995. Guam's ocean water quality is relatively good with the exception of locations close to river mouths or sewage treatment outfalls. Guam beaches are tested weekly using biological parameters. Several beach and harbor areas on Rota are tested quarterly for fecal coliform. No testing is done on FDM which is uninhabited (PACOM, 1999).

Surface Water. Surface water quality in the Mariana Islands, in general, is good. Guam's surface waters are vulnerable to contamination from sewage disposal overflows, animal wastes, and sediment erosion carried into streams during periods of heavy rainfall. Inland surface water bodies are of highest quality, whereas coastal regions contain surface water bodies of medium to low quality. Surface water bodies on Tinian and Rota are similarly vulnerable to contamination (PACOM, 1999).

*Guam***.** Guam's only large reservoir of water is confined behind a dam and is located on Navy lands at the Ordnance Annex. The Fena Reservoir has a capacity of approximately 7,050 acre-ft and confines the water from four rivers: the Imong, Almagosa, Sadag Gago, and Maulap. Water from the Fena Reservoir, along with surface water redirected from Almagosa and Bona Springs, is pumped to the Fena Water Treatment Plant and then into Navy and municipal distribution systems (COMNAVMARIANAS, 2001).

Fena Reservoir and springs within the Ordnance Annex are important sources of water for the U.S. Navy and the Government of Guam, providing approximately 30 percent of Guam's current water requirements. Water quality from Fena Reservoir and springs is generally high, requiring minimum treatment and chlorination for domestic use. Threats to the water quality in Ordnance Annex include sedimentation from accelerated erosion and fecal material contamination from feral ungulates and other animals (COMNAVMARIANAS, 2001).

The general landscape of southern Guam is not conducive to the construction of dams to confine surface waters. Many stream courses are short and have steep gradients where the water flows into broad valleys unsuitable for the construction of dams.

*Tinian***.** Surface water on Tinian is restricted to the wetlands comprised of areas of impermeable clay that impound rainwater. There are several wetland areas, the largest of which is Hagoi in the northern part of the island southwest of the EMUA. Hagoi, like other Tinian wetlands, is dependent entirely on precipitation as a water source; and, in periods of drought, the water level drops and open water dramatically decreases. Navy biologists have not observed the wetland to be completely dry. Other Tinian wetlands are smaller than Hagoi and considered ephemeral because they are not large enough to sustain periods of low rainfall. Mahalang and Bateha wetlands are suspected to be artificial bomb craters or man-made water reservoirs for cattle. Makpo Swamp once supported open water, but municipal groundwater pumping significantly altered the water levels (COMNAVMARIANAS, 2003).

Floodplains are low-lying areas subject to flooding due to excessive rains and high runoff of surface water from higher elevations. Since the elevation is relatively uniform and there is little surface water runoff, flooding is not an important natural hazard on Tinian. FEMA delineates flood hazard areas and nineteen isolated areas are designated as Flood Zone A, which are areas likely to be inundated in a 100-year flood event. The remainder of Tinian, exclusive of the coastline is outside the regulatory floodplain. Zone A areas are unpopulated areas and include Hagoi, and portions of North Field, Tinian International Airport, and Makpo (COMNAVMARIANAS, 2003) (refer to Figure 3.3-1).

*Saipan***.** Surface water on Saipan includes canyon drainages throughout the island. Lake Susupe and its contiguous reed marsh is the largest surface water body on the island. The southern two-thirds of Saipan’s western coast is a low-lying coastal plain adjacent to the lagoon. Many depressional wetlands can be found along this coastal plain (AECOS, 2005).

*Rota***.** Surface water on the island of Rota is limited to streams along the southern edge of the island and small, isolated, depressional wetlands. The most common wetlands on Rota are those associated with the island’s streams (AECOS, 2005). An aqueduct connects a system of springs and wells along the southern perimeter of the island.

*FDM***.** Very little published information is available for FDM. Surface water is limited to one small area of ponded rainwater recorded in the west-central slope of FDM (COMNAVMARIANAS, 2003).

Groundwater. Groundwater quality in the Mariana Islands, in general, is good. Groundwater serves as the primary source of drinking water to Guam and other nearby islands. Groundwater is stored in highly-permeable limestone aquifers which were originally formed as coral reefs. In some areas, these limestone aquifers have been uplifted by the underlying volcanic rocks, or “high-level limestone aquifers” (USAF, 2006).

Groundwater aquifers on Tinian and Rota are vulnerable to contamination by substances introduced onto the soil surface because the porous soil and underlying limestone do not significantly impede the passage of contaminants to the shallow aquifers. Guam's groundwater is relatively free from point source pollutant discharges that are usually associated with larger landmasses. This results in water quality remaining at a consistently high level island-wide. Groundwater in the northern aquifer is protected from surface contamination by natural filtration through hundreds of feet of coralline limestone (PACOM, 1999).

*Guam***.** As an isolated island in the Western Pacific, Guam is totally dependent on rainfall to supply water to support life on the island. The availability of sufficient high quality water is critical to maintain healthy ecosystems; therefore water is a vital natural resource. The availability of water for most life forms is dependent on sufficient storage on or near the earth’s surface. In natural environments water is stored in the soil profile, underlying rocks, canopy of vegetation, rivers, streams, and wetlands. The abundant rainfall on Guam supplies high quality, clean water to meet the needs of most species. The construction of catchment systems and drilling deep wells to extract water has expanded the quantity of water available to meet the requirements of people and industry (COMNAVMARIANAS, 2001).

The movement and storage of water on Guam is greatly influenced by the island’s geology. Water is held in the soil pore space by cohesive attraction between water molecules and the mineral and organic components of the soil. The limestone geology of northern Guam is soluble and is very porous. Dissolution of the limestone by percolating rainwater has resulted in complex underground drainage systems, including caves and depressions. The large pore spaces and fractures in limestone rock result in water percolating rapidly downward through the soil profile with no surface water flow and little water being stored in the upper soil profile. The limestone in northern Guam is underlain with impervious volcanic rock at varying depths. Where the underlain volcanic rock is situated below sea level, saltwater permeates laterally through the porous limestone. The downward movement of water through the limestone continues until the water encounters an impervious mineral layer of volcanic rock or the higher density saltwater. If the downward percolating water encounters impervious mineral rock, parabasal water (or freshwater that flows directly on the impermeable volcanic basement rock) is stored in the porous limestone rock above the impervious rock (COMNAVMARIANAS, 2001).

Because fresh water has a lower density than saltwater, the fresh groundwater “floats” on saltwater. This freshwater resting on saltwater is called basal water, and the resulting groundwater lens is known as a Ghyben-Herzberg Lens. The Ghyben-Herzberg Lens is comprised of zones. Brackish water is present where there is a mixing of the freshwater and saltwater. Above this mixing zone is a zone of freshwater that saturates the porous limestone. There is a strong relationship between the thickness of the limestone rock above the saltwater and the thickness of the groundwater lens. As depth of the limestone above sea level increases, the greater the potential depth of the freshwater lens (COMNAVMARIANAS, 2001).

Limestone layers below the surface often contain numerous open cavities that can store water for extended periods of time. However, because gravity acts on this groundwater, the freshwater flows laterally until it is discharged into the ocean. Conduit flow occurs where the groundwater travels through underground channels. Groundwater can travel rapidly through these underground fractures. Diffuse flow occurs where groundwater moves through the pores in the limestone rock. Diffuse flow is much slower than conduit flow (COMNAVMARIANAS, 2001).

The Ghyben-Herzberg Lens is recharged with rainwater falling on the limestone geology. The diffuse recharge by rainwater percolated through hundreds of feet of porous limestone can be slow. Point recharge is the quickest means for rainwater to reach the groundwater via sinkholes and conduits leading from them. Development of northern Guam is resulting in extensive surface areas being sealed with impervious materials (houses, roads, parking areas). Municipal stormwater collection and conduits are often designed to direct stormwater into sinkholes where the water rapidly percolates. Water collected from roads and parking lots often contains pollutants, which lower water quality (COMNAVMARIANAS, 2001).

The hydrology of water falling on volcanic soils in southern Guam is very different than the limestone geology of northern Guam. The rocks that underlay southern Guam were derived from consolidated volcanic ash deposited under the sea and then uplifted. The uplifted rock is underlain with numerous faults with a complex sloping topography. Over several million years this material has weathered to form the soils that generally contain a large percentage of clay particles and smaller pore spaces. If the soils are not already saturated with water, rainfall percolates into the soil and is held by cohesive forces in the smaller pore spaces. If rainfall intensity exceeds the rate of percolation, surface flow will occur. Also, because the depth to impervious mineral layers is generally shallow the soil profile can become saturated if the duration and frequency of rainfall exceeds the discharge rate of groundwater into streams, which will result in surface flow (COMNAVMARIANAS, 2001).

Groundwater flows laterally along the impervious layers of volcanic rock until it diffuses into seeps, springs, streams, or wetlands. These areas of surface water provide important habitat for wildlife. The quantity of surface water stored in streams and wetland is dependent on the seasonality, intensity, and duration of rainfall. Once the soil profile is saturated any additional rainfall is diffused into the streams and travels to the ocean (COMNAVMARIANAS, 2001).

Figure 3.3-1: Flood Zone A Map of Tinian

The Northern Guam Lens aquifer supplies up to 80 percent of the island's potable water and serves as the primary source of potable water for the island. Other potable water sources are from surface water on the island. The aquifer is replenished from precipitation that percolates through the limestone. Groundwater is typically found approximately 450 to 500 ft (137 to 152 m) below ground surface (bgs). The Northern Guam Lens is considered by the Guam EPA as groundwater under direct influence of surface water. The aquifer has also been designated by the USEPA as a Sole Source Aquifer under the Safe Drinking Water Act. The high permeability of the limestone in northern Guam allows rapid infiltration of rainfall so surface runoff occurs locally only after intense rain. The limestone also offers little resistance to groundwater flow so only a thin freshwater lens has developed. Water levels in the freshwater lens vary several feet daily and seasonally in response to ocean tides, recharge, and ground-water withdrawal. The thickness of the freshwater lens varies seasonally, primarily in response to seasonal variations in recharge.

The only source of groundwater is precipitation, which infiltrates to the subsurface and recharges the underlying water table (the upper surface of the groundwater system). Guam receives approximately 90-100 inches of rain per year. A significant portion of this is lost to evapotranspiration; some is lost to surface runoff, and the remaining portion is available as recharge to groundwater. The average annual recharge rate is estimated at 35 inches per year. The thickness of the groundwater lens is directly related to the recharge rate and to water withdrawal rates (USAF, 2006).

Andersen AFB lies on the northern portion of three groundwater subbasins: the Finegayan subbasin under the western third of the Base; the Agafa Gumas subbasin under the central portion of the Base, which includes Northwest Field; and the Andersen subbasin under the eastern portion of the Base (Andersen AFB, 2000). Over 100 dry wells were created at the Base to assist in storm water recharge into the aquifer. However, this method has the potential to cause groundwater contamination from storm water runoff. Past activities have not resulted in extensive groundwater contamination due to implementation of the Base Storm Water Pollution Prevention Plan. Groundwater in each subbasin consists of a basal or parabasal zone. Subsurface freshwater floats above the seawater within the basal zone, while in the parabasal zone, freshwater flows directly on the impermeable volcanic basement rock (USAF, 2006).

Parts of Andersen AFB overlie the Groundwater Protection Zone, an area which supplies most of the island's population with drinking water. Groundwater underlying Andersen AFB was found to be contaminated with volatile organic compounds (VOC). VOCs at levels above the Agency for Toxic Substances and Disease Registry (ATSDR) health-based comparison values and USEPA Safe Drinking Water Standards were also found in three base production wells. These VOCs included tricholorethylene and tetrachloroethylene. Other active drinking water base production wells are either upgradient of or some distance away from areas of contamination. ATSDR evaluated past exposure to contaminants in the affected production wells and determined that drinking this water would not harm individuals or increase their likelihood of developing adverse health effects. ATSDR also concluded the agency does not expect any public health hazards, now or in the future, for individuals drinking water from the Andersen AFB water supply or any other production wells on Guam. Several reasons for this include: 1) the military's remediation actions are further reducing contamination at the Base; and 2) the natural groundwater flow patterns dilute chemical contaminants to concentrations well below levels of public health concern. Finally, mixing of drinking water in the Base's distribution system further dilutes the levels of any contaminants in the water before the water reaches the taps. On the basis of its evaluation of available environmental information, ATSDR concluded that exposures to contaminants in groundwater, surface soil, and local plants and animals harvested for consumption are below levels that would cause adverse health effects. ATSDR has categorized the Base as "no apparent public health hazard" because of the Air Force's education efforts, access restrictions and monitoring programs at Andersen AFB, and contact with unexploded ordnance (UXO) and the possibility of harm are remote. Approximately 43 mgd of water is withdrawn from the Northern Guam Lens aquifer. The 2.5 mgd of water Andersen AFB withdraws from the aquifer equates to about 5.81 percent of the daily water withdrawal (USAF, 2006).

*Tinian***.** Most of Tinian's groundwater supply is located within units of the Takpochao Limestone and the known Ghyben-Herzberg Lens areas. The basal fresh water lens extends from 2 to 4 ft (0.6 to 1.2 m) above mean sea level to approximately 80 to 160 ft (24 to 49 m) below sea level at its deepest point. Most households utilize municipal water and a small percentage of these homes are totally dependent on rainwater catchment. Historically, the groundwater resources supported over 150,000 military personnel during WW II. Approximately 40 wells were drilled at an average depth of 229.7 ft (70 m), however most of these have been abandoned (COMNAVMARIANAS, 2003). The Makpo wetland area supplies agricultural and domestic water supply for the island of Tinian. The potable water supply well was originally drilled by the U.S. military in 1945 and is located north of the agricultural well. Potable water is stored in tanks at Makpo Heights and Carolinas Heights (COMNAVMARIANAS, 2003).

*Saipan***.** All fresh groundwater on Saipan originates as rainfall (Carruth, 2003). Groundwater is the major source of water on Saipan. Residents do not have a continuous potable water supply, many areas do not receive water 24 hours a day and most of the water that is produced does not meet USEPA drinking water quality standards. Water supply problems are intensified during the dry season and during recurring periods of drought (USGS, 2008).

On Saipan, about 130 municipal production wells produce about 11 million gallons of water per day, accounting for about 90 percent of the municipal water supply. Three developed springs and a rainwater catchment system at the airport make up the remaining 10 percent of the water supply. The thickness of the freshwater lens in the coastal aquifer system on Saipan ranges from about 20 to 60 ft (6 to 18 m) and many wells produce water with high chloride concentrations (USGS, 2008).

*Rota***.** As an island covered by uplifted limestone, Rota relies on its limestone aquifers for most of its potable water. The entire island surface is covered by uplifted limestone with the exception of a 2.5-mile (4 km) scarp along the southernmost flank of the island where the volcanic core is exposed. Almost all of the island's potable water supply is produced from springs that emerge along the face of the scarp (USGS, 2003). Water sampled from exploratory wells drilled in 1999 meet USEPA requirements for potable water source, and have been designated as municipal water wells (USGS, 2005).

*FDM***.** There is no published data on the hydrology of FDM. There is no aquifer information (COMNAVMARIANAS, 2003).

3.3.2.1 Current Protective Measures

Navy activities could result in environmental effects on water quality in ocean areas due to shipboard training, expenditure of ordnance, and training-related debris such as used targets. Navy ships are required to conduct activities at sea in a manner that minimizes or eliminates any adverse impacts on the marine environment. Environmental compliance policies and procedures applicable to shipboard training afloat and pollution prevention are defined in Navy instructions, DoD Instruction 5000.2-R, EO 12856, and EO 13101. These instructions 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. Navy protective measures for shipboard management, storage, and discharge of hazardous materials and wastes, and other pollution protection measures are intended to protect water quality.

Governing procedures for the use of training areas, ranges and airspace operated and controlled by the Commander U.S. Naval Forces, Marianas including instructions and procedures for the use of Guam, Saipan, Tinian, Rota and FDM are included in COMNAVMARIANAS Instruction 3500.4 (Marianas Training Handbook). This guidance identifies specific land use constraints to enable protection of environmental resources during military training activities in the MIRC.

3.3.3 Environmental Consequences

3.3.3.1 No Action Alternative

At-sea training and test activities involve numerous combatant ships, torpedo retrieval boats, and other support craft. These vessels are manned, and, with the exception of the use of marine location markers (e.g., MK-58) used in man overboard training and shipboard familiarization fire training, do not intentionally expend any munitions constituents into the water. Offshore training activities also expend bombs, missiles, torpedoes, sonobuoys, targets, flares, or chaff from ships, submarines, or aircraft. These training materials are shot, launched, dropped, or placed within the range. Expended materials entering the ocean could affect marine water quality.

Most weapons and devices used during training exercises are removed at the conclusion of the exercises. Some training materials, including gun ammunition and naval shells, bombs and missiles, targets, sonobuoys, and flares, however, are used on the range and not recovered. Items expended on the water, and fragments not recognizable as training debris (e.g., flare residue or candle mix), typically are not recovered. The types of expendable training materials used in each category of at-sea training typically contain various constituents of concern.

3.3.3.1.1 Expended Training Materials

Torpedoes. Torpedoes are recovered at the end of each exercise, however, non-hazardous materials associated with their launch are expended and ultimately settle on the ocean floor. These include the guidance wire, flexible hose, nose cap, suspension bands, air stabilizer, release wire, propeller baffle, sway brace pad, arming wire and fahnstock clip. Potential effects of torpedoes on water or sediment quality are associated with propulsion systems, chemical releases, or expended accessories. The potential hazardous or harmful materials are not normally released into the marine environment because the torpedo is sealed and, at the end of a run, the torpedoes are recovered. Torpedoes contain only small quantities of hazardous components. Torpedoes are programmed to avoid targets and the ocean bottom, however, in the unlikely event of impact with a target or the ocean floor, the small quantities of hazardous materials will diffuse rapidly in the water column.

Recoverable Exercise Torpedoes (REXTORP) are non-explosive exercise torpedoes that use air charges or hydrostatic pressure to discharge ballast and float to the water's surface. They have no warheads, no propellant, and negligible amounts of hazardous materials. Table 3.3-4 describes torpedoes typically used in training, and Table 3.3-5 describes torpedo constituents.

Table 3.3-4: Torpedoes Typically Used in Navy Training Activities

Torpedo	Characteristics
MK-46 EXTORP	Hazardous materials include explosive bolts (less than 0.035 oz.), gas generator (130.9 lb), and a seawater battery (4 oz). The monopropellant is Otto fuel.
MK-48 ADCAP EXTORP	The hazardous materials list is classified.
MK-54 EXTORP	This EXTORP is based on the propulsion system of the MK-46 torpedo and the search and homing capabilities of the MK-50 torpedo.

Sources: Naval Institute Guide to Ships and Aircraft of the U.S. Fleet, 2001.

Table 3.3-5: MK-46 Torpedo Constituents

Materials	
Torpedo Hydraulic Fluid (MIL-H-5606E mineral oil base)	Practice Arming Rotor (Lead Azide
Grease (Dow Corning 55M Grease)	Scuttle Valve (Lead Azide)
Lubricating and Motor Oils	Frangible Bolt (Lead Azide and Cyclonite)
Luminous Dye (Sodium Fluorescein)	Propellant (Ammonium Perchlorate)
Solder (QQ-S-571, SN60)	Gas Generator (Barium Chromate and Lead Azide)
Ethylene Glycol (two speed valve backfill fluid	Release Mechanism (Barium Chromate and Lead Azide)
Ballast Lead Weight	Stabilizer (Barium Chromate and Lead Azide)
Explosive Bolts (Lead Azide and Cyclonite)	Cartridge Activated Cutter (Barium Chromate and Lead Azide
Pressure Actuated Bolt (Potassium Perchlorate)	Propulsion Igniter
Practice Exploder (Lead Azide)	Exercise Head Battery

Source: U.S. Department of the Navy, 1996a

OTTO Fuel II propulsion systems are used in both the MK-46 and the MK-48 torpedoes. OTTO Fuel II may be toxic to marine organisms (DoN, 1996a). There have been over 5,800 exercise test runs of the MK-46 torpedo worldwide between FY89 and FY96 (DoN, 1996a), and approximately 30,000 exercise test runs of the MK-48 torpedo over the last 25 years (DoN, 1996b). Most of these launches have been on Navy test ranges, where there have been no reports of deleterious impact on marine water quality from the effects of OTTO Fuel II or its combustion products (DoN, 1996a). Furthermore, Navy studies conducted at torpedo test ranges that have lower flusing rates than the open ocean did not detect residual OTTO Fuel II in the marine environment (DoN, 1996a). Thus, no adverse effects are anticipated from the use of OTTO Fuel II.

In addition to typical combustion products, hydrogen cyanide (HCN) is generated when the torpedo is fired using Otto Fuel II. HCN does not normally occur in seawater and, at high enough concentrations, could pose a risk to both humans and marine biota. The USEPA acute and chronic national recommendation for cyanide in marine waters is 1.0 ug/L, or approximately one ppb (DoN, 1996a). Hydrogen cyanide concentrations of 280 ppb would be discharged by MK-46 torpedoes and 140 to 150 ppb from MK-48 torpedoes (DoN, 1996a). These initial concentrations are well above the USEPA recommendations for cyanide. However, since HCN is highly soluble in seawater, HCN would be diluted to less than 1.0 ug/L at 17.7 ft from the center of the torpedo's path, and thus should pose no substantial threat to marine organisms.

Although highly unlikely, up to 59 lb of OTTO Fuel II could be released from a MK-46 torpedo from a catastrophic failure (DoN, 1996a). Even in the event of such a spill, no long-term adverse impacts on marine water quality would result because the water volume and depth would dilute the spill. In addition, common marine bacteria would degrade and ultimately break down OTTO fuel (DoN, 1996a).

Lead ballasts which are released to allow the torpedo to rise for surface recovery are steel-jacketed, and under ocean bottom conditions of slightly basic with low oxygen content, lead will not ionize. The lead will not be in direct contact with seawater. In areas of soft bottoms, the lead weight would quickly be buried due to the velocity of its impact with the bottom and its greater density. As a result, releases of dissolved lead into bottom waters are unlikely.

Under the No Action alternative, up to 22 MK-48 torpedoes per year will be used. Based on the above, no adverse effects are anticipated from the use of torpedoes in the MIRC Study area.

Sonobuoys. Sonobuoys are electromechanical devices used for a variety of ocean sensing and monitoring tasks. Lead solder, lead weights, and copper anodes are used in the sonobuoys. Sonobuoys also may contain fluorocarbons and lithium sulfur dioxide, lithium, or thermal batteries.

During operation, a sonobuoy's seawater batteries could release copper, silver, lithium, or other metals to the surrounding marine environment, depending upon the type of battery used. They also may release fluorocarbons. Marine organisms in its vicinity could be exposed to battery effluents for up to 8 hours, which is about the maximum life of seawater batteries. The batteries cease operating when their chemical constituents have been consumed. Once expended and scuttled, the sonobuoys would sink to the ocean floor.

Various types of sonobuoys could be used, so the exact amounts of hazardous materials that would be expended on the ranges are not known. Table 3.3-7 provides estimates of sonobuoy wastes, based on the types of sonobuoys typically used for current Navy training activities. Under the No Action alternative, 1,671 sonobuoys per year will be used, resulting in a release of about 2.46 tons (2.24 metric tons) of hazardous materials annually to the marine environment. The large ocean volume of the Study Area would dilute the hazardous materials release from sonobuoys to very low concentrations that is not expected to alter the water quality characteristics of seawater. For example, assuming only a 1 m depth of ocean, the total volume of seawater over the entire MIRC is approximately 1.7 x 10^{15} liters. Therefore, the concentration of copper thiocyanate (the largest amount released from sonobuoys) would only be 7 x 10^{-7} mg/liter.

Table 3.3-7: Sonobuoy Hazardous Constituents – No Action Alternative

Constituent	Amount/Sonobuoy* lb (kg)	Annual Amount tons (metric tons)
Copper thiocyanate	1.59 (0.72)	1.33 (1.21)
Fluorocarbons	0.02 (0.01)	0.02 (0.02)
Copper	0.34 (0.15)	0.28 (0.25)
Lead	0.94 (0.43)	0.79 (0.72)
Steel, tin/lead plated	0.06 (0.03)	0.05 (0.05)
TOTAL	2.95 (1.34)	2.46 (2.24)

*Source: DoN, San Clemente Island Ordnance Database (No Date)

Chaff. Chaff is a thin polymer with an aluminum coating used to decoy enemy radars. Chaff reflects radar signals and forms a very large image or electronic cloud of reflected signals on a radar screen. Chaff is comprised of silica, aluminum, and stearic acid, which are generally prevalent in the environment. A single bundle of chaff consists of the filaments in a cartridge with a plastic piston, a cushioned spacer, and two plastic end caps. The chaff is shot out of launchers using a propellant charge. The plastic end caps and spacer fall off when chaff is dispensed. Table 3.3-8 lists the components of the silica core and the aluminum coating. The weight of chaff material in the RR-188 cartridge is approximately 3.35 oz (95 gm) (USAF, 1997). It is estimated that 2,092 canisters of chaff will be used annually under the No Action alternative, resulting in a release of 0.22 tons (0.20 metric tons) of chaff material, the majority of which will fall into the open ocean. Chemicals leached from the chaff will be diluted by the surrounding seawater, reducing the potential for concentrations of these chemicals to build up to levels that can affect sediment quality and benthic habitats. Chaff will have no discernable effect on the marine environment (USAF, 1997).

Table 3.3-8: Components of RR-188 or RR-170 Chaff

Compound/Element	Percent by Weight
Silica Core	
Silicon dioxide	52-56
Alumina	12-16
Calcium Oxide and Magnesium Oxide	16-25
Boron Oxide	8-13
Sodium Oxide and Potassium Oxide	1-4
Iron Oxide	1 or less
Aluminum Coating (Typically Alloy 1145)	
Aluminum	99.45 minimum
Silicon and Iron	0.55 maximum
Copper	0.05 maximum
Manganese	0.05 maximum
Magnesium	0.05 maximum
Zinc	0.05 maximum
Vanadium	0.05 maximum
Titanium	0.03 maximum
Others	0.03 maximum

Source: USAF, 1997

Pyrotechnics. Flares, smoke grenades and other pyrotechnic training devices expended in the water may leak or leach toxic substances as they degrade and decompose. Solid flare and pyrotechnic residues may contain, depending on their purpose and color, aluminum, magnesium, zinc, strontium, barium, cadmium, nickel, and perchlorates. Hazardous constituents in pyrotechnic residues are typically present in small amounts or low concentrations, and are bound up in relatively insoluble compounds. The perchlorate compounds present in the residues are highly soluble, although persistent in the environment and should disperse quickly. At an average residue weight of about 0.85 lb (0.39 kg) per item, an estimated 0.86 tons (0.78 metric tons) per year of pyrotechnic residues from 2,020 flares used annually under the No Action alternative will be deposited in the marine environment. The large ocean volume of the Study Area would dilute pyrotechnic residues to very low concentrations that would not alter the water quality characteristics of seawater. Using the same calculation for copper thiocyanate released from sonobuoys, the concentration of pyrotechnic residues would be about 4.5×10^{-7} mg/liter, assuming only 1 meter of ocean depth over the entire Study Area.

Ordnance. The ordnance used in offshore training activities usually does not carry live warheads with explosives. Explosives and propellants in live rounds are mostly consumed during use of the item, leaving only residues. Training items containing energetic materials may fail to function properly, however, and if not recovered, remain on the range as unexploded ordnance (UXO) containing explosives or propellants. Table 3.3-9 lists constituents of concern for some ordnance components.

Munitions constituents of concern also include nitroaromatics – principally Trinitrotoluene (TNT), its degradation products, related compounds, and cyclonitramines, including Royal Demolition Explosive (RDX), High Melting Explosive (HMX), and their degradation products. TNT degrades to dinitrotoluene (DNT) and subsequent degradation products from exposure to sunlight (photolysis) or bacteria (biodegradation). RDX also is subject to photolysis and biodegradation once exposed to the environment. As a group, military-grade explosives have low water solubility and are relatively immobile in water. The physical structure and composition of blended explosives containing multiple chemical compounds (Table 3.3-10), often with additional binding agents, may further slow the degradation and dissolution of these materials.

Table 3.3-9: Ordnance Constituents of Concern

Training Munitions	Constituent of Concern
Pyrotechnics **Tracers** **Spotting Charges**	Barium chromate Potassium perchlorate
Oxidizers	Lead oxide
Delay Elements	Barium chromate Potassium perchlorate Lead chromate
Propellants	Ammonium perchlorate
20-mm Projectiles	Depleted Uranium
Fuses	Potassium perchlorate
Detonators	Fulminate of mercury Potassium perchlorate
Primers	Lead azide

Table 3.3-10: Explosive Components of Munitions

Name	Composition	Use
Composition A	91% Royal Demolition Explosive (RDX)	Grenades, projectiles
Composition B	60% RDX, 39% trinitroluene (TNT)	Projectiles, grenades, shells, bombs
Composition C-4	91% RDX, 9% plasticizer	Demolition explosive
Explosive D	Picric acid, ammonium picrate	Bombs, projectiles
Octol	70-75% High Melting Explosive (HMX), 25-30% TNT	Shaped and bursting charges
TNT	100% TNT	Projectiles, shells
Tritonal	80% TNT, 20% aluminum	Bombs, projectiles
H6	80% Composition B, 20% aluminum	Bombs, projectiles

Source: USEPA, 2006.

Explosive byproducts generated when ordnance functions as designed (high-order detonation) or experiences a low-order detonation, also generate constituents of concern. The major explosive byproducts of organic nitrated compounds such as TNT and RDX include water, carbon dioxide, carbon monoxide, and nitrogen. Residues of high-order detonations are primarily micron-sized and submicron-sized particles that are spread over a large area. High-order detonations result in almost complete conversion of explosives (99.997% or more [USACE, 2003] into such inorganic compounds, whereas low-order detonations result in incomplete conversion (i.e., a mixture of the original explosive and its byproducts).

Munitions constituents are deposited on the surface of the ocean during training and testing in amounts similar to those identified on land ranges. Laboratory studies have determined that TNT exhibits toxicity in the marine environment at concentrations of 0.9 to 11.5 milligrams per liter (mg/L), while RDX generally showed limited toxicity. In marine sediments, TNT exhibits toxicity at concentrations of 159 to 320 parts per million (ppm). RDX exhibits no sediment toxicity at the concentrations tested (Lotufo and Ludy, 2005; Rosen and Lotufo, 2005; Rosen and Lotufo, 2007a, 2007b). In a series of tests mimicking a natural environment, Ek *et al*. (2006) determined that, under environmental conditions typical of in-water UXO, no substantial toxicity or bioaccumulation of TNT munitions occurred. In general, munitions constituents in the marine environment appear to pose little risk to the environment.

Gun Shells, Small Arms, and Practice Bombs. These training materials generally remain intact upon contact with the surface of the ocean, and sink quickly through the water column to the bottom. Thus, they do not affect water quality directly. Degradation and dispersal of explosive and propellant residues, and explosives and propellants from items that did not function (i.e., UXO), would not substantially affect water quality or bottom sediments. Corrosion of metallic materials may affect the bottom sediments immediately surrounding expended items, but would not contaminate substantial portions of the ocean bottom. Corrosion of metallic materials and the leaching of toxic substances from them also may indirectly affect water quality in their vicinity, but not to a substantial degree due to the relatively insignificant amount of material, its slow rate of release into the environment, and the action of ocean currents in dispersing the materials once they enter the water column.

Underwater Explosives. Underwater detonations associated with MIW training conducted at Outer Apra Harbor, Agat Bay and the Piti Mine Neutralization Area is conducted at a depth of 125 feet (40 m) using charges up to 10 lb NEW. Underwater demolitions using 100 lb NEW charges are conducted at undersea space associated with W-517 or the ATCAAs. Based on studies of the effects of explosive source sonobuoys, the explosive reaction that follows detonation would result in release of gaseous byproducts formed in an air bubble to the surface where byproducts would be released into the atmosphere. There are no risk evaluations of effects of underwater detonations on water quality, nor are there risk-based benchmarks for toxic constituents. Studies show that only a small percentage (0.63 percent) of available hydrogen fluoride explosive product is expected to become solubilized before reaching the surface and that rapid dilution would occur upon mixing with ambient water. Based on these sonobuoy explosive studies, it is unlikely that explosive reactions contribute contaminant risks to the aquatic community (DoN, 2008).

Combustion products of typical military explosives such as RDX and PETN consist of common gases (e.g., nitrogen, carbon dioxide) and relatively inert inorganic salts. Combustion efficiency of underwater detonations is relatively high, and residues of these hazardous materials may remain in the water and sediment. However, they would be present in trace concentrations that would not have an adverse effect on water quality.

Under the No Action alternative, up to 500 lb NEW would be used annually for underwater detonations, which are normally high-order detonations. Based on a 99.997% conversion efficiency for high-order detonations, explosive residue would amount to approximately 0.015 lb. The large ocean volume of the Study Area would dilute explosive residues to very low concentrations. For this reason, there would be no significant impact to water quality from the use of underwater explosives.

Missiles. Missiles used in training contain hazardous materials as normal parts of their functional components. Missiles contain igniters, explosive bolts, batteries, warheads, and solid propellants. Exterior surfaces may be coated with anti-corrosion compounds containing toxic metals. Most of the missiles are equipped with non-explosive warheads that contain no hazardous materials. For missiles falling in the ocean, the principal contaminant is unburned solid propellant residue and batteries. Table 3.3-11 lists the missiles typically fired during training and their associated hazardous materials.

Table 3.3-11: Missiles Typically Fired in Training Exercises

Type	Hazardous Materials
AIM-7 Sparrow	The missile is propelled by a Hercules MK-58 dual-thrust solid propellant rocket motor. The explosive charge is an 88-lb WDU-27/B blast-fragmentation warhead.
AIM-9 Sidewinder	Depending on the model, the propulsion system contains up to 44 lb of solid double-base propellant. The warhead contains approximately 10 lb of PBX-N HE.
AIM-11B Hellfire	The missile is propelled by a solid propellant rocket motor, the Thiokol TX-657 (M120E1)
AIM-120 AMRAAM	The missile is propelled by a solid propellant (ATK WPU-6B booster and sustainer) rocket motor that uses RS HTPB solid propellant fuel. The warhead is 40 lb of HE.
SM-1 and SM-2 Standard Missile	Propulsion system has 1,550 lb of aluminum and ammonia propellant in the booster and 386 lb of propellant in the sustainer. The warhead is 75-80 lb, depending on the version. Potassium hydroxide battery 1.9 oz.

Missile propellants typically contain ammonium perchlorate, aluminum compounds, copper, and organic lead compounds. Perchlorate is an inorganic chemical used in the manufacture of solid rocket propellants and explosives. A typical surface-to-air missile (e.g., SM-2) initially has 150 lb of solid propellant and uses 99 to 100 percent of the propellant during the exercise (i.e., < 1.5 lb remaining). The remaining solid propellant fragments sink to the ocean floor and undergo physical and chemical changes in the presence of seawater. Tests show that water penetrates only 0.06 inches into the propellant during the first 24 hours of immersion, and that fragments slowly release ammonium and perchlorate ions. These ions rapidly disperse into the surrounding seawater such that local concentrations are extremely low. The leaching rate will decrease over time as the concentration of perchlorate in the propellant declines. The aluminum in the propellant binder will eventually be oxidized by seawater to aluminum oxide. The remaining binder material and aluminum oxide will not pose a threat to the marine environment.

For missiles with explosive warheads, an estimated 99.997% of this material would be consumed in a high-order detonation, typically leaving less than 1.0 lb of residue. Explosive residues would degrade and disperse in a manner similar to that of propellants, and similarly would not be a substantial concern. Studies have concluded that munitions residues do not impact the marine environment.

Under the No Action Alternative, 27 various missiles will be used annually, resulting in less than 68 lb of explosive residues and solid propellant being released on ocean waters. The large ocean volume of the Study Area would dilute explosive residues and solid propellant to very low concentrations. For this reason, there would be no significant impact to water quality from missile use.

Missile batteries are another source of potential contamination. The batteries used for missiles are similar in type and size to those used for sonobuoys. The evaluation of effects of expended sonobuoys concluded that they do not have a substantial effect on marine water or sediment quality (refer to Subsection 3.3. 3.1.1 and Table 3.3-7).

3.3.3.1.2 Effects on Water Resources

Training activities would not permanently alter surface flows, and would have no adverse effect on surface hydrology or floodplains within the drainage basin. Certain training activities result in minor topographic alterations of beaches, but disturbed areas would be restored to pre-existing conditions at the conclusion of the training exercise. Landing craft can cause temporary, minor alterations in bottom topography at the shoreline. Non-recovery of fired missiles would result in deposition of material on the ocean floor.

Training exercises that use inert or live munitions on ground targets would result in continued alteration of topography in areas where such activities are part of ongoing training activities and may result in the alteration of surface flows. However, the majority of munitions used is inert and may or may not contain only marking charges for indicating location of impact. The types, amounts, and NEW of ordnance used is provided in Chapter 2.

The military training areas on each island have limited natural surface waters, some of which feed rainfall into potable groundwater aquifers. Water quality concerns are associated with prevention of groundwater contamination. The primary areas of concern would be at the Ordnance Annex located near Fena Reservoir, the EMUA and North Field on Tinian adjacent to Hagoi, and the west central slope on FDM (which may encompass Impact Areas 1 and 2). Although surface water impoundments may be absent from training locations such as Northwest Field on Andersen AFB, groundwater contamination can still occur due to the rapid percolation of surface flow into the aquifer. Training activities such as SUW live fire exercises, STW firing munitions onto ground targets, NSW amphibious warfare exercises, MIW, and use of non-explosive ordnance all have potential to entrain hazardous materials as runoff or by infiltration.

Water quality parameters of concern consist of physical characteristics such as temperature, density, stratification, clarity, dissolved gases (e.g., oxygen), and suspended sediments, and concentrations of water pollutants. Military training activities would have no known effects on ocean water temperature, density, stratification, or dissolved gases.

Training involves the use of fuels, engine oil, hydraulic fluids, batteries, flares, and explosives, all of which contain hazardous constituents that may adversely affect water quality. Anti-corrosion coatings typically include cadmium. Anti-fouling paints may contain copper, and batteries may contain lead, cadmium, or mercury. Explosives of less than 1 pound NEW are used during breaching training activities at the Ordnance Annex Breacher House. These hazardous substances may be present in materials leaked or spilled in the water, or in runoff from surfaces flushed with water. They also may leach from surfaces in constant contact with the water.

Petroleum products, including fuel, oil, hydraulic fluids, and lubricants, may be released into bay and ocean waters by Navy vessels and equipment during training activities. The hazardous constituents of concern for petroleum products, such as fuels, engine oil, and hydraulic fluid, are hydrocarbons. The most toxic components of petroleum products are polycyclic aromatic hydrocarbons such as benzene, toluene, xylene, and naphthalene. These chemicals are relatively volatile, and highly water soluble. Used engine oil, fuel additives, and hydraulic fluids also may contain traces of toxic metals such as chromium, cadmium, and nickel. At low concentrations typical of water pollution, these chemicals pose no acute threat to human health.

Because of the number of potential sources and the stresses placed on personnel and equipment in the training environment, small leaks or spills due to equipment failure (e.g., burst hydraulic line) or human error occasionally occur. While most spills are typically less than five gallons, all spills are routinely cleaned up by on-site personnel, using spill control equipment and supplies normally stored on Navy vessels, in military vehicles, and at military facilities. Thus, the residual (i.e., unrecovered) spilled materials left in the water would be a small portion of the quantity originally spilled.

Concentrations of copper and other toxic constituents of marine vessel anti-fouling coatings are of concern for ocean water quality, as are anode materials used in cathodic protection systems. Navy vessels can contribute to the concentration of these constituents in smaller water bodies however; training activities have little or no effect on concentrations of these substances in bay and ocean waters. Smaller Navy vessels and watercraft stored out of the water when not in use have insufficient contact time with the water to be a significant source of contaminants.

As noted in Table 3.3-2, discharges of black water from Navy ships within 3 nm (5 km) of shore are prohibited. Most training activities take place within this zone, so discharges of black water associated with training in the MIRC are expected to be negligible. Discharges of gray water within 3 nm of shore are allowed only if there is no pier-side capability for collecting gray water. Discharges of gray water, however, are not expected to have an adverse effect on inshore water quality.

One possible source of water quality degradation is the solid wastes produced by training participants, both in beach areas and on vessels afloat. The Navy has instituted solid waste management guidelines and procedures for surface ships. The guidelines stipulate minimum distances from shore for discharges of solid wastes. The Navy vessels supporting training activities in the MIRC do not intentionally discharge any solid wastes into the water. Shore-based personnel similarly are required to collect and dispose of solid wastes properly. Because solid wastes are not discharged by Navy vessels during training activities, the amount of solid wastes entering marine waters from training activities would not have an adverse effect on water quality.

Training activities in the MIRC would continue with detonation of small amounts of explosives on the water surface and underwater. Training that involves the detonation of underwater explosives could create craters in the bay bottom sediments depending upon the size of the explosives charge and the depth of the water. Such training events would result in temporary disturbance to the ocean bottom surface and suspension of sediments which may contribute to temporary degradation of water quality. Effects of training activities on soil erosion and sediment transport are addressed in Subchapter 3.1 (Geology, Soils and Bathymetry).

Contaminants from many sources accumulate in bay and ocean bottom sediments over time. Ship movements and amphibious exercises, including some of the logistics training activities, stir up bottom sediments. This activity temporarily increases the concentration of suspended sediments and decreases water clarity in the vicinity of the training exercise. Detonating underwater explosives charges in shallow water also stirs up sediments, with a short-term increase in turbidity in the vicinity of the exercise.

When military training activities disturb bottom sediments, re-suspending them in the water, the contaminants present in the sediments may re-enter the water. Sediments offshore of training locations have above-average loads of organic materials and of some toxic metals. Following completion of training activities, sediments will begin to aggregate and re-settle to the ocean bottom. In addition, training events with potential to stir bottom sediments are spaced over time, allowing sediments to re-settle. For these reasons, the suspension of bottom sediments from training activities would not result in adverse effects on water quality.

3.3.3.2 Alternative 1

Alternative 1 would include all of the training activities under the No Action Alternative with the addition of increased training activities as a result of upgrades and modernization of the existing ranges and training areas and training associated with the Air Force ISR/Strike and other initiatives at Andersen AFB. Under Alternative 1, the number of Navy training events at all training locations would increase. No new construction would be required, although some facilities would be repaired or upgraded.

Surface and subsurface training activities would contribute to temporary sedimentation in ocean and surface waters. Any physical improvements to facilities or infrastructure that includes ground disturbance could result in potential impacts to water quality as a result of small quantities of spills or leaks of hazardous materials that can cause contamination. As required in the Marianas Training Handbook (refer to Subchapter 3.2), hazardous materials, including petroleum, oil and lubricants, will be managed to include secondary containment.

Table 3.3-12 provides a comparison of training materials and associated releases to the marine environment under Alternative 1 to those of the No Action Alternative.

Table 3.3-12: Select Training Materials and Associated Releases to the Marine Environment for the No Action Alternative and Alternative 1

Training Material	No Action Alternative		Alternative 1	
	Number of Units	Amount of Release	Number of Units	Amount of Release
MK-48 Torpedoes	22	-*	42	-*
Sonobuoys	1,574	2.46 tons	1,760	2.75 tons
Chaff	2,092	0.22 tons	5,830	0.61 tons
Flares	2,020	0.86 tons	5,740	2.44 tons
Underwater Explosives	500 lb NEW	0.015 lb	1,400 lb NEW	0.042 lb
Missiles	27	< 68 lb	50	< 125 lb

*information on composition is classified.

Training exercises using inert or live munitions on ground targets would increase over existing conditions. This would result in an increase in alteration of topography, however training would be limited to existing disturbed areas. Impacts on water quality would not differ substantially from those described under the No Action Alternative. The nature of the training activities would not change substantially with the exception of the number of exercises to be conducted at each location. Use of existing training locations and ranges would intensify as a result of the increase in range capability and modernization would include enhanced activities in anti-submarine warfare, mine warfare, MOUT, combined arms warfare, airspace and electronic combat. With the increase in training exercises at each location, specific preventive measures to protect water quality will require evaluation for adequacy and applicability in consideration of the increase in multi-Service personnel that will have joint participation in major exercises.

Impacts on water quality would not differ substantially from those described under the No Action Alternative. With the increase in training exercises, specific preventive measures to protect water quality would continue to be implemented.

3.3.3.3 Alternative 2

Alternative 2 would include all of the training activities under Alternative 1 with the addition of more major exercises. Under Alternative 2, a majority of the training events would increase above the level projected for Alternative 1. The nature of the training activities would not change substantially with the exception of the number of exercises to be conducted at each location.

Table 3.3-13 provides a comparison of training materials and associated releases to the marine environment under Alternative 2 to those of the No Action Alternative.

Table 3.3-13: Select Training Materials and Associated Releases to the Marine Environment for the No Action Alternative and Alternative 2

Training Material	No Action Alternative		Alternative 2	
	Number of Units	Amount of Release	Number of Units	Amount of Release
MK-48 Torpedoes	22	-*	50	-*
Sonobuoys	1,574	2.46 tons	1,951	3.05 tons
Chaff	2,092	0.22 tons	6,528	0.69 tons
Flares	2,020	0.86 tons	6,420	2.73 tons
Underwater Explosives	500 lb NEW	0.015 lb	1,400 lb NEW	0.042 lb
Missiles	27	< 68 lb	54	< 135 lb

*information on composition is classified.

Impacts on water quality would not differ substantially from those described under the No Action Alternative and Alternative 1. With the increase in training exercises, specific preventive measures to protect water quality would continue to be implemented.

3.3.4 Unavoidable Significant Environmental Effects

The proposed training activities in the MIRC would have unavoidable effects on ocean and surface water quality. Trace quantities of hazardous materials and hazardous constituents of training materials would be discharged into these waters, and training activities that re-suspend bottom sediments would reintroduce contaminants contained in these sediments to the water column. Contamination of surface drainage areas from runoff would continue. Contaminant accumulation in waters from leaks or spills of hazardous substances may occur. Siltation and formation of sediment plumes may form in water bodies where training activities occur. While unavoidable, these temporary effects on water quality would not result in adverse effects.

Proposed training activities in the MIRC also would have unavoidable effects on public use of coastal waters. The increased marine and amphibious vessel traffic associated with the Proposed Action would not result in any change to water quality. Training activities would be limited to short-term activities (i.e., several hours). While unavoidable, these temporary effects would not be considered adverse.

3.3.5 Summary of Environmental Effects

Table 3.3-14 summarizes the effects of the No Action Alternative, Alternative 1, and Alternative 2 on water quality. For purposes of analyzing such effects in accordance with NEPA and EO 12114, this table summarizes effects on a jurisdictional basis (*i.e.*, under NEPA for actions or effects within U.S. Territory, and under EO 12114 for actions or effects outside of U.S. Territories).

Table 3.3-14: Summary of Impacts on Water Quality

Alternative	NEPA (Land and US. Territorial Waters, <12 nm)	EO 12114 (Non-U.S. Territorial Waters, >12nm)
No Action Alternative	Releases of munitions constituents from explosives, ordnance, and small arms rounds used during training exercises have no short-term impacts. No long-term degradation of marine, surface, or groundwater quality.	Munitions 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	Munitions constituents (explosives, ordnance, small arms rounds) from training devices and training exercises would have little effect or result in short-term impacts. No long-term degradation of marine, surface, or groundwater quality.	Munitions 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	Munitions constituents (explosives, ordnance, small arms rounds) from training devices and training exercises would have little effect or result in short-term impacts. No long-term degradation of marine, surface, or groundwater quality.	Munitions constituents and other materials (batteries, fuel, and propellant) from training devices would have minimal effect, would be below standard, or would result in localized, short-term impacts. No long-term degradation of marine water quality.

3.4 AIR QUALITY

Air quality in a given location is described by the concentration of various pollutants in the atmosphere, generally expressed in units of parts per million (ppm) or micrograms per cubic meter ($\mu g/m^3$), the size and topography of the air basin, and the prevailing meteorological conditions. The USEPA sets concentration levels for specific pollutants of concern with respect to the health and welfare of the general public. The six major pollutants of concern are carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), suspended particulate matter (PM_{10} and $PM_{2.5}$), and lead (Pb). The USEPA established the National Ambient Air Quality Standards (NAAQS) for these “criteria pollutants.” The NAAQS establishes ambient concentrations of criteria pollutants considered protective of public health and welfare.

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. Primary pollutants, such as CO, SO_2, Pb, and some particulates, are emitted directly into the atmosphere from emission sources. Secondary pollutants such as O_3, NO_2, and some particulates are formed through atmospheric photochemical reactions that are influenced by meteorology, ultraviolet light, and other atmospheric processes.

Wind direction will determine the trajectory, or path, of air pollutants from their source to any receptor. Wind speed and the distance from the source will determine the time it will take air pollutants to travel from source to receptor. At high wind speeds, the air will experience more mechanical turbulence and pollutants released near ground level will disperse more rapidly. However, air pollutants emitted by elevated stack sources may be more rapidly transported to the ground during high wind speeds and can actually lead to higher ground-level pollutant concentrations. At low wind speeds, pollutants emitted from sources near ground level, such as vehicle exhaust, will disperse at a slower rate.

The combination of a strong temperature inversion and light winds may lead to a layer of cold, stagnant air near the ground. Pollutants emitted from sources close to the ground, such as vehicles, are trapped in this layer of air. A persistent temperature inversion over a long period of time may lead to increased concentrations of air pollutants in the lower atmosphere from these sources.

The region of air that extends from the earth's surface to the base of the temperature inversion is referred to as the mixing layer. This layer of air is relatively well mixed due to heating from the sun and from human sources. The depth of the mixing layer defines the volume of air in which air pollutants can be mixed. The lower the depth of the mixing layer, the less volume that is available to disperse air pollutants. A persistent lack of a mixing layer or shallow mixing depth may lead to episodes of high pollution concentrations. The mixing layer is especially important in urban locations where large quantities of pollutants are released near ground level.

In general terms, the air quality of the MIRC is considered very good (designated in attainment of the NAAQS, except for SO_2 around the two power facilities on Guam). As mentioned above, this is reflective of the pollutant concentrations, the size and topography of the MIRC, and the prevailing meteorological conditions. The nearly constant easterly trade winds, which average about 4 to 12 miles (6.4 to 19.3 kilometers [km]) per hour, are dominant throughout the year and prevent the occurrence of inversion layers and the build-up of pollutants.

The proposed project consists of continuing military training activities in the MIRC. The project does not include the construction of new stationary emission sources; however, it includes repair and maintenance of existing training facilities to accommodate increased training events.

3.4.1 Introduction and Methods

3.4.1.1 Regulatory Framework

Federal Laws and Regulations

The USEPA is the federal agency responsible for enforcing the Clean Air Act (CAA) of 1970 and its 1977 and 1990 amendments (42 USC §7401 *et seq*.). The purpose of the CAA is to establish the NAAQS, classify areas as to their attainment status relative to the NAAQS, develop schedules and strategies to meet the NAAQS, and regulate emissions of criteria and toxic air pollutants to protect public health and welfare. Under the CAA, individual states are allowed to adopt ambient air quality standards and other regulations provided they are at least as stringent as federal standards.

The USEPA requires each state to prepare a State Implementation Plan (SIP) that describes how that state will achieve compliance with the NAAQS. A SIP is a compilation of goals, strategies, schedules, and enforcement actions that will lead the state into compliance with all federal air quality standards. The predominant air quality regulations promulgated under the CAA potentially applicable to the proposed action include:

- NAAQS and
- General Conformity Rule.

A New Source Review (NSR) is required when a source has the potential to emit any pollutant regulated under the CAA in amounts equal to or exceeding specified major source thresholds (100 or 250 tons per year) which are predicated on a source's industrial category. A major modification to the source also triggers an NSR. A major modification is a physical change or change in the method of operation at an existing major source that causes a significant "net emissions increase" at that source of any pollutant regulated under the CAA. Any new or modified stationary emission sources require permits from the Air Pollution Control District (APCD) to construct and operate. Through the APCD's permitting process, all stationary sources are reviewed and are subject to an NSR process. The NSR process ensures that factors such as the availability of emission offsets and their ability to reduce emissions are addressed and conform with the SIP.

The NEPA process ensures that environmental impacts of proposed major federal actions are considered in the decision-making process. EO 12114 requires environmental consideration (i.e., preparation of an OEA) for actions that may significantly harm the environment of the global commons (i.e., environment outside U.S. Territorial Waters).

EO 12088, Federal Compliance with Pollution Control Standards, requires the head of each federal agency to comply with "applicable pollution control standards" defined as "the same substantive, procedural, and other requirements that would apply to a private person." The EO further requires federal agencies to cooperate with the USEPA, state, and local environmental regulatory officials. To ensure their cost-effective and timely compliance with applicable pollution control standards, the USEPA Administrator is required to provide technical advice and assistance to executive agencies. EO 12088 also provides that disputes between the USEPA and other federal agencies, regarding environmental violations, shall be elevated to the Office of Management and Budget for resolution. EO 12088 was revoked in part, Section 1-4 Pollution Control Plan, by EO 13148.

EO 13148, Greening the Government Through Leadership in Environmental Management, was issued to ensure that all necessary actions are taken to integrate environmental accountability in agency day-to-day decision making and long-term planning processes across all agency missions, activities, and functions. Pollution prevention is highlighted as a key aspect to the environmental management system process. The head of each federal agency is responsible for ensuring that all necessary actions are taken to integrate environmental accountability into agency day-to-day decision making and long-term planning processes, across all agency missions, activities, and functions. Consequently, environmental management considerations must be a fundamental and integral component of federal government policies, training, planning, and management. The head of each federal agency is responsible for meeting the goals and requirements of this order. Examples of environmental requirements include air, water, wastewater, or hazardous waste permits.

The Navy, in fulfilling the requirements of EO 12088 and 13148, has developed Chief of Naval Operations Instruction (OPNAVINST) 5090.1C, which contains guidance for environmental evaluation. Chapter 5 of the CAA and Appendix F of 5090.1C contain guidance for air quality analysis and general conformity determinations.

NAAQS

The CAA requires the USEPA to set NAAQS (40 CFR Part 50) for pollutants considered harmful to public health and the environment (Table 3.4-1). The CAA established two types of national air quality standards (primary and secondary). Primary standards set limits to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

As previously mentioned, the USEPA set NAAQS for six pollutants ("criteria pollutants"). Areas within a particular state that do not meet the NAAQS for a criteria pollutant are designated as being in "nonattainment" for that pollutant. Nonattainment status is further defined by the extent to which the standard is exceeded. O_3 nonattainment status is categorized by six classifications: traditional, marginal, moderate, serious, severe, and extreme; CO and PM_{10} nonattainment status is categorized by two classifications: moderate and serious. The remaining criteria pollutants have designations of either "attainment," "nonattainment," or "unclassifiable." Areas that achieve the air quality standard after being designated in nonattainment are redesignated as in attainment following USEPA approval of a maintenance plan. These areas are commonly known as "maintenance areas," signifying that they are attainment areas with a maintenance plan approved by USEPA. The maintenance plan must include emissions budgets demonstrating measures to be taken to ensure the area continues to meet the NAAQS.

General Conformity Rule

The USEPA rule implementing the conformity requirements, "Determining Conformity of General Federal Actions to State or Federal Implementation Plans," was published on 30 November 1993 at 58 FR 63214 and codified at 40 CFR Parts 51 and 93. 40 CFR Part 51, Subpart W, contains the General Conformity Rule provisions that must be incorporated into SIPs, including the requirement that states revise the SIPs to include the conformity requirements. Once a SIP has been revised and approved by USEPA, the conformity requirements become federally enforceable and federal agencies are subject to the conformity requirements as they appear in the SIP. In cases where a Federal Implementation Plan (FIP) is in effect, federal actions must conform to the requirements of the FIP (DoN 2007). Each federal agency taking an action subject to the General Conformity Rule must make its own conformity determination (40 CFR 93.154).

A Conformity Review must be completed for every Navy action that generates air emissions. The action proponent is responsible for the documentation. The Conformity Review can be satisfied by (1) a determination that the action is not subject to the General Conformity Rule, (2) a Record of Non-Applicability, or (3) a Conformity Determination (DoN 2007).

Table 3.4-1: National Ambient Air Quality Standards

Pollutant	Primary Standards	Averaging Times	Secondary Standards
Carbon Monoxide	9 ppm (10 μg/m^3)	8-hour[1]	None
	35 ppm (40 μg/m^3)	1-hour[1]	None
Lead	1.5 μg/m^3	Quarterly Average	Same as Primary
Nitrogen Dioxide	0.053 ppm (100 μg/m^3)	Annual (Arithmetic Mean)	Same as Primary
Particulate Matter (PM_{10})	150 μg/m^3	24-hour[2]	Same as Primary
Particulate Matter ($PM_{2.5}$)	15.0 μg/m^3	Annual[3] (Arithmetic Mean)	Same as Primary
	35 μg/m^3	24-hour[4]	Same as Primary
Ozone	0.075 ppm (2008 std)	8-hour[5]	Same as Primary
	0.08 ppm (1997 std)	8-hour[6]	Same as Primary
	0.12 ppm	1-hour[7] (Applies only in limited areas)	Same as Primary
Sulfur Oxides	0.03 ppm	Annual (Arithmetic Mean)	0.5 ppm (1,300 μg/m^3) 3-hour[1]
	0.14 ppm	24-hour[1]	

Source: http://epa.gov/air/criteria.html

Notes:

1. Not to be exceeded more than once per year.
2. Not to be exceeded more than once per year on average over 3 years.
3. To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0μg/m^3.
4. To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35μg/m^3 (effective December 17, 2006).
5. To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average O_3 concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm (effective May 27, 2008).
6. (a) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average O_3 concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
   (b) The 1997 standard – and the implementation rules for that standard – will remain in place for implementation purposes as EPA undertakes rulemaking to address the transition from the 1997 O_3 standard to the 2008 O_3 standard.
7. (a) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is ≤1.
   (b) As of June 15, 2005, USEPA revoked the 1-hour O_3 standard in all areas, except the 8-hour O_3 nonattainment Early Action Compact (EAC) Areas.

The action proponent may make a determination that the proposed action is not subject to the General Conformity Rule. Actions not subject to the rule are actions that occur in attainment areas, and that do not generate emissions in nonattainment areas, or actions where the criteria pollutant emitted (or its precursors) is one for which the area is in attainment. If NEPA documentation is prepared for the action, the determination shall be described in that documentation; otherwise, no documentation is required (OPNAVINST 5090.1C [2007]). This EIS/OEIS includes the determination that all actions occurring in the attainment areas are not subject to the General Conformity Rule.

Territory and Commonwealth Laws and Regulations

Guam has an approved SIP which was developed to allow the Territory to achieve attainment of the NAAQS for sulfur oxides in an area where the standard is exceeded (area where power production facilities [Tanguisson and Piti power plants] burning high sulfur content fuel oil are located). In lieu of the USEPA's Title V operating permit program, Guam has an approved alternate operating permit program (40 CFR Part 69, Subpart A – Guam).

The USEPA's Region 9 Air Division manages, implements, and enforces programs covering indoor and outdoor air quality, radiation, control of air pollution from stationary and mobile sources, stratospheric O_3 protection, and other air quality related programs for the Pacific Southwest. Region 9 also has an active and direct role over islands west and south of Hawaii, including the U.S. territories of Guam and American Samoa, the CNMI, and other unincorporated U.S. Pacific possessions.

The Air and Land Programs Division of the GEPA administers the air pollution control program in Guam by implementing and enforcing Guam's Air Pollution Control Standards and Regulations. The Air Pollution Control Act of Guam or Public Law 10-74 was promulgated and codified under Chapter 49, Title 10 of the Guam Code Annotated (GCA) to support requirements of the CAA.

The CNMI DEQ is the primary environmental regulatory agency in the Commonwealth. It is responsible for developing, implementing, and enforcing programs and regulations designed to protect human health and the environment. The CNMI DEQ's air pollution control regulations can be found in the Federal Register (FR) (52 FR 43574).

Regional Air Quality

The fundamental method by which the USEPA tracks compliance with the NAAQS is the designation of a particular region as "attainment" or "nonattainment." Based on the NAAQS, each state is divided into three types of areas for each of the criteria pollutants. The areas are:

- Those areas in compliance with the NAAQS (attainment);
- Those areas that do not meet the ambient air quality standards (nonattainment); and
- Those areas where a determination of attainment/nonattainment cannot be made due to a lack of monitoring data (unclassifiable – treated as attainment until proven otherwise).

Generally, areas in violation of one or more of the NAAQS are designated nonattainment and must comply with stringent restrictions until all standards are met. In the case of O_3, CO, and PM_{10}, the USEPA divides nonattainment areas into different categories, depending on the severity of the problem in each area. Each nonattainment category has a separate deadline for attainment and a different set of control requirements under the SIP.

The GEPA is responsible for air quality within Guam Air Quality Control Region (AQCR) 246. The USEPA designated the entire island of Guam to be in attainment or unclassified for all criteria pollutants, except for SO_2 within a 3.5-kilometer radius of the Tanguisson and Piti power plants (40 CFR 81.353). The SO_2 nonattainment area is shown on Figure 3.4-1. All training areas are in attainment areas, with the exception of the Piti Floating Mine Neutralization Area, Reserve Craft Beach, Polaris Point Field, and the firing ranges at the Finegayan Communications Annex. Under either proposed action alternatives, increased training activities within the MIRC would result in minor, short-term effects, such as minor increases of aircraft air emissions within the airsheds, but would have no unavoidable significant environmental effects.

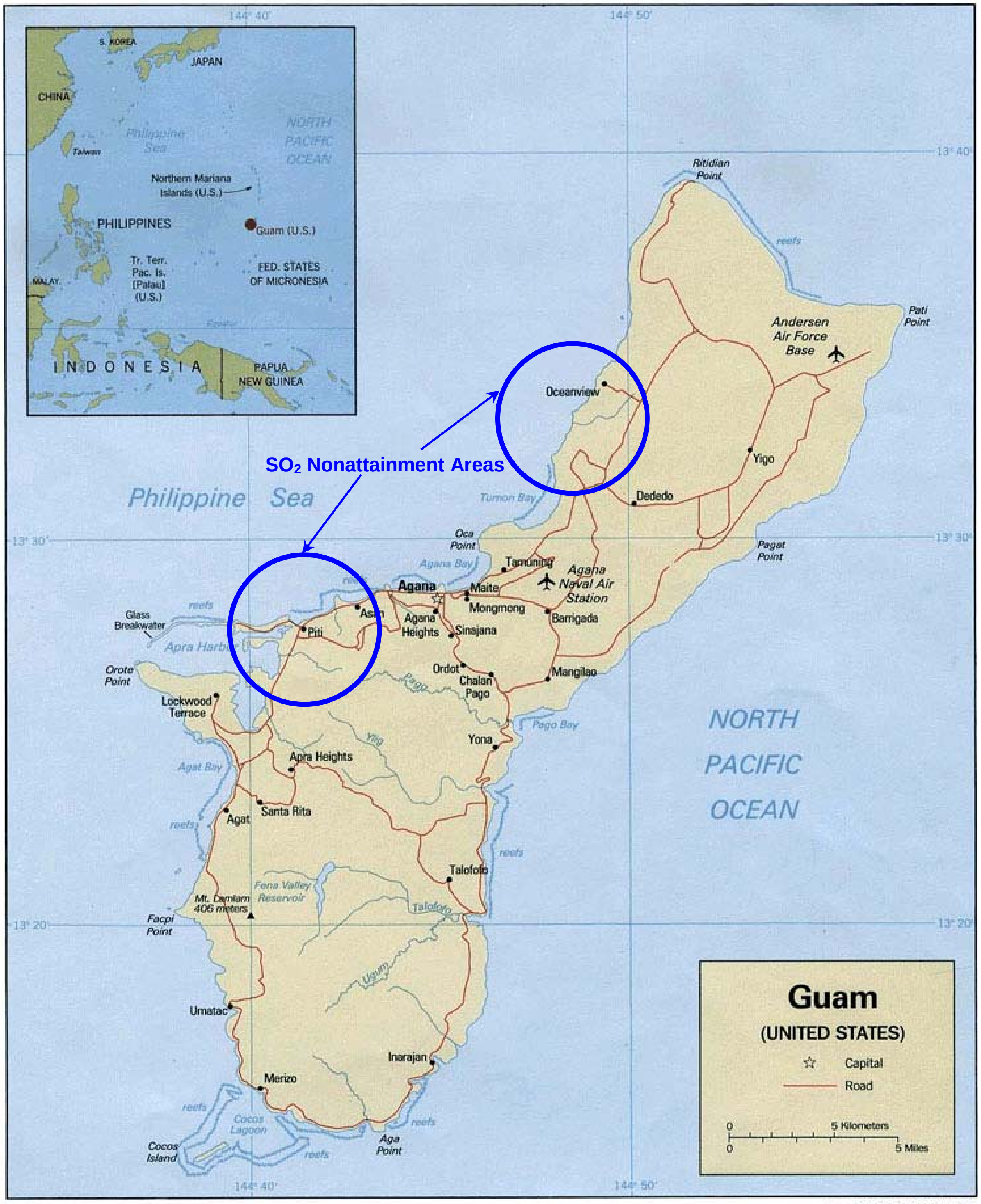

Figure 3.4-1: Guam SO_2 Nonattainment Areas

Air quality data and an island-wide emissions inventory are not readily available. The USEPA has not received any emissions data from GEPA (Biland, personal communication; Dombrowski, personal communication). The only emissions inventory information for Guam available from the Internet is from 1973, developed in support of Guam's original submittal to the USEPA for a SIP.

The CNMI DEQ is responsible for air quality within the CNMI. Air quality is not monitored in the CNMI, except for SO_2 related to volcanic activity from Anatahan, which is monitored by the CNMI Emergency Management Office (Bearden, personal communication). The USEPA designated the Northern Mariana Islands to be in attainment or unclassified for all criteria pollutants (40 CFR 81.354). Because the CNMI is in attainment of the NAAQS, a SIP is not required. Except for power generating facilities (e.g., large power plants, hotel generators), there are no significant sources of air emissions within the CNMI (Castro, personal communication).

3.4.1.2 Warfare Areas and Associated Environmental Stressors

The warfare training areas associated with training in the MIRC are listed in Table 3.4-2. For each warfare training area, emission sources (environmental stressors) are listed. These sources/stressors are associated with either the training platform, the weapon system utilized during the exercise, or the target or support craft. Emissions occurring or that would occur above 3,000 ft (914 m) are considered to be above the atmospheric inversion layer and are considered to have no impact on the local air quality (USEPA 1992).

In general, helicopter and small boat exercises take place closer to the shore, whereas fixed wing aircraft and large ship exercises take place at a great distance from shore. This is important from an air quality perspective because it helps to understand which exercise emission sources would contribute to the overall air quality for human receptors. When emissions occur near shore or over land, they can mix with the air breathed by human receptors. Table 3.4-2 summarizes the emissions sources associated with each exercise.

The number of training events, the types of training platforms, the magnitude of each training event, and the training location under each alternative were compared to those under the no action alternative as a basis for analyzing impacts to air quality. With the exception of emissions from ships and aircraft participating in major training exercises and emissions associated with the Air Force ISR/Strike initiative (which, together, generate a significant amount of emissions from proposed training activities within the MIRC), a qualitative analysis is provided for other training emission sources in lieu of a quantitative analysis because of the high variability in the number of training events per year, the unpredictability of the types and training events each year (due to varying contingency response requirements of the Services), the number of participants, weapon platforms and support equipment for each training event. In addition, information related to military vehicle use (types and numbers, fuel use, vehicle miles travelled, etc.), small boat use (types and numbers, distances travelled, fuel consumption, etc.), or auxiliary equipment use (types and numbers, fuel consumption, duration of use, etc.) varies greatly depending upon the training scenarios needed for each event, and are not readily available. However, in assessing increases in air emissions, it was assumed that each training event type is relatively uniform. Slight increases in emissions are indicated for training events that occur in open ocean, as well as for increased training events that originally are low in numbers and remain relatively low (e.g., one or two events increasing to two or four events). Increased emissions are indicated for training events that increase by more than 200 percent and the training events that involve land-based events and equipment such as trucks and light wheeled vehicles.

Table 3.4-2: MIRC Training Areas and Associated Air Quality Environmental Stressors

Training Area	Training Exercise	Number of Exercises			Potential Emission Sources	Potential Impacts to Air Quality	
		No Action	Alt 1	Alt 2		Alt 1	Alt 2
W-517	GUNEX (S-S) (Boat); GUNEX (A-S); Chaff Exercise	32	42	46	Ships, small water craft, and helicopters.	Slight increase in emissions.	Slight increase in emissions.
R-7201 (FDM)	Hydrographic Surveys; Direct Action; BOMBEX (Land); MISSILEX (A-G); FIREX (Land)	520	2,500	2,500	Aircraft and ships.	Increased emissions.	Increased emissions.
Agat Bay; Piti Mine Neutralization Area	Mine Neutralization Area	20	32	48	Combat rubber raiding craft.	Slight increase in emissions.	Increased emissions.
Tipalao Cove	Hydrographic Surveys	1	1	1	Landing Craft Air Cushion and Amphibious Assault Vehicle.	Same as No Action.	Same as No Action.
SINKEX East	SINKEX	1	2	2	Ships.	Slight increase in emissions.	Slight increase in emissions.
SINKEX South	SINKEX	1	2	2	Ships.	Slight increase in emissions.	Slight increase in emissions.
TORPEX Guam	TORPEX	3	10	20	Ships, helicopters, and sea-control aircraft.	Slight increase in emissions.	Slight increase in emissions.
MIRC Study Area	ASW Tracking Exercise	9	18	30	Ships and aircraft.	Slight increase in emissions.	Slight increase in emissions.

Table 3.4-2: MIRC Training Areas and Associated Air Quality Environmental Stressors (continued)

Training Area	Training Exercise	Number of Exercises			Potential Emission Sources	Potential Impacts to Air Quality	
		No Action	Alt 1	Alt 2		Alt 1	Alt 2
Outer Apra Harbor	Insertion/Extraction; Underwater Demolitions; VBSS	47	51	63	Ships and aircraft.	Slight increase in emissions.	Slight increase in emissions.
Inner Apra Harbor	Insertion/Extraction; Mine Neutralization; Land Demolitions; Embassy Reinforcement; Anti-Terrorism	24	30	30	Ships, small water craft, aircraft, trucks, and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
Kilo Wharf	Embassy Reinforcement	1	2	2	Vehicles.	Slight increase in emissions.	Slight increase in emissions.
GAB GAB Beach	Land Demolitions; Direct Action	4	12	12	Trucks and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
Sumay Channel/Cove	Amphibious Landings	2	4	4	Small water craft.	Slight increase in emissions.	Slight increase in emissions.
Reserve Craft Beach	Insertion/Extraction; Land Demolitions; Expeditionary Raid; Embassy Reinforcement	8	12	12	Ships, small water craft, aircraft, trucks, and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
Polaris Point Site III	Anti-Terrorism	1	2	2	Trucks and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.

Table 3.4-2: MIRC Training Areas and Associated Air Quality Environmental Stressors (continued)

Training Area	Training Exercise	Number of Exercises			Potential Emission Sources	Potential Impacts to Air Quality	
		No Action	Alt 1	Alt 2		Alt 1	Alt 2
Polaris Point Field	FTX; Parachute Insertion; Assault Support; Insertion/Extraction; Land Demolitions	28	34	34	Ships, small water craft, aircraft, trucks, and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
Orote Point Airfield/Runway	FTX; NSW OPS; Parachute Insertion; Insertion/Extraction; Land Demolitions; Mission Area Training; Embassy Reinforcement	60	72	72	Aircraft, trucks, and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
Orote Pt. CQC Facility	Insertion/Extraction; Breaching; Land Demolitions; MOUT; Direct Action; Embassy Reinforcement	55	66	66	Aircraft, trucks, and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
Orote Pt. Small Arms Range	Marksmanship	215	261	261	Trucks and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
Orote Pt. Known Distance Range	Insertion/Extraction; Assault Support; Marksmanship	247	261	261	Trucks and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.

Table 3.4-2: MIRC Training Areas and Associated Air Quality Environmental Stressors (continued)

Training Area	Training Exercise	Number of Exercises			Potential Emission Sources	Potential Impacts to Air Quality	
		No Action	Alt 1	Alt 2		Alt 1	Alt 2
Orote Pt. Triple Spot	Parachute Insertion; Insertion/Extraction; Embassy Reinforcement	18	24	24	Aircraft, trucks, and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
Ordnance Annex Breacher House	Parachute Insertion; MOUT; Insertion/Extraction; Breaching; Land Demolitions; Anti-Terrorism	20	24	24	Aircraft, trucks, and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
Ordnance Annex Emergency Detonation Site	Land Demolitions; Anti-Terrorism	85	100	100	Aircraft, trucks, and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
Northern Land Navigation Area	FTX; Operational Maneuver; Direct Action; Land Demolitions; Embassy Reinforcement	19	24	24	Trucks and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
Southern Land Navigation Area	Operational Maneuver; Land Demolitions; Embassy Reinforcement	14	18	18	Trucks and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.

Table 3.4-2: MIRC Training Areas and Associated Air Quality Environmental Stressors (continued)

Training Area	Training Exercise	Number of Exercises			Potential Emission Sources	Potential Impacts to Air Quality	
		No Action	Alt 1	Alt 2		Alt 1	Alt 2
Finegayan Communications Annex	Marksmanship	130	261	261	Trucks and light-wheeled vehicles.	Increased emissions.	Increased emissions.
	ISR	2	4	4	Trucks and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
	Insertion/ Extraction	2	4	4	Aircraft, trucks, and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
Barrigada Communications Annex	ISR; MOUT; Land Demolitions; Direct Action	31	38	38	Trucks and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
Tinian Exclusive Military Use Area	ISR; FTX; STOM; NEO; Assault Support; Hydrographic Surveys; CSAR	30	40	80	Ships, small water craft, aircraft, trucks, and light-wheeled vehicles.	Slight increase in emissions.	Increased emissions.
Tinian Lease Back Area	ISR	1	2	4	Aircraft, trucks, and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
Saipan; Rota	AT/FP, NSW, MOUT	2	4	4	Ships, small water craft, aircraft, trucks, and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
Andersen AFB/Northwest Field	FTX; Anti-Terrorism; Seize Airfield; Airlift; Air Expeditionary; Force Protection	177	300	300	Aircraft, trucks, and light-wheeled vehicles.	Increased emissions.	Increased emissions.
Andersen South	FTX; MOUT	38	84	84	Trucks and light-wheeled vehicles.	Increased emissions.	Increased emissions.
Andersen AFB/Pati Pt. CATM Range (Tarague Beach)	Direct Live-Fire; Anti-Terrorism	120	322	322	Trucks and light-wheeled vehicles.	Increased emissions.	Increased emissions.
ATCAA 1/2	Chaff Exercise	49	160	160	Aircraft.	Increased emissions.	Increased emissions.

Table 3.4-2: MIRC Training Areas and Associated Air Quality Environmental Stressors (continued)

Training Area	Training Exercise	Number of Exercises			Potential Emission Sources	Potential Impacts to Air Quality	
		No Action	Alt 1	Alt 2		Alt 1	Alt 2
ATCAA 1/2/3/5	MISSILEX (A-A)	34	150	150	Aircraft.	Increased emissions.	Increased emissions.
ATCAA 3	BOMBEX (Land)	514	2,500	2,500	Aircraft.	Increased emissions.	Increased emissions.
Multiple Strike Group Exercises (Primarily Offshore; annual event, but may include nearshore, Guam, FDM, and CNMI) and Amphibious Assault Group Exercise – No Action would be one of the two exercises. Alt 1 and Alt 2 consist of one Multiple Strike Group Exercise, and on Amphibious Assault Exercise	Joint Exercise/USPACOM	1	2	2	Ships, small water craft, aircraft, trucks, and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
Expeditionary Warfare Exercise (Offshore/Nearshore/ Tinian/Guam/Saipan/Rota/FDM)	USMC-Navy STOM/USMC-Navy	1	2	2	Ships, small water craft, aircraft, trucks, and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.
Urban Warfare Exercise (Sustainment) (Primarily on Guam; semi-annually, 3-4 weeks per event; may include STOM and Tinian/Saipan/Rota)	USMC Urban Ops/USMC	2	3	3	Ships, small water craft, aircraft, trucks, and light-wheeled vehicles.	Slight increase in emissions.	Slight increase in emissions.

Locations of training events are based on baseline training locations. Training events associated with Alternative 1 and Alternative 2 are proposed to occur in the same locations as the baseline, unless otherwise noted. Locations of training events are the locations where the actual events would occur. Transits to and from port or airfield are not considered part of the event.

3.4.2 Affected Environment

Section 2.1 describes the location of the MIRC and Mariana Islands Study Area and Section 2.3 provides details related to current training activities. The affected environment for purposes of air quality includes:

- Warning Area W-517 and Restricted Airspace R-7201 (FDM);
- Guam Offshore;
- Guam Commercial Harbor;
- Apra Naval Harbor Complex;
- Ordnance Annex;
- Communication Annexes;
- Tinian;
- Saipan and Rota;
- Andersen AFB;
- FAA Assigned Airspace; and,
- Multiple Locations (during major exercises) including all or some of the above and seaspace/undersea space beyond 12 nm (22.2 km) of Guam and the CNMI.

Table 3.4-2 indicates that the majority of emission sources are from mobile sources, particularly surface ships and aircraft associated with training platforms. Minor sources of emissions include military vehicles and ordnance use. These emissions are generated on an intermittent basis and only when training exercises are ongoing.

3.4.2.1 Surface Ship Training Activities

Marine vessel traffic in the MIRC is composed of military ship and boat traffic, including support vessels providing services for military training exercises. Commercial vessels are regularly present within the MIRC at the commercial ports of Guam and the CNMI and are a significant portion of the marine vessel traffic in the area that contribute to air emissions. On Guam, these marine vessels consist of container ships, break bulk vessels, barges, and fishing vessels which totaled to 1,196 ship calls in 2006 (Parsons Brinkerhoff 2008). These vessels were not evaluated in the air quality analysis as they are not part of the proposed action.

Because no time is spent by surface ships within a nonattainment AQCR, it was not necessary to investigate in detail, the time spent within particular locations, at what power level, or the path taken by the boat or ship within the MIRC. Training includes the use of small boats to transit through U.S. Territorial Waters to training areas located between 3 nm (5.6 km) and 12 nm (22.2 km) from shore. Small harbor boats also produce minor amounts of outboard motor emissions in transit to training areas located 3 nm (5.6 km) to 12 nm (22.2 km) offshore. Larger ships also transit through U.S. Territorial Waters on their way to training areas located beyond 12 nm (22.2 km) from shore. Only minor boat engine emissions are involved in these training transits in relation to the emissions from commercial boat traffic entering and leaving the Guam Commercial Harbor. Other surface craft emissions can come from support craft used in training events or small powered target craft. Support craft may be used for target setup or retrieval or aerial drone recovery.

Estimates of surface ship emissions from major exercises for the three alternatives (based on duration of the exercise and numbers and types of participating vessels as detailed in Table 2-6) are presented in Table 3.4-3. It should be noted that although the emissions are significant, they occur in areas beyond

U.S. Territorial Waters and would have little to no effect onshore. These estimates are provided to support the conclusions for potential impacts to air quality as presented in Table 3.4-2.

Table 3.4-3: Air Emissions Associated with Surface Ships During Major Exercises

Source (Number of Vessels*)	Criteria Pollutant, tons per year				
	CO	VOC	NO_X	SO_X	PM_{10}
No Action Alternative - Joint Multi-Strike Group Exercise (35)	182.7	19.5	129.9	141.6	26.9
Alternative 1 (87)	306.3	47.6	336.7	635.8	125.2
Alternative 2 (108)	362.9	53.2	375.0	662.5	132.2

*Includes Navy ships, submarines and participating foreign ships

3.4.2.2 Aircraft Emissions

Evaluating aircraft emissions involves evaluating the type of training 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 during training. Aircraft emit the following NAAQS criteria pollutants: Volatile Organic Compounds (VOCs), NO_x, CO, SO_2 and $PM_{10.}$ Emissions occurring above 3,000 ft (914 m) AGL need not be addressed in accordance with USEPA guidance (USEPA 1992). Aircraft flights, for the most part originate from an onshore air station (e.g., Andersen AFB), but some are from aircraft carriers offshore. It was assumed that all fixed wing aircraft would be traveling from Andersen AFB or an aircraft carrier to the ATCAAs and R-7201 at elevations above 3,000 ft (914 m), and that transit to and from the airspaces would not affect local air quality. With the exception of HC-25 helicopters, the majority of aircraft emissions in the airspaces occur above 3,000 ft (914 m). Training activities involving helicopters will occur in the attainment and unclassified areas of the MIRC.

Aircraft operating in the MIRC generally have reciprocating, turboprop, or jet engines. Most of these aircraft use JP-5 or JP-8 as a standard fuel. Emissions of concern are primarily hydrocarbons that disperse readily in the atmosphere. A portion of those emissions may be VOCs, which are associated with the generation of ground level O_3.

The U.S. Air Force is in the process of establishing ISR/Strike capability at Andersen AFB. The ISR/Strike training at FDM is included as part of Alternative 1 and Alternative 2 for this EIS. . ISR/Strike includes the use of 48 fighter aircraft, 12 KC-135s, six bombers, and four Global Hawk UAVs which were assessed in the Final EIS for Establishment and Operation of an Intelligence, Surveillance, Reconnaissance, and Strike Capability, Andersen Air Force Base, Guam (USAF, 2006). . Recurring emissions associated with the ISR/Strike mission are presented in Table 3.4-4. Emissions are generated from the operation of aircraft during training runs, use of aerospace ground equipment (AGE) and privately owned vehicles (POVs) (by ISR/Strike Air Force personnel), and aircraft maintenance at Andersen AFB facilities.

Table 3.4-4: Recurring Air Emissions Associated with the ISR/Strike Initiative

Source	Criteria Pollutant, tons per year				
	CO	VOC	NO_X	SO_X	PM_{10}
Aircraft	31.0	7.8	14.8	2.5	4.4
AGE	1.2	0.4	4.3	0.5	0.3
POV	56.6	4.1	6.5	0.7	40.7
Fuel Cell Maintenance	0.0	0.3	0.0	0.0	0.0
Corrosion Control	0	0.4	0.0	0.0	0.3
TOTAL	88.8	13.0	25.6	3.7	45.7

Source: USAF, 2006.

ISR/Strike annual aircraft emissions are associated with 38, 868 annual airfield operations or 162.2 daily airfield operations or 5,116 annual sorties for a total annual flying time of 20,242 hours (Note: an airfield operation is the single movement or individual portion of a flight in the airfield airspace environment, such as one departure (takeoff), one arrival (landing), or one transit through the airport traffic area. The airfield airspace environment is typically referred to as airspace allocated to the air traffic control tower and includes the airspace within an approximate five-mile radius of the airfield and up to 2,500 feet AGL. A low approach or a missed approach consists of two airfield operations, i.e., one arrival and one departure. A closed pattern consists of two airfield operations (i.e., one takeoff and one landing accomplished as one touch and go). The minimum number of airfield operations for one sortie is two operations, one takeoff (departure) and one landing (arrival) (USAF 2006).

For the most part, aircraft training activities proposed for the MIRC outside of ISR/Strike are attributable to major exercises (listed in Table 2-6). Assuming an average of one sortie per aircraft per training day, annual aircraft emissions from non-ISR/Strike training activities presented in Table 3.4-5 are estimated using total sorties as the proportioning factor. Actual ground level emissions may even be less than estimated as most of these aircraft training runs originate and terminate on aircraft carriers that are deployed in the open ocean beyond 12 nm (22.2 km) of shore.

Table 3.4-5: Aircraft Emissions Associated with Major Exercises

Source (Total Sorties)	Criteria Pollutant, tons per year				
	CO	VOC	NO_X	SO_X	PM_{10}
ISR/Strike Aircraft (5,116 sorties)	31.0	7.8	14.8	2.5	4.4
No Action Alternative (Joint Multi-Strike Group Exercise, 2,618 sorties)	15.9	4.0	7.6	1.3	2.3
Alternative 1 (6,630 sorties)	40.2	10.1	19.2	3.2	5.7
Alternative 2 (7,086 sorties)	42.9	10.8	20.5	3.5	6.1

3.4.2.3 Emissions from Weapons and Explosives

Other common chemical emissions associated with Navy training are explosive compounds and oxidation products from ordnance use. The majority of air emissions from ordnance use consist of oxides of carbon (carbon dioxide [CO_2], CO), nitrogen and water, thus reducing the likelihood of parent chemicals (trinitrotoluene [TNT] and cyclonite [RDX]) entering surrounding environments. Other nitroaromatic compounds such as octogen (HMX), tetryl, and picric acid (used in fuzes and primers) produce the same oxidation reactions. Practice ordnance does not carry an explosive charge; it carries only a smoke or marking charge, and thus, the incidence of emission particles is negligible. The detonation of the marking charge consumes approximately 98 to 99 percent of the explosive filler. The one to two percent of the marking charge not consumed is generally dispersed, with most falling to the water in the immediate vicinity of the blast and the balance being dispersed in the air subject to wind currents and weather conditions. Similarly, 98 to 99 percent of the explosive material in live ordnance is consumed, with the remaining one to two percent falling into the water or dispersed in air.

Much of the smoke and fumes given off by pyrotechnics and screening devices are considered nontoxic and only mildly irritating to the eyes and nasal passages when encountered in relatively light concentrations out-of-doors. Heavy concentrations in closely confined spaces, however, are dangerous and may be lethal because they reduce the amount of oxygen in the air. Because smoke floats and flares are used infrequently, out-of-doors, and at great distances from land, associated air emissions would be considered non-toxic to residents in the MIRC.

Underwater detonations are conducted at Agat Bay and at Apra Harbor. Underwater detonations associated with Explosive Ordnance Disposal (EOD) Mine Neutralization training utilize less than 5 lbs NEW of C4 or 10 to 20 lbs NEW of trinitrotoluene (TNT). C4 consists of RDX plus a small amount of polyisobutylene binder. The principal explosive byproducts of C4 are water, CO_2, CO, nitrogen, and hydrogen; those of TNT are CO_2, water, nitrogen and a small amount of carbon particulates from incomplete combustion. Like other underwater explosions, a cavity filled with high-pressure gas is created, which pushes the water out radially against the opposing external hydrostatic pressure. At the instant of explosion, a certain amount of gas is instantaneously generated at high pressure and temperature, creating a bubble. In addition, the heat causes a certain amount of water to vaporize, adding to the volume of the bubble. This action immediately begins to force the water in contact with the blast front in an outward direction. It is estimated that 90 percent of the gaseous explosion products would become airborne (DoN 2001). Airborne explosion products are assumed to stabilize in a spherical form and move downwind, with concentrations remaining for the first 100 ft (30 m). This "cloud" would not be visible. Then, the airborne cloud would continue to move at the speed of the wind and become diluted and dispersed by atmospheric turbulence (DoN 2001). The underwater detonation explosive byproducts consisting of CO_2, CO, carbon particles, nitrogen, hydrogen and water will have no effect on regional air quality.

The air quality impacts of chaff were evaluated by the U.S. Air Force in "Environmental Effects of Self-Protection Chaff and Flares" (USAF 1997). The study concluded that most chaff fibers maintain their integrity after ejection. Although some fibers are likely to fracture during ejection, this does not result in the release of particulate matter.

Although not significant, tests indicated that the explosive charge in the impulse cartridge results in minimal releases of particulate matter. Therefore, chaff deployment would not result in an exceedance of the NAAQS. Chaff exercises in the MIRC are conducted relatively infrequently, and are always conducted beyond 12 nm (22.2 km) from shore.

3.4.2.4 FDM Range

Aircraft training in the airspace above FDM use JP-5 as a standard fuel. Emissions of concern are primarily hydrocarbons that disperse readily in the atmosphere. A portion of those emissions may be VOCs, which are associated with the generation of ground level O_3. However, the volume of aircraft training events in the over land SUA is relatively small and adjacent areas are in attainment for O_3 levels. Therefore, emissions related to aircraft activities at FDM are not anticipated to have a negative impact on the Study Area environment.

Another potential stressor to air quality from bombing training events at FDM would be from the release of bomb constituents or releases of pollutants from bombing targets. Ordnance greater than 2,000 lbs is not permitted at FDM. Inert bombs used at the range contain a small spotting charge attached to the bomb. The spotting charge is a small smoke charge activated by a mechanical fuze when the bomb hits the ground to readily see where the bomb hits the target for scoring purposes. Detonation of the spotting charge consumes approximately 98 to 99 percent of the explosive filler. The 1 or 2 percent of explosive filler not consumed is generally dispersed, with most falling to the soil in the immediate vicinity of the impact and the balance being dispersed in the air subject to wind currents and weather conditions.

Ordnance dropped at FDM results in short-term emissions of particulate matter in the form of organics, dust, and sand. Depending on the size and mass of the particulate matter and local wind conditions, it either settles out in the immediate vicinity or may be carried an unknown distance.

3.4.3 Environmental Consequences

The method used in this EIS/OEIS to assess the air quality impacts associated with existing and proposed Navy training and testing within the MIRC include following the steps:

- Analyze existing federal and state air quality regulations applicable to the proposed action. Determine applicability of the General Conformity Rule;
- Analyze existing air quality in the range complex;
- Analyze the types of emission sources associated with training and testing within the MIRC;

- Determine overall air quality impacts associated with existing training within the range complex given the regulatory framework; and
- Determine overall air quality impacts associated with the proposed increases in training within the range complex given the regulatory framework.

Because military training activities are intermittent events (and not continuous area or point emission sources), air quality modeling and air monitoring are not recommended.

Evaluation of potential air quality impacts includes two separate analyses. Effects of air pollutant emissions from MIRC training activities occurring within the U.S. Territory (within 12 nm [22.2 km] of the coastline) are assessed under NEPA. Effects of air pollutant emissions from MIRC training activities occurring outside the U.S. Territory are assessed under EO 12114.

For the purposes of assessing air quality effects under NEPA, all training activities involving the use of aircraft and vessels at or below 3,000 ft (914 m) in areas within U.S. Territorial Waters or overland were included in the assessment. For the purposes of assessing air quality effects under EO 12114, only those training events involving aircraft, vessels, and missiles/targets occurring at or below 3,000 ft (914 m) and outside U.S. Territorial Waters were considered in the evaluation.

The NEPA analysis involves evaluating emissions generated from the proposed activities and assessing potential impacts on air quality, including an evaluation of potential exposures to toxic air pollutant emissions. Normally, criteria air pollutant emissions assessed under NEPA would be compared to a regional air pollutant emissions inventory to determine significance. If emissions equaled or exceeded 10 percent of the region's total emissions, the emissions would be significant. Because Guam and the CNMI do not have regional emission inventories to determine whether emissions from the action would be significant, the major source threshold of 250 tons per year for new major sources in attainment areas is the criteria used for determining significance of air emissions from the project alternatives.

Trace amounts of toxic air emissions would be generated from combustion sources and use of ordnance. Air toxics emissions include hazardous air pollutants not covered under ambient air quality standards. Potential hazardous air pollutant sources are associated with missile and target training events and include rocket motor exhaust and unspent missile fuel vapors. These emissions would be minor and would not result in significant impacts due to the distance from sensitive receptors that could be affected by air toxics and the negligible levels of emissions.

This NEPA analysis does not include a CAA General Conformity analysis. Although some training activities occur in the SO_2 nonattainment areas of Guam as listed in Table 3.4-2 (Reserve Craft Beach, Polaris Point Field, Finegayan Communications Annex, Piti Mine Neutralization Area), these activities are intermittent and do not involve the combustion of fuel for power production. The combustion of fuel oil with a relatively high sulfur content for power production at the Piti and Tanguisson power plants is responsible for the SO_2 nonattainment designation of areas around these power plants. The Guam SIP control strategy for achieving attainment of the SO_2 NAAQS is to limit sulfur in fuels for power production to 0.74 % sulfur or a SO_2 emission limit of 0.8 lbs per million BTUs of heat input. Based on the number and types of activities listed in Table 3.4-2 occurring within the footprint of the SO_2 nonattainment areas on Guam and associated emission sources, direct and indirect emissions of criteria pollutants or precursors are expected to be less than the corresponding annual emission rates listed in 40 CFR 93.153(b)(1) that require a General Conformity Determination. Thus, in accordance with OPNAVINST 5090.1C (DoN 2007), the proposed action is not subject to the General Conformity Rule.

3.4.3.1 No Action Alternative

The No Action Alternative consists of maintaining the current levels of training and testing in the MIRC. Thus, there would be no change in current levels of emissions associated with training or testing.

The MIRC is currently designated as in attainment for all criteria pollutants. Included within this characterization of regional air quality are the existing aircraft, surface ship, small water craft, and weapon emissions. A continuation of baseline training and testing levels would not require a General Conformity Rule determination because the training occurs in areas designated as attainment for all criteria pollutants. Therefore, there would be no significant impact to air quality from implementing the No Action Alternative.

The offshore reaches of the MIRC (beyond 12 nm [22.2 km]) are non-classifiable for priority pollutants under the CAA. Therefore, the CAA General Conformity Review is not applicable. Initial concentrations of air emissions over the ocean would disperse rapidly in the atmosphere. Because of the low initial concentrations and rapid dispersion of exhaust and explosion byproducts, there would not be any risk to human health. Therefore, there would be no significant harm to offshore air quality from implementing the No Action Alternative.

3.4.3.2 Alternative 1

Under Alternative 1 there would be a slight increase in air pollutants within the Study Area in comparison to baseline levels. The CAA General Conformity Rules would not apply to the actions conducted within the MIRC (those areas within the 3 nm jurisdiction of the CAA), as they are designated in attainment area for all criteria pollutants. The air quality impacts from increased training events, including ISR/Strike and other Air Force training initiatives would be primarily from ship, small water craft, truck and light vehicles, and aircraft. These impacts would be minor, dispersed, and would be short-term in nature. Most of the aircraft training events take place above 3,000 ft (914 m) AGL. Air emissions above 3,000 ft (914 m) AGL are not addressed in accordance with USEPA guidance (USEPA, 1992). Additionally, most ship and aircraft training events occur beyond 12 nm (22.2 km) from shore, thus substantially reducing the likelihood that any of the associated emissions would mix with over land airsheds.

Training levels are expected to be relatively consistent with baseline levels for the other MIRC training at the Guam Commercial Harbor, Apra Naval Harbor Complex, Ordnance and Communication Annexes, Tinian, Saipan, Rota, and Andersen AFB. These other training events would be land based or within harbors.

In conclusion, the actions evaluated under Alternative 1 generally take place either:

- within areas designated in attainment for all criteria pollutants, and therefore the CAA General Conformity Rule does not apply; or
- within offshore areas unclassified for priority pollutants, where surface ship and aircraft emissions are minimal and typically produce emissions above the mixing layer; or
- within areas designated as nonattainment for SO_2 and the associated total annual emissions are less than the annual emission rates requiring a General Conformity determination.

Therefore, there would be no significant impact to air quality from implementing Alternative 1. Furthermore, there would be no significant harm to the air quality over non-territorial waters from implementing Alternative 1.

3.4.3.3 Alternative 2

Like Alternative 1, under Alternative 2, there would be a slight increase in air pollutants within the EIS/OEIS Study Area in comparison to baseline levels. Under Alternative 2, there would be additional increases in emissions over Alternative 1 from an increase in major exercises. Most of the increase in emissions would be generated at least 12 nm (22.2 km) from shore where major exercises are conducted. These impacts would be minor, dispersed, and short-term in nature. The conclusion for Alternative 1 also applies to Alternative 2.

3.4.4 Unavoidable Significant Environmental Effects

Under either proposed action alternatives, increased training activities within the MIRC would result in minor, short-term effects, such as minor increases of aircraft air emissions within the airsheds, but would have no unavoidable significant environmental effects.

3.4.5 Summary of Environmental Effects (NEPA and EO 12114)

Emissions associated with implementation of Alternatives 1 and 2 would result in minor increases in air emissions above baseline (No Action Alternative) conditions. Within U.S. territory, emissions are mainly associated with increased small boat and support vehicle emissions. Outside U.S. territory, emission increases are mainly associated with surface vessel exercises, with additional contributions from participating aircraft. In conclusion, although Alternatives 1 and 2 would result in increases in emissions of air pollutants, all air impacts would be less than significant in scope and intensity for the following reasons:

- All training events analyzed in this EIS/OEIS occur within areas designated by the USEPA as being in attainment for all criteria pollutants or in nonattainment areas for SO_2 where the associated total annual emissions are less than the criteria for General Conformity determination. Therefore, the General Conformity Rule does not apply.
- The majority of training event types and the majority of training activities/sorties occur more than 12 nm from the shore and would not affect air quality for human receptors. Furthermore, the majority of aircraft training emissions occur above 3,000 ft (914 m) (above the atmospheric inversion layer), and would have no impact on local air quality (USEPA 1992).

As shown in Table 3.4-6, implementation of the No Action Alternative, Alternative 1, or Alternative 2 would not result in significant adverse impacts to regional air quality. Implementation of the No Action Alternative, Alternative 1 or Alternative 2 would not result in significant harm to the air quality of the global commons.

Table 3.4-6: Summary of Environmental Effects of the Alternatives on Air Quality in the MIRC Study Area

Alternative and Stressor	NEPA (Land and Territorial Waters, <12 nm)	Executive Order 12114 (Non-Territorial Waters, >12 nm)
No Action		
Surface ship Emissions	Minor localized emissions. Coastal areas in attainment for all criteria pollutants.	Minor at-sea emissions. No long-term harm to the global commons.
Aircraft emissions	Minor localized emissions in areas that are in attainment for all criteria pollutants.	Minor at-sea emissions. No long-term harm to the global commons.
S&R Training, FTX, Live Fire, MOUT, STOM, NEO, Direct Fire, Protect the Force, Insertion/Extraction, Direct Action, Airfield Seizure, AMW, EOD, CSAR, AT	Minor localized emissions in areas that are in attainment for all criteria pollutants and in areas that are nonattainment for SO_2.	Minor at-sea emissions. No long-term harm to the global commons.
Impact Conclusion	No significant impacts to Study Area air quality.	No significant harm to Study Area air quality.
Alternative 1		
Surface ship Emissions	Minor localized emissions. Coastal counties in attainment for all criteria pollutants.	Minor at-sea emissions. No long-term harm to the global commons.
Aircraft emissions	Minor localized emissions in areas that are in attainment for all criteria pollutants.	Minor at-sea emissions. No long-term harm to the global commons.
S&R Training, FTX, Live Fire, MOUT, STOM, NEO, Direct Fire, Protect the Force, Insertion/Extraction, Direct Action, Airfield Seizure, AMW, EOD, CSAR, AT	Minor localized emissions in areas that are in attainment for all criteria pollutants and in areas that are nonattainment for SO_2.	Minor at-sea emissions. No long-term harm to the global commons.
Impact Conclusion	No significant impacts to Study Area air quality.	No significant harm to Study Area air quality.
Alternative 2		
Surface ship Emissions	Minor localized emissions. Coastal counties in attainment for all criteria pollutants.	Minor at-sea emissions. No long-term harm to the global commons.
Aircraft emissions	Minor localized emissions in areas that are in attainment for all criteria pollutants.	Minor at-sea emissions. No long-term harm to the global commons.
S&R Training, FTX, Live Fire, MOUT, STOM, NEO, Direct Fire, Protect the Force, Insertion/Extraction, Direct Action, Airfield Seizure, AMW, EOD, CSAR, AT	Minor localized emissions in areas that are in attainment for all criteria pollutants and in areas that are nonattainment for SO_2.	Minor at-sea emissions. No long-term harm to the global commons.
Impact Conclusion	No significant impacts to Study Area air quality.	No significant harm to Study Area air quality.

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3.5 AIRBORNE NOISE

3.5.1 Introduction and Methods

This chapter describes the existing environmental resources that could be affected by activities listed under Alternative 1, Alternative 2, or the No-Action Alternative. Only those specific resources relevant to potential impacts to human receptors are described in detail. The baseline represents the current condition for the respective resources or conditions that may exist due to the No-Action Alternative.

3.5.1.1 Definition of Resource

Noise is defined as any sound that is undesirable because it interferes with communication, is intense enough to damage hearing, diminishes the quality of the environment, or is otherwise annoying. Response to noise varies by the type and characteristics of the noise source, distance between source and receptor, receptor sensitivity, and time of day. Noise may be intermittent or continuous, steady or impulsive, and may be generated by stationary sources such as industrial plants or by transient sources such as automobiles and aircraft. Noise receptors can include humans as well as terrestrial animals. Each receptor has higher or lower sensitivities to sounds of varying characteristics. However, of specific concern to this analysis are potential noise effects on humans and in general, federally listed animal species. Information specific to other noise receptors of concern (*e.g.*, marine mammals, birds, and fish, *etc*.) is provided in the appropriate sections.

This section describes the airborne component of noise from military activities. As such, the following introductory description of the characteristics of airborne noise provides a basis for descriptions later in this section of the existing airborne noise in various parts of the Mariana Islands Range Complex (MIRC). A brief description of underwater sounds will be provided later, but will be presented in the context of propagation of airborne noise sources into the water column.

3.5.1.2 Airborne Noise Characteristics

Noise Terminology. Sound waves are longitudinal (linear or on a line) mechanical waves. They can be propagated in solids, liquids, and gases. The material particles transmitting such a wave oscillate in the direction of propagation of the wave itself. Sound waves originate from a vibrating surface (e.g., vibrating string of a violin, a person's vocal cords, a vibrating column of air from an organ or clarinet, or a vibrating panel from a loudspeaker, drum, aircraft, or train). All of these vibrating elements alternatively compress the surrounding air on a forward movement and rarefy it on a backward movement. This wave compression and rarefaction is transmitted through the medium because the material possesses elasticity as well as inertia or mass. Thus, the propagation of sound depends on these physical properties of the medium.

There is a large range of frequencies within which longitudinal mechanical waves can be generated, sound waves being confined to the frequency range that can stimulate the auditory organs to the sensation of hearing. For humans this range is from about 20 hertz (Hz) to about 20,000 Hz. The air transmits this frequency disturbance outward from the source of the wave. Sound waves, if unimpeded, will spread out in all directions from a source. Upon entering the auditory organs, these waves produce the sensation of sound. Waveforms that are approximately periodic or consist of a small number of periodic components can give rise to a pleasant sensation (assuming the intensity is not too high), for example, as in a musical composition. Noise can be represented as a superposition of periodic waves with a large number of components.

Airborne sound is a rapid fluctuation of air pressure above and below atmospheric levels. The loudest sounds the human ear can hear comfortably are approximately one trillion times the acoustic energy that the ear can barely detect. Because of this vast range, any attempt to represent the acoustic intensity of a particular sound on a linear scale becomes unwieldy. As a result of this, a logarithmic ratio originally conceived for radio and telephone work known as the decibel (dB or one-tenth Bel) is commonly employed. The decibel is thus defined as 10 times the common (base ten) logarithm of the measured sound intensity to some reference level. For the purposes of airborne environmental monitoring, this level is defined as 20 times the logarithm of the measured sound pressure to a reference pressure. This reference pressure level is taken as 20 micropascals or 20 x 10^{-6} Pascals (2.9 x 10^{-9} PSI or 1.973 x 10^{-10} atmospheres [ATM]).

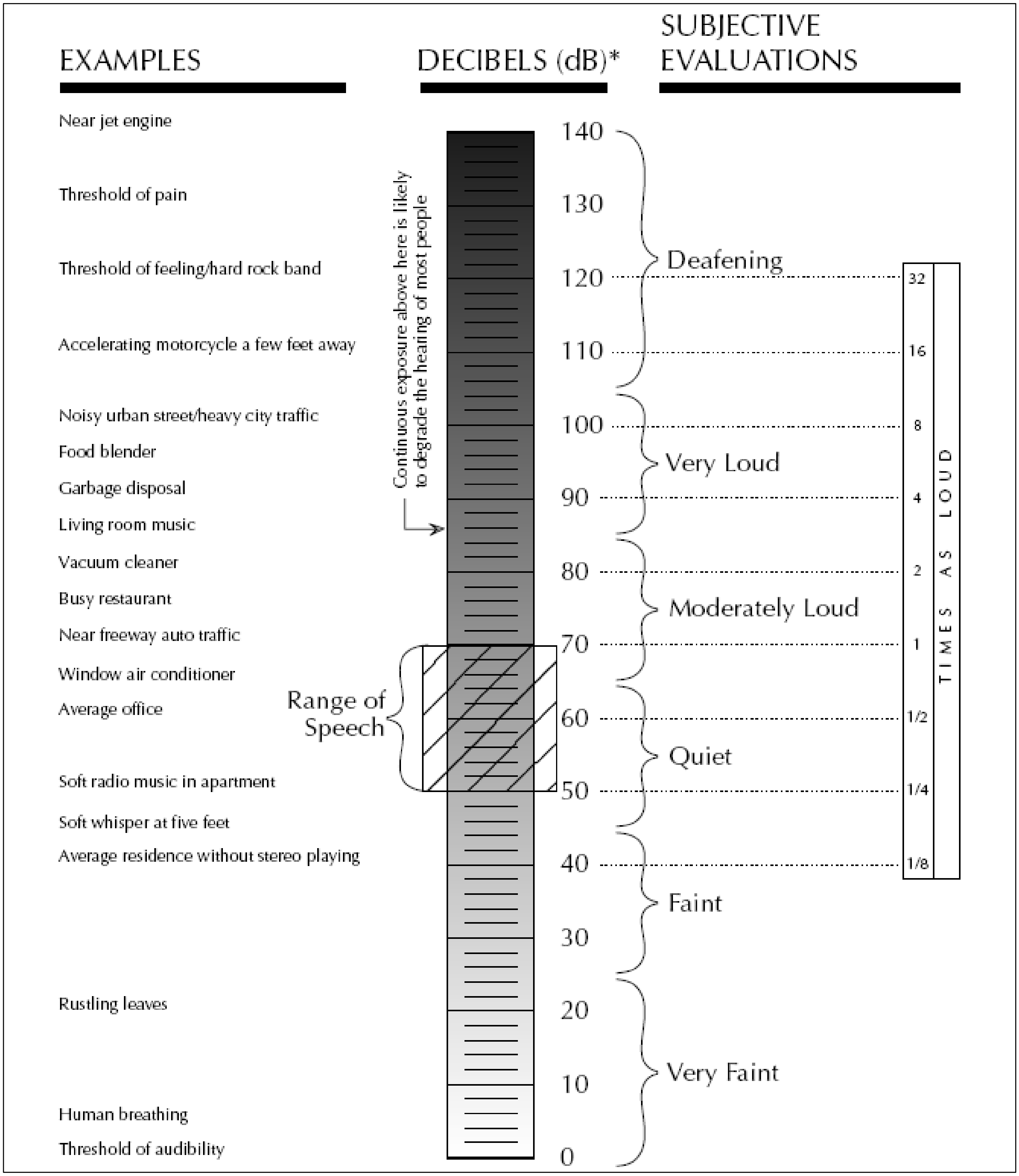
A sound level of zero "0" dB is scaled such that it is defined as the threshold of human hearing and would be barely audible to a human of normal hearing under extremely quiet listening conditions and would correspond to a sound pressure level equal to the reference level of 20 micropascals. Such conditions can only be generated in anechoic or "dead rooms." Typically the quietest environmental conditions (extreme rural areas with extensive shielding) yield sound levels of approximately 20 decibels. Normal speech has a sound level of approximately 60 dB. Sound levels above 120 dB roughly correspond to the threshold of pain.

The minimum change in sound level that the human ear can detect is approximately three dB. A change in sound level of 10 dB is usually perceived by the average person as a doubling (or halving) of a sound's loudness (Figure 3.5-1). A change in sound level of 10 dB actually represents an approximately 90 percent change in the sound intensity, but only about a 50 percent change in the perceived loudness. This is due to the nonlinear response of the human ear to sound.

As described above, 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. Although exposure to high noise levels has been demonstrated to cause hearing loss, the principal human response to environmental noise is annoyance. The response of individuals to similar noise events is diverse and influenced by the type of noise, the perceived importance of the noise and its appropriateness in the setting, the time of day, and the sensitivity of the individual hearing the sound.

The method commonly used to quantify environmental sounds consists of determining all of the frequencies of a sound according to a weighting system that reflects the nonlinear response characteristics of the human ear. This is called "A" weighting, and the decibel level measured is called the A-weighted sound level (or 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.

Although the A-weighted sound level may adequately indicate the level of airborne environmental noise at any instant in time, community noise levels vary continuously. Most environmental noise includes a conglomeration of sounds from distant sources that create a relatively steady background noise in which no particular source is identifiable. For this type of noise a single descriptor called the L_{eq} (or equivalent sound level) is used. L_{eq} is the energy-mean A-weighted sound level during a measured time interval. It is the "equivalent" constant sound level that would have to be produced by a given source to equal the fluctuating level measured.



Source: U.S. Department of Housing and Urban Development 2002

Figure 3.5-1: Sound Levels of Typical Noise Sources and Environments

Single Event Sound Metrics. Although the highest dBA level measured during an event (i.e., maximum sound level, L_{max}) is the most easily understood descriptor for a noise event, alone it provides little information. Specifically, it provides no information concerning either the duration of the event or the amount of sound energy. Thus, sound exposure level (SEL), which is a measure of the physical energy of the noise event and accounts for both intensity and duration, is used for single event noise analysis. Subjective tests indicate that human response to noise is a function not only of the maximum level, but also of the duration of the event and its variation with respect to time. Evidence indicates that two noise events with equal sound energy will produce the same response. For example, a noise at a constant level of 85 dBA lasting for 10 seconds would be judged to be equally as annoying as a noise event at a constant level of 82 dBA and duration of 20 seconds (i.e., three dBA decrease equals one half the sound energy but lasting for twice the time period). This is known as the "equal energy principle." The SEL value represents the A-weighted level of a constant sound with duration of one second, providing an amount of sound energy equal to the event under consideration.

By definition, SEL values are referenced to a duration of one second and should not be confused with either the average (L_{eq}) or L_{max} associated with a specific event. The L_{eq} is the constant level which has the same A-weighted sound energy as that contained in the time-varying sound. When an event lasts longer than one second, the SEL value will be higher than the Lmax from the event. The L_{max} would typically be five to ten dBA below the SEL value for aircraft overflight.

Averaged Noise Metrics. Single event analysis has a major shortcoming -- single event metrics do not describe the overall noise environment. Day-Night Level (DNL) is the measure of the total noise environment. DNL averages the sum of all aircraft noise producing events over a 24-hour period, with a 10 dBA upward adjustment added to the nighttime events (between 10:00 p.m. and 7:00 a.m.). Figure 3.5-2 depicts the relationship of the single event, the number of events, the time of day, and DNL. This adjustment is an effort to account for increased human sensitivity to nighttime noise events. A similar metric, the community noise equivalent level (CNEL), is calculated similar to the DNL, but an additional upward adjustment of five dBA is added to evening events (between 7:00 p.m. and 10:00 .m.). The summing of sound during a 24-hour period does not ignore the louder single events, it actually tends to emphasize both the sound level and number of those events. The logarithmic nature of the dB unit causes sound levels of the loudest events to control the 24-hour average.

DNL is the accepted unit for quantifying annoyance to humans from general environmental noise, including aircraft noise. The Federal Interagency Committee on Urban Noise (FICUN) developed land use compatibility guidelines for noise exposure areas (FICUN 1980). Based on these FICUN guidelines, the Federal Aviation Administration (FAA) developed recommended land uses in aircraft noise exposure areas. The Air Force uses DNL as the method to estimate the amount of exposure to aircraft noise and predict impacts. Land use compatibility and incompatibility are determined by comparing the predicted DNL level at a site with the recommended land uses (Section 3.5.1.6).

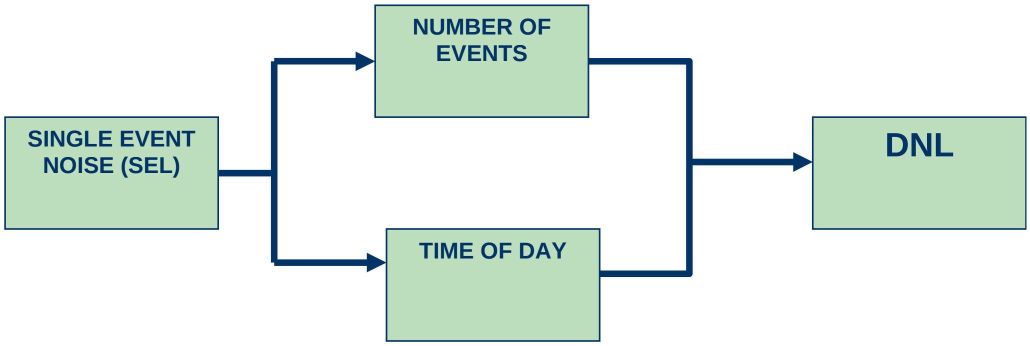


Figure 3.5-2: Day-Night Average A-Weighted Sound Level

3.5.1.3 Applicable Noise Regulations

OPNAVINST 5090.1C contains guidance for environmental evaluations. Chapter 17, Noise Prevention Ashore, contains guidance for noise control and abatement of Navy shore activities. Planning in the Noise Environment, (DoN 1978) provides compatibility criteria for various land uses. Residences and public use facilities such as schools, libraries, hospitals, churches, nursing homes, and recreational areas are more sensitive to noise than those in other types of facilities because the activities that take place in those structures require lower sound levels. Sound levels up to 65 dBA, CNEL are compatible with land uses such as residences, transient lodging, and medical facilities. Appropriate noise mitigation is required for development in areas where the CNEL exceeds 65 dBA. These levels are similar to levels listed in 14 CFR Part 150, which are listed in Table 3.5-2. Sound levels exceeding 75 dBA, CNEL are incompatible with these types of land uses. Similar criteria are included in OPNAVINST 11010.36A, Air Installations Compatible Use Zones (AICUZ) Program. No Navy regulations restrict noise emissions from stationary noise sources, either at the property line or within a Navy/Marine facility. NAVFAC P-970 indicates that impulse sounds should be considered separately when the peak noise level exceeds 110 dB. It also indicates that, when peak sound levels exceed 140 dB, evaluation of effects such as hearing loss and structural damage should be undertaken.

The FAA criteria suggest that sound levels lower than 65 DNL would be compatible with all land uses. As the Government of Guam (GovGuam) does not have specific noise level regulations, Federal standards would apply, if appropriate. Federal agencies apply noise levels and criteria based on noise levels in relation to proposed land use. These criteria have been developed by various agencies such as the U.S. Environmental Protection Agency (USEPA) and FAA to meet specific objectives. There is no single set of criteria that applies to all noise evaluations. The most sensitive land use and associated population type is residential. Other sensitive noise receptors include schools, libraries, hospitals, and churches. Except for the USEPA, Federal agencies generally use 65 DNL as a maximum exposure level for residential land use without incorporation of interior sound attenuation. Specific Federal standards are as follows:

- According to FAA guidelines, all land uses are considered compatible with noise levels less than 65 DNL. The FAA generally accepts 60 DNL as the maximum for "open environment" life styles. At higher noise exposures, certain selected land uses are deemed acceptable.
- The USEPA recommends a DNL below 55 for outdoors noise levels and 45 for indoor noise levels in residential areas.
- For residential areas, the Federal Housing Administration (FHA) and the Department of Housing and Urban Development (HUD) consider 65 DNL or lower to be an acceptable exterior noise level only if appropriate sound attenuation is provided. This standard is applied nationally for U.S. Department of Defense (DoD) housing projects.

Table 3.5-1: Land Use Compatibility Guidelines

LAND USE CATEGORY		OUTDOOR NOISE LEVELS 55-65 DNL	65-75 DNL	75+ DNL
Residential	Single Family Home	Compatible Land Use	Incompatible Land Use	Incompatible Land Use
	Multi-Family Home	Compatible Land Use	Incompatible Land Use	Incompatible Land Use
	Mobile Homes	Compatible Land Use	Incompatible Land Use	Incompatible Land Use
	Dorms, etc.	Compatible Land Use	Incompatible Land Use	Incompatible Land Use
Institutional	Schools	Compatible Land Use	Compatible Land Use with Sound Insulation	Incompatible Land Use
	Churches	Compatible Land Use	Incompatible Land Use	Incompatible Land Use
	Hospitals	Compatible Land Use	Compatible Land Use with Sound Insulation	Incompatible Land Use
	Nursing Homes	Compatible Land Use	Compatible Land Use with Sound Insulation	Incompatible Land Use
	Libraries	Compatible Land Use	Compatible Land Use with Sound Insulation	Incompatible Land Use
Recreational	Sports/Play	Compatible Land Use	Compatible Land Use with Sound Insulation	Incompatible Land Use
	Music Shells	Compatible Land Use	Incompatible Land Use	Incompatible Land Use
	Camping	Compatible Land Use	Compatible Land Use	Incompatible Land Use
Commercial	All Uses	Compatible Land Use	Compatible Land Use	Compatible Land Use
Industrial	All Uses	Compatible Land Use	Compatible Land Use	Compatible Land Use
Agricultural	All Uses	Compatible Land Use	Compatible Land Use	Compatible Land Use

Compatible Land Use — Compatible Land Use with Sound Insulation — Incompatible Land Use

Source: FAA, Land Use Compatibility and Airports, a Guide for Effective Land Use Planning, 1999

3.5.2 Affected Environment

The Study Area for airborne noise includes all areas of the MIRC where aircraft, ship, boat, or other sound is emitted by Navy activities, especially areas where concentrated or routine activities occur. This includes areas on the island of Guam and surrounding Marianas Islands.

3.5.2.1 Regional Setting

Noise sources in the MIRC can be transitory and widely dispersed or concentrated in small areas for varying periods of time. Airborne sound sources that could rise to noise include civilian and military aircraft (both of which fly at altitudes ranging from hundreds of feet to tens of thousands of feet above the surface), as well as missiles and targets.

3.5.2.2 Onshore and Nearshore Airborne Sound Sources

The primary sound sources of noise in the MIRC are aircraft and vehicle traffic and industry. The only source of noise on the uninhabited Farallon de Medinilla (FDM) is periodic military bombardment and aircraft overflights. The sources of noise on Tinian are aircraft and vehicular traffic. The north end of the island, including the Exclusive Military Use Area (EMUA), is in the landing approach for Saipan

International Airport and is subject to periodic elevated noise levels from low-altitude jet aircraft throughout the day. Aircraft and general traffic and industrial noise sources in the Agana-Tamuning metropolitan area generate noise on Guam. Noise from power plants, aircraft, and vehicular traffic is limited.

Land explosion noise in the MIRC typically involves active explosive demolition practice, explosive ordnance disposal (EOD), active bombing practice, offshore bombardment, artillery and small arms fire. The type and quantity of ordnance expended depends highly on the training objectives and range utilized. By far the greatest amount of land explosion noise occurs in the FDM area with smaller amounts in the Ordnance Annex, Orote Point and the Communications Annex on Guam.

Missile and target launch noise occurs in the MIRC in an infrequent manner, and only during scheduled activities. Due to safety concerns associated with launch activities, a large buffer zone of several square miles is typically instituted. Noise due to missile and target launch activities is typically maximum at the point of initiation and rapidly fades as: a) the missile or target reaches optimal thrust conditions at which time thermal equilibrium of gasses surrounding the exhaust nozzle occur; and b) the missile or target reaches an adequate downrange distance.

3.5.3 Environmental Consequences

3.5.3.1 Approach to Analysis

The analysis presented in this section is limited to impacts of military-generated noise on humans. Impacts of military-generated noise on biological resources such as birds, fish, marine mammals, and sea turtles, are presented in their respective sections. The following sections below divide operations into component activities that may contribute to the acoustic environment, as listed in Table 2-6 and described in detail in Section 2.3.1. To determine potential acoustic effects from military activities, these sections will first describe the acoustic environment created by each activity, determine activity location(s), and apply this information to the specific locality and respective sensitive receptors.

Potential airborne sound-generating events associated with the Proposed Action were identified, and the potential airborne sound levels that could result from these activities were estimated on the basis of published data on military sound sources. These estimated sound levels were reviewed to determine whether they would (a) represent a substantial increase in the average ambient sound level, (b) have an adverse effect on a substantial population of sensitive receptors, or (c) be inconsistent with any relevant and applicable standards. Table 3.5-2 presents the likeliness of a defined operation to contribute significantly to community sound levels at public sensitive receptors and exceed 65 dB DNL. Detailed descriptions of activities and analysis of noise resulting from them are listed in their respective sections below.

Table 3.5-2: Likeliness of Operational Types to Contribute to Community DNL

Likeliness of Operation to Exceed 65 dB DNL at Public Sensitive Receptors			
Operation	**No Action Alternative**	**Alternative 1**	**Alternative 2**
Aircraft Overflights	Occasional	Occasional	Occasional
Tactical Insertions	Unlikely	Unlikely	Unlikely
Direct Actions	Unlikely	Unlikely	Unlikely
Assault Support	Occasional	Occasional	Occasional
Parachute	Unlikely	Unlikely	Unlikely
Airlift	Unlikely	Unlikely	Unlikely
Seize Airfield	Unlikely	Unlikely	Unlikely
Offshore Operations	Unlikely	Unlikely	Unlikely
GUNEX	Unlikely	Unlikely	Unlikely
BOMBEX	Unlikely	Unlikely	Unlikely
MISSILEX (Surface)	Unlikely	Unlikely	Unlikely
MISSILEX (Air)	Unlikely	Unlikely	Unlikely
FIREX	Unlikely	Unlikely	Unlikely
Beaching	Unlikely	Unlikely	Unlikely
Land Demolitions	Occasional	Occasional	Occasional
Marksmanship	Unlikely	Unlikely	Unlikely
MOUT	Occasional	Occasional	Occasional

3.5.3.2 No Action Alternative

The No Action Alternative is representative of baseline conditions, where the action presented represents a regular and historical level of activity on the MIRC to support training activities and exercises. The No Action Alternative serves as a baseline, and represents the "status quo" when studying levels of range usage and activity. The No Action Alternative, or the current level of training and Research, Development, Testing, and Evaluation (RDT&E) activities, has been analyzed in the *Military Training in the Marianas Environmental Impact Statement (EIS), June 1999* and in several Environmental Assessments (EAs) (e.g., Overseas Environmental Assessment [OEA] Notification for Air/Surface International Warning Areas and Valiant Shield OEA) for more specific training events or platforms. While the referenced documents indicated that there were no effects to human receptors, the general activities presented in Section 2.3 are described in more detail to further facilitate discussion of potential effects on human sensitive receptors from the implementation of either of the Action Alternatives. The potential effects from noise under existing environmental conditions were restricted to Mariana fruit bats (*Pteropus marianus marianus*) and the Marianas crow (*Corvus kubaryi*) and are fully discussed in Section 3.11.

Airborne noise in offshore and nearshore areas typically consists of ambient noise levels from natural and man-made sources. Airborne sound decreases in magnitude as it moves away from the noise source due to transmission and absorption losses. These sound decreases are partially dependent on the types of interaction surfaces (e.g., water, sand, and vegetation) and on atmospheric conditions (e.g., temperature and inversion layers, wind speed and direction, and relative humidity). A common source of airborne noise in offshore areas is marine vessels and associated training activities. Noise sources associated with marine vessels include engine noise, intake and exhaust noise, auxiliary equipment, and firing activities. 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 impact analysis).

Aircraft Overflights. Aircraft from both Andersen Air Force Base (AAFB) and the Guam International Airport contribute to aircraft noise on Guam. The International Airport is operated by the Guam International Airport Authority (GIAA), a public corporation and autonomous agency of GovGuam. Located about 3.1 mi (five km) northeast of Hagatna and approximately four mi (6.4 km) southwest of the proposed ASTA, it handles nearly all of the commercial flights into and out of Guam and is the only civilian air transportation facility on Guam. Eight major airlines operate there, making it the hub of air transportation for Micronesia and the Western Pacific. AAFB handles Air Mobility Command Flights for military personnel and their dependents. AAFB is home the 36^{th} Wing (host unit) as well as to the 734th Air Mobility Support Squadron, Navy Helicopter Squadron 25 (HC-25), and several other tenant organizations. The primary mission of AAFB is to maintain the manpower infrastructure to provide support for tactical and strategic peacetime, contingency, and wartime deployment and employment activities, strategic airlifts, transient support, and staging activities. Commercial aircraft may occasionally fly through AAFB airspace, but only with permission from the AAFB control tower.

The primary sources of noise on Tinian are aircraft and vehicular traffic. The north end of the island, including the EMUA, is in the landing approach for Saipan International Airport and is subject to periodic elevated noise levels from low-altitude jet aircraft throughout the day. International flights on approach to Saipan International pass over North Field Runway One at an altitude of about 2,200 to 2,600 ft (650 to 800 m). Aircraft flying into West Tinian Airport, located within the Leaseback Area (LBA) of Tinian's Military Lease Area (MLA) also use flight tracks above North Field. West Tinian airport is currently being expanded to accommodate jet aircraft. North Field Runway Able is used for military fixed-wing and helicopter activities during training exercises. North Field Runway Two is used for parachute drops and helicopter activities. These relatively low altitude activities may occur below flight paths used by large commercial jet aircraft on approach to Saipan.

Single Event Sound Analysis. In 2003, the Air Force Center for Engineering and Environmental (AFCEE) conducted a single event analysis was to evaluate effects on noise-sensitive receptors in the immediate vicinity of AAFB (AFCEE 2003). Table 3.5-3 and Figure 3.5-3 show ten points surrounding the airfield that were identified for analysis in the area. These points were selected as they represented locations where the general public may be sensitive to noise from single aircraft overflights.

Figure 3.5-2 shows the DNL noise contours for the baseline average daily airfield activities condition at Andersen Air Force Base (AFB) as reported in the AAFB EIS (2006). While the aircraft reported in Table 3.5-3 represent the loudest SEL for only those aircraft flying the top 20 flight track events contributing the most DNL at each location, the DNL contours in Figure 3.5-3 represent all aircraft activities at AAFB. Only a small portion off-base (353 acres) is within the 65-dB contour from baseline aircraft activities.

Most of the off-base land in the immediate vicinity of AAFB main base is undeveloped or residential with low to moderate density (approximately 0.7 persons per acre). A relationship between noise and annoyance levels was suggested by Schultz (1978) and was reevaluated for use in describing the reaction of people to environmental noise (Fidell, et al. 1988). These data provide a perspective on the level of annoyance that might occur. For example, 12 to 22 percent of people exposed on a long-term basis to DNL of 65 to 70 dBA are expected to be potentially highly annoyed by noise events. Based on population density in the area anticipated to encounter DNLs above 65 dBA, approximately 53 people are expected to be highly annoyed by aircraft activities at AAFB. However, the 2001 AICUZ Report indicates there is no off-Base incompatible land use resulting from aircraft noise (AAFB 1998).

Table 3.5-3: Baseline DNL and SEL at Analysis Points

Number	Description	DNL (dBA)	Aircraft	SEL (dBA)
1	Dededo	49	C-5	99
2	Falcona Beach	47	C-5	108
3	Jinapsan Beach	47	C-5	111
4	Andersen AFB Middle School	55	EA-6B	103
5	Pati Point	66	C-5	116
6	Tarague Beach	44	C-5	98
7	Tarague Channel	44	F-18	97
8	Uruno Point	36	C-5	90
9	Off-Base School (Machanananao)	41	C-5	106
10	Yigo	54	EA-6B	108

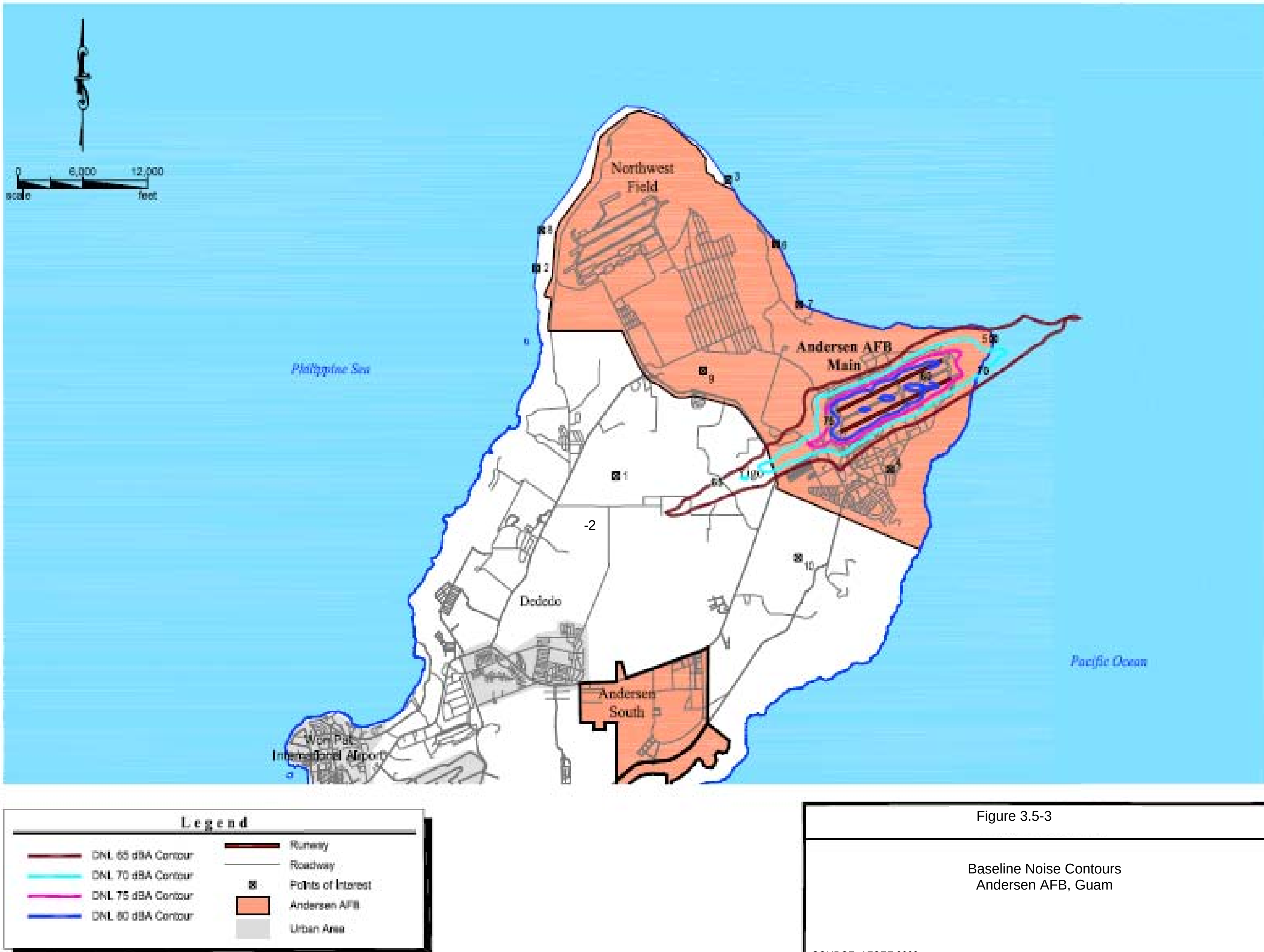


Figure 3.5-3

Baseline Noise Contours
Andersen AFB, Guam

SOURCE: AFCEE 2003

Subsequent to the AFCEE noise modeling effort, an additional noise analysis was conducted for the Joint Guam Program Office for proposed activity at AAFB. The data are based on the 2003 noise study by the AFCEE (presented above) that was initially intended to provide input to an AICUZ update for the installation; however, no AICUZ study was ever produced or released using the data. In 2007, Wyle Laboratories prepared a set of data collection packages based on previous modeling of AAFB and performed a site visit to AAFB. As a result of the site visit and interviews, significant changes were made to the flight tracks, aircraft mix, and operations of the previous modeling (Table 4-1; Wyle 2008).

Operation types include departures, straight-in (nonbreak) arrivals, overhead break arrivals, touch-and-go patterns, and ground controlled approach (GCA) patterns. Because much of AAFB flight activity is by deployed or transient aircraft, the fleet mix for the modeling scenario includes many aircraft types. The top users of the airfield are the MH-60S Knighthawks in HSC-25 (modeled as SH-60B aircraft in RNM), with 66 percent of the total military operations. Jet tankers (modeled as KC-135R) are the next most frequent users of the airfield, with approximately 10 percent of the total operations. F/A-18E/F and T-45 comprise eight percent of the total operations. The next most frequent users are transient F-15s, with approximately seven percent of the total operations. Based HSC-25 aircraft perform approximately 6 percent of their operations during the acoustical nighttime (10pm – 7am) period, and transient aircraft perform an average of 14 percent of their operations during the same period.

This data was used to calculate and plot the 60 dB through 85 dB DNL contours for the AFD operations for AAFB, as shown in Figure 3.5-4. The off-base overland portion of the 60 dB DNL contour extends along runway heading approximately five statute miles southwest of the base boundary. The off-base overland portion of the 65 dB DNL contour extends approximately 2.5 miles southwest of the AFB boundary. The main contributors to off-base overland noise exposure are the approaches to Runway 06R and pattern work on Runway 06R. The highest off-base overland DNL exposure outside Andersen AFB property is between 75 dB and 80 dB DNL evidenced by the 75 dB DNL contour extending approximately 600 feet past the southwest base boundary.

Under the existing conditions presented in the Wyle (2008) report, approximately 66 percent of military activities are operations of MH-60S helicopter. This helicopter can produce single-event pass-by noise levels approaching 94 dBA, SEL at 100 ft from the source. Typical training missions can occur both day and night, and often transit areas of civilian housing at low elevations. While these events are short lived, the low elevations of these routes would create brief noise levels that would be above the ambient noise levels of the area. At distances beyond about 2,500 ft, noise from such a source would be at or below typical background noise levels for a daytime urban area (Table 3.5-1). This noise level is assumed to be reasonably representative of the average noise emissions from all types of helicopters used in training.

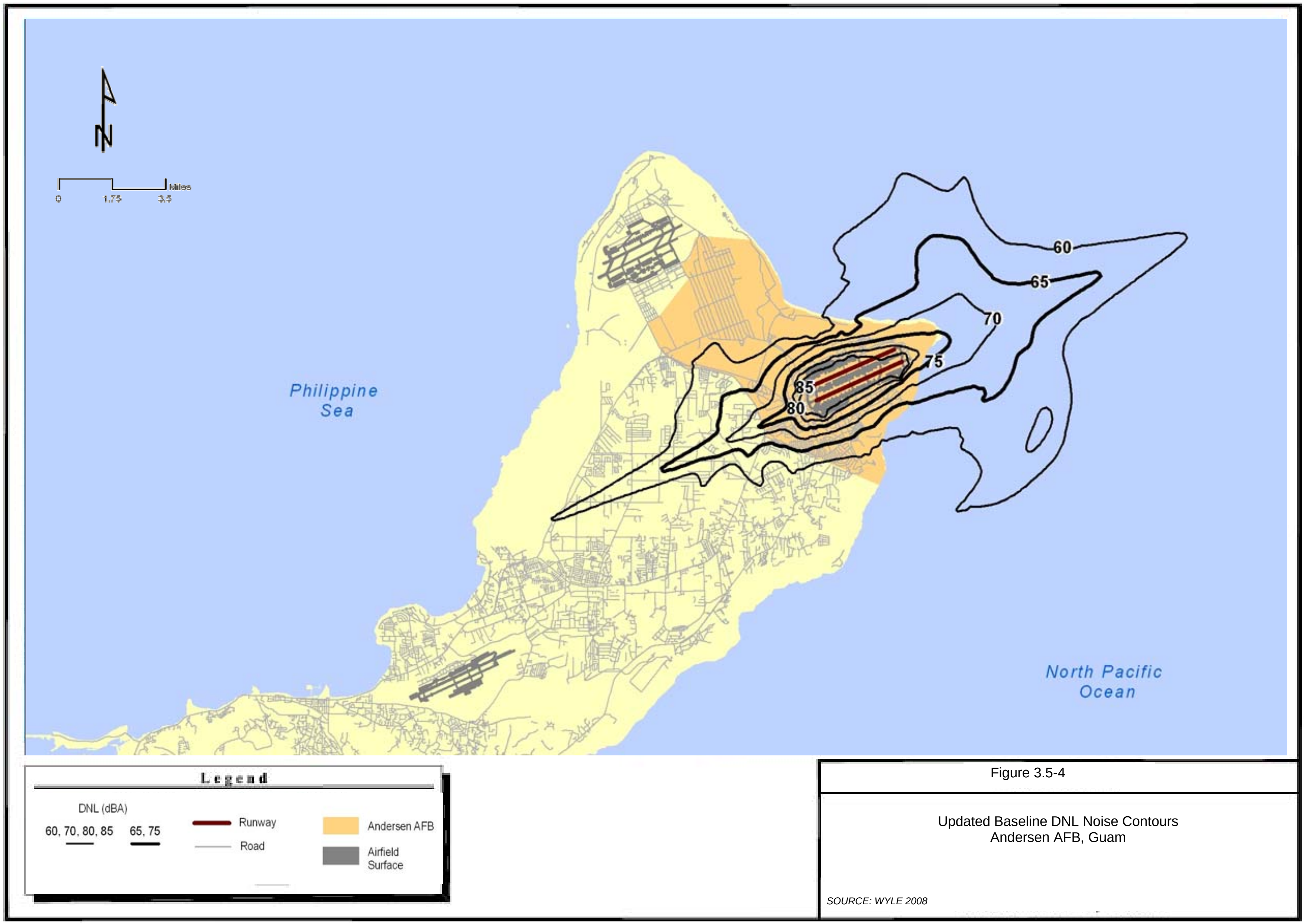


Figure 3.5-4

Updated Baseline DNL Noise Contours
Andersen AFB, Guam

SOURCE: WYLE 2008

Noise sources in and around Northwest Field on AAFB include surface traffic and other ground training activities. The south runway at Northwest Field is used for fixed-wing aircraft activities and airmobile or airborne activities, which include airdrop activities at a drop zone on the eastern end of the runway. The north runway is used for helicopter practice landings and airdrop activities at a drop zone on the eastern end of the runway. During periods of no flying activity, noise results primarily from bivouac and maneuver training by Army National Guard and Army Reserve personnel (AAFB 2000). The only operating facility at Northwest Field is the satellite tracking station. Aircraft activities and ground training activities at Northwest Field are infrequent. Noise modeling for aircraft activities is not required by Air Force directives if the noise contours do not extend beyond the installation boundary, or if there are fewer than 10 jet or 25 propeller driven aircraft activities per day. The level of aircraft activities at Northwest Field is well below these thresholds (AAFB 2000). The 4.6-mile distance between the main base airfield and Northwest Field naturally attenuates aircraft-generated noise at the main base airfield. Existing ambient noise conditions at and around Northwest Field include aircraft overflight from main base activities, shotgun firing associated with the public hunting program, vehicle traffic on unimproved access roads, and thunderclaps during thunderstorms. The noise environment at Northwest Field and the immediately adjacent off-Base area is estimated to be typical for a quiet urban daytime (i.e., 50 dBA).

The number of aircraft typically involved in an operation combined with the length of the operation and distance from aircraft all directly affect the received noise levels at locations of sensitive receptors. Based on the noise emission factor for the SH-60 helicopter, a single airborne helicopter will produce a peak pass-by noise level of about 94 dBA SEL at a distance of 100 ft and about 75 dB at 1,000 ft. Two helicopters operating in the same general area at this distance may generate a combined noise level of up to 78 dBA, and three helicopters may generate a combined noise level of up to 80 dBA. Peak noise levels are referenced to a one second duration. Four minutes per hour of noise at a level of 80 dBA would exceed an hourly L_{eq} of 65 dBA, which could cause a substantial number of individuals to be "highly annoyed." In contrast, relatively infrequent, short-duration pass-bys over public areas constitute discrete intrusive noise events that, while noticeable because they substantially exceed the ambient background noise level, typically contribute very little to the hourly average noise level. Numerous activities throughout the MIRC utilize aircraft as part of their activities and are described below.

Tactical Insertions/Extractions. Insertion/extraction activities train forces, both Navy (primarily Special Forces and Explosive Ordnance Dispostal [EOD]) and Marine Corps, to deliver and extract personnel and equipment. The majority of activities involve the use of SH-60 helicopters and to a lesser extent, C-130 aircraft. As described above, the typical overflight of a SH-60 helicopter (typical aircraft for training activities at MIRC) can produce single-event pass-by noise levels approaching 94 dBA, SEL at 100 ft from the source. At distances beyond about 2,500 ft, noise from such a source would be at or below typical background noise levels for a daytime urban area. The majority of insertion/extraction exercises involving the use of aircraft are located in the Guam Commercial Harbor and within the Apra Harbor Naval Complex (Table 2-6), both of which are at distances from public lands that operational noise would not contribute to community noise levels.

Direct Action. Naval Special Warfare (NSW) Direct Action is either covert or overt directed against an enemy force to seize, damage, or destroy a target and/or capture or recover personnel or material. Training activities are small-scale offensive actions including raids; ambushes; standoff attacks by firing from ground, air, or maritime platforms; designate or illuminate targets for precision-guided munitions; support for cover and deception activities; and sabotage inside enemy-held territory. Units involved are typically at the squad or platoon level staged on ships at sea. They arrive in the area of operations by helicopter (typical sound levels presented above) or small rubber boats (Combat Rubber Raiding Craft [CRRC]) across a beach. NSW and visiting Special Forces training in the MIRC will frequently include training that utilizes the access provided by Gab Gab Beach to Apra Harbor and Orote Point training areas, as well as the Orote Pt. Close Quarter Combat (CQC) Facility (OPCQC).

Under the No Action Alternative, approximately 22 Direct Action activities occur annually. The majority of these Direct Action activities (15) occur at the OPCQC House in the Apra Harbor Naval Complex. Noise from helicopter insertions is expected to be transient and of short duration. Combined with the distance between operational areas and adjacent public land use, there is no expected contribution to the community noise levels on adjacent non-military land or effects to other sensitive receptors from aircraft noise during these activities.

Assault Support. Assault Support exercises provide helicopter support for command and control, assault escort, troop lift/logistics, reconnaissance, search and rescue (SAR), medical evacuation (MEDEVAC), reconnaissance team insertion/extract and Helicopter Coordinator (Airborne) (HC[A]) duties. Typical aircraft may include from one to four H-60, H-46, H-53, or V-22 variants. Under the No Action Alternative, Assault Support activities occur 9 times at Polaris Point Field and Orote Point Known Distance (KD) Range sites from which the MEU commander can provide assault support activities to his forces within the MIRC. Assault support activities also occurred 8 times annually on Tinian at the EMUA.

Noise levels from H-60 and H-46 helicopters are similar, each capable during overflights of producing SELs of approximately 94 dBA at 100 ft from the source. H-53 and C-130 variants are each capable of producing SELs of up to 105 dBA during a single overflight. Sensitive receptors in the immediate vicinity of these activities may be affected. Based on the noise emission factor for the H-60 or H-46 helicopters, a single airborne helicopter will produce a peak pass-by noise level of about 65 dBA at a distance of one mile, which is the approximate distance between the Northwest Field operational site and the closest non-military land use. Two helicopters operating in the same general area may generate a combined received noise level of up to 68 dBA, and three helicopters may generate a combined noise level of up to 70 dBA. Peak noise levels are referenced to a one second duration. Assuming a typical ambient noise level of 55 dBA, approximately 18 minutes per hour of noise at a received level of 70 dBA would be necessary to exceed an hourly L_{eq} of 65 dBA. Typical Assault Support activities last between two to four hours and aircraft would need to remain localized to the operational area for 30 percent of the operation time as well as in close proximity to the ground to create noise levels that exceed L_{eq} of 65 dBA for the duration of the operation. While noise from these exercises are expected to contribute to the ambient noise levels in surrounding public lands, the contribution at the indicated levels would not be sufficient to elevate DNLs to levels above 65 dBA, most notably when operational hours are limited to 0700 to 2200.

Polaris Point Field and Orote Point KD Range sites are both farther from adjacent non-military lands than the Northwest Field, and as such, received noise levels at non-military land locations would be less than those determined for activities at Northwest Field on AAFB. These activities do not contribute to the community noise levels of adjacent non-military land and no human sensitive receptors are affected by the sound from such activities.

Parachute Insertions and Air Assault. These air activities are conducted to insert troops and equipment by parachute and/or air land by fixed or rotary wing aircraft to a specified objective area. Typical aircraft may include from one to four H-60, H-46, H-53, V-22, or C-130 variants. Under the No Action Alternative, 26 of these activities occur annually at Orote Point Triple Spot, Polaris Point Field, Ordnance Annex Breacher House, or Northwest Field, AAFB. Additionally, Orote Point Airfield/Runway supports personnel, equipment, and Container Delivery System airborne parachute insertions. Noise from aircraft utilized in this operation are typically less than those presented in the previous section, as aircraft are not expected to remain in the same area for an extended period of time, and altitudes are typically above 1,500 feet above ground level. At these altitudes, peak sound levels would be expected to be approximately 80 dBA from H-60 or H-46 helicopters. Fixed-wing aircraft, while producing louder sounds, typically operate at higher altitudes, thus reducing the amount of sound that propagates to the ground. Given these estimated sound levels, approximately 20 minutes of these sound levels during an hour would raise the hourly L_{eq} to 75 dBA. However, as the majority of parachute insertion activities take less than two hours, rarely involve four aircraft and aircraft locations during each operation vary in elevation and proximity to each other, it is highly unlikely that this level of intensity is reached ***during*** these activities for a duration long enough to affect community noise levels, even at the base boundary northwest of Northwest Field.

Airlift. Airlift activities provide airlift support to combat forces. Aircraft and ground training activities at Northwest Field are infrequent, under the No Action Alternative, 77 airlift activities occur at Northwest Field on AAFB annually. Typical aircraft may include H-60, H-46, H-53, V-22, or C-130 variants and up to four of these aircraft can be used per operation. As indicated previously, the noise environment at Northwest Field and the immediately adjacent off-Base area is estimated to be typical for a quiet urban daytime (i.e., 50 dBA) when activities are not occurring. Existing ambient noise conditions at and around Northwest Field include aircraft overflight from main base activities, shotgun firing associated with the public hunting program, vehicle traffic on unimproved access roads, and thunderclaps during thunderstorms.

The expected sound levels involving a single helicopter could reach 94 dBA SEL in the immediate vicinity of the operation (approximately 100 ft). Two helicopters at this range would produce SELs nearing 97 dBA and four aircraft operating in this defined area would produce SELs nearing 100 dBA. However, the closest non-military land use area is over 500 m to the west of the airfield. No schools or hospitals occur in this zone. Scattered beachfront houses do occur between the Pacific Ocean shoreline and the Base boundary northwest of Northwest Field. At distances to these receptors, four helicopters operating near the ground would produce SELs of approximately 76 dB. Fewer aircraft per operation, or higher operating elevations would reduce this sound level. Given these estimated sound levels, approximately 45 minutes of these levels during an hour would raise the hourly L_{eq} to 75 dBA. It would take over two hours of the activity level to raise the DNL above 65 dBA. As the majority of airlift activities take less than two hours, rarely involve four aircraft and aircraft locations during each operation vary in elevation and proximity to each other, it is highly unlikely that this level of intensity is reached during these activities for a duration long enough to affect community noise levels, even at the base boundary northwest of Northwest Field.

Seize Airfield. Airfield Seizure activities are used to secure key facilities in order to support follow-on forces, or enable the introduction of follow-on forces. An airfield seizure consists of a raid/seizure force from over the horizon assaulting across a hostile territory in a combination of helicopters, vertical takeoff and landing (VTOL aircraft), and other landing craft with the purpose of securing an airfield or a port. NSW teams have conducted this operation at Northwest Field on AAFB. As typical aircraft and operation duration is similar to that of airlift activities at Northwest Field on AAFB, the effects from a single operation are the same as described above. However, this operation occurs very rarely and does not contribute to community noise levels.

Offshore Operations. This section will assess airborne noise effects from activities that occur offshore of islands in the MIRC as well as activities occurring in Warning Area and Restricted Airspace, including FDM. Types and numbers of activities occurring in the baseline and the proposed alternatives may be found in Section 2.0 and Table 2-6. Though there are several major exercises that occur under the No Action Alternative, they are primarily offshore and typically do not affect terrestrial/airborne sensitive receptors. Components of these major exercises that can contribute to airborne noise and potentially affect sensitive receptors such as aircraft overflights are similar to effects described in the above sections, and potential effects from ordnance used during these activities (i.e. Gunnery Exercise [GUNEX], Bombing Exercise [BOMBEX], etc.) are similar to those described below. These range exercises typically last between 2-3 weeks and occur on an annual basis, minimizing contributions to long-term noise levels.

GUNEX. Surface-To-Surface GUNEX takes place in the open ocean offshore areas of MIRC to provide gunnery practice for Navy and Coast Guard ships utilizing shipboard gun systems and small craft crews supporting NSW, EOD, and Mobile Security Squadrons (MSS) utilizing small arms. GUNEX training activities conducted in W-517 involve only surface stationary targets such as a MK-42 Floating At Sea Target (FAST) or MK-58 marker (smoke) buoys. The systems employed against surface targets include the 5-in,76-mm, 25-mm chain gun, 20-mm Close In Weapon System (CIWS), .50 caliber machine gun, 7.62 mm machine gun, small arms, and 40-mm grenades. Air-to-Surface (A-S) GUNEX activities are conducted by rotary-wing aircraft against stationary targets (FAST and smoke buoy). Rotary-wing aircraft involved in this operation would use either 7.62-mm or .50-caliber door-mounted machine guns

Noise produced by GUNEX activities is varied in nature and typically consist of engine and boat noise or aircraft noise (A-S activities) with intermittent .50-cal machine gun and small arms firing. Of the ordnance types listed above, the loudest sounds would be from the 5-inch and 76- mm guns, both of which are capable of producing SELs of 110 dBA at distances of 50 ft from the source. The SH-60 helicopters that most typically participate in A-S GUNEX activities can produce single event overflight levels approaching 90 dBA SEL. Effects from these acoustic sources are minimal to non-existent as the offshore areas are remote from populated areas, participants are all beyond safe distances, and there are no sensitive human sources in the vicinity.

BOMBEX. BOMBEX (Land) allows aircrews to train in the delivery of bombs and munitions against ground targets at FDM. BOMBEX exercises can involve a single aircraft or multiple aircraft which can include aircraft such as FA-18, B-1B, B-2, B-52, and H-60. F-22 and F-15 aircraft will be part of the ISR/Task Force and may require use of this training range as well. Noise from aircraft is minimal, as long-range bombers typically operate at higher elevations (15,000 ft above ground level [AGL] or higher), and smaller tactical aircraft operate much lower, though usually above 3,000 ft AGL. At these elevations, SELs from direct overflights of F-18s and SH-60s would approach 95 dBA and 70 dBA, respectively. The ordnance commonly used in this training on FDM are inert training munitions (e.g., MK-76, BDU-45, BDU-48, BDU-56), and live MK-80-series bombs. Of these, the loudest sounds would be from live MK-80-series bombs, with SELs ranging between 110 dBA and 125 dBA, with peak sound levels being much higher. However, the noise impacts to humans would be minimal because the offshore areas are remote from populated areas, participants are all beyond safe distances, and there are no sensitive human receptors in the vicinity.

MISSILEX (Surface). The Air-to-ground Missile Exercise (MISSILEX) provides live-fire opportunities for aircrews and supporting maintenance. On FDM it is conducted mainly by H-60 aircraft using AGM-114 Hellfire missiles and occasionally by fixed wing aircraft using AGM-65 and AGM-88 missiles. A basic air-to-ground attack involves one or two H-60 aircraft. Typically, the aircraft will approach the target, acquire the target, and launch the missile. The missile is launched in forward flight or at hover at an altitude of 300 ft AGL.

Fixed wing aircraft would produce some noise at the surface, but noise levels for helicopters would be more intense, about 90 dBA. Although no precise data are available on powered missile impact noise levels, they can be approximated by live MK-80-series bombs, which can produce SELs in the range of 110-125 dBA at 50 ft (15 m). However, because of the remoteness of the FDM area, the ambient wind noise, and the lack of sensitive human receptors, the impacts would be less than significant for the No Action and the other two alternatives.

MISSILEX (Air). The Air-to-air Missile Training Exercise provides live-fire opportunities for aircrews and supporting maintenance. Typically, these exercises are conducted by Air Force and Navy fighter aircraft, firing live missiles against unmanned, air-launched drones or flares. Historically, these events have accompanied COCOM-level exercises and take place in Warning Areas at significant range (60 nm or greater) from inhabited areas, negating potential noise impacts on local populace.

FIREX. FIREX (Land) on FDM consists of the shore bombardment of an impact area by Navy guns as part of the training of both the gunners and Shore Fire Control Parties (SFCP). A SFCP consists of spotters who act as the eyes of a Navy ship when gunners cannot see the intended target. From positions on the ground or air, spotters provide the target coordinates at which the ship's crew directs its fire. The spotter provides adjustments to the fall of shot, as necessary, until the target is destroyed. On FDM, spotting may be conducted from the special use 'no fire' zone or provided from a helicopter platform.

Noise associated with FIREX exercises typically exceed 110 dBA SEL at the source (i.e., gun muzzle) for each round fired. For a 110-round exercise over six hours, a typical 60 dBA hourly L_{eq} impact contour of 0.1 nm (180 m) would be expected around the ship, which is about five to seven nm (9 - 13 km) offshore. The potential impact of these sound levels is minimal because of its close-in distance to the ship and extremely low probability that any non-participant ship, boat or divers would be in this close vicinity.

Breaching. Breaching activities train personnel to employ any means available to break through or secure a passage through an enemy defense, obstacle, minefield, or fortification. This enables a force to maintain its mobility by removing or reducing natural and man-made obstacles. In the NSW sense, breacher activities are designed to provide Navy SEAL teams experience knocking down doors to enter a building or structure. During the conduct of a normal breach operation, SEALs practice knocking down the door using explosives that are less than one pound net explosive weight (NEW). Training activities are infrequent, occurring about 13 times a year at the Ordnance Annex Breacher House and exercised using simulations occur at the OPCQC House. Explosives at OPCQC are not permitted, which limits the value of conducting this training at OPCQC.

Typical noise levels associated with detonations of one pound NEW have been reported producing peak sound level of approximately 150 dBA at a distance of 150 m from the source. As these detonations are brief in duration and transient in occurrence, associated SELs are much lower, the contribution of this noise to community DNLs and the projected impacts to human sensitive receptors is low. Breacher training is restricted to the Ordnance Annex Breacher House, which is approximately 500 m from the Ordnance Annex Boundary. In addition, the varied elevation and terrain surrounding the breacher house which would serve to further attenuate propagation, would limit the effect of this training activity on time-averaged community noise levels. However, individuals or non-human sensitive species exposed to these noise events may be startled if they are unaware of the source of the noise. The infrequency of this event represents a transient stimulus which does not have a prolonged effect on human sensitive receptors.

Explosive Ordnance Disposal Training.

Land Demolition Activities. Activities using land demolitions are designed to develop and hone EOD detachment mission proficiency in location, excavation, identification, and neutralization of buried land mines. During the training, teams transit to the training site in trucks or other light wheeled vehicles. A search is conducted to locate inert (non-explosively filled) land mines or Improvised Explosive Devices (IED)s and then designate the target for destruction. Buried land mines and unexploded ordnance (UXO) require the detachment to employ probing techniques and metal detectors for location phase. Use of hand tools and digging equipment is required to excavate. Once exposed and/or properly identified, the detachment neutralizes threats using simulated or live explosives that utilize up to two pounds NEW. Land demolition training is actively conducted throughout the MIRC. Land demolition activities have occurred at Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point Airfield/Runway, OPCQC House, Ordnance Annex Breacher House, Ordnance Annex Detonation Range, Fire Break # 3, Ordnance Annex Galley Building 460, Southern Land Navigation Area, and Barrigada Housing.

Under the No Action Alternative, these activities take place approximately 136 times annually, with 82 of the activities culminating in the use of explosives to neutralize mines or UXO. These 82 activities all occurred at the Ordnance Annex Demolition Range which is located approximately 1,250 m from the closest public boundary. Typical peak noise levels associated with detonations of up to two pounds NEW are approximately 155 dBA at a distance of 150 m from the source. The received peak levels at the Annex boundary without taking noise attenuation from terrain shielding or a berm into account would be expected to be approximately 137 dB, with the respective SEL being lower, as this is an extremely brief event. While individuals or non-human sensitive receptors exposed to these noise events may be startled if they are unaware of the source of the noise, the brevity of these received levels and relative infrequency of activities do not contribute to Community Noise Equivalent Levels (CNELs) even at the closest public land use area to the Ordnance Annex, and the impacts to human sensitive receptors is low to minimal.

Marksmanship. Marksmanship exercises are used to train personnel in the use of all small arms weapons for the purpose of ship self defense and security. Basic marksmanship activities are strictly controlled and regulated by specific individual weapon qualification standards. Small arms include but are not limited to 9-mm pistol, 12-gauge shotgun, and 7.62-mm rifles. These exercises have occurred at Orote Point and Finegayan small arms ranges, and Orote Point known distance (KD) range and are the most common activity that occurs in the MIRC, with over 570 activities annually.

Small arms firing can produce peak noise levels of 90 to 100 dB at 500 ft (152 m) and 80 to 90 dB at 1,000 ft (305 m) for the most common types of small arms. While the use of these arms can produce received sound levels up to 90 dBA SEL at 50 ft for each round fired, these sound-generating events are not continuous, which minimizes their contribution to hourly L_{eq} values or community DNLs. In addition, these exercises occur in areas that are restricted to general public use and are well away from surrounding community land use. In addition, propagation of noise from small arms fire is in the direction of the firing activity, in these cases, away from public land-use, further minimizing their contribution to hourly L_{eq} values or community DNLs. Potential impacts to non-human sensitive receptors, such as federally listed species, is expected to be minimal to non-existent as marksmanship activities occur away from known habitats of sensitive species. These activities do not make large contributions to the community noise levels of adjacent non-military land and no human sensitive receptors are affected by the sound from such activities.

MOUT. Military Operations in Urban Terrain (MOUT) activities encompass advanced offensive close quarter battle techniques used on urban terrain conducted by units trained to a higher level than conventional infantry. Techniques include advanced breaching, selected target engagement, and dynamic assault techniques using organizational equipment and assets. MOUT is primarily an offensive operation, where noncombatants are or may be present and collateral damage must be kept to a minimum. MOUT can consist of more than one type. One example might be a “raid,” in which Army Special Forces or Navy Sea, Air, and Land Forces (SEALs) use MOUT tactics to seize and secure an objective, accomplish their mission and withdraw. Another example might be a Marine Expeditionary Force (MEF) using MOUT tactics to seize and secure an objective for the long term. Regardless, of the type, training to neutralize enemy forces must be accomplished in a built-up area featuring structures, streets, vehicles, and civilian population. MOUT training involves clearing buildings; room-by-room, stairwell-by-stairwell, and keeping them clear. It is manpower intensive, requiring close fire and maneuver coordination and extensive training. Limited, non-live fire, MOUT training is conducted at the OPCQC House, the Ordnance Annex Breacher House, Barrigada Housing, and the Andersen South Housing Area. Additionally, the OPCQC supports “raid” type MOUT training on a limited basis.

About 100 MOUT events occur per year, the majority of which include the firing of blanks or simulated munitions (known as “simunitions”). The most intensive use would occur during TRUEX type exercises, when up to three Marine Corps companies utilize Anderson South range for up to three weeks, which currently occurs twice a year. Small arms firing can produce peak noise levels of 90 to 100 dB at 500 ft (152 m) and 80 to 90 dB at 1,000 ft (305 m) for the most common types of small arms. Most blank ammunition for small arms has a smaller propellant charge than that used for live ammunition. As a result, noise from small arms blank ammunition typically generates noise levels about four decibels below those of live ammunition. A blank produces a noise level of about 96 dBA at a distance of 500 ft (152 m) and about 90 dBA at a distance of 1,000 ft (305 m). Activities that utilize low numbers of simunitions do not likely contribute to surrounding land-use noise levels, as the infrequency and brief duration of each event do not influence hourly equivalent noise levels. However, intense activities could contribute to the surrounding noise levels depending on the location the activities take place. For example, 1,400 blanks fired within an hour from the same approximate location produce an hourly L_{eq} of about 85 dBA at a distance of 750 ft (229 m), which would influence community DNLs in that vicinity. These high intensity events may be distracting or annoying in nearby public areas. However, MOUT activities that occur at the Orote CQC House and the Ordnance Annex Breacher House are not in close proximity to public land use and do not contribute to the community noise levels. MOUT activities occurring at the Barrigada Housing site and Andersen South Housing Areas during prolonged intense training activities and in close proximity to adjacent public lands for the duration of the event could elevate community noise levels but is unlikely due to the infrequency of activities in these locations.

Direct Action. Direct action activities also occur at FDM. In addition to the aircraft noise described in Section 3.5.2.2, small arms, grenades, and crew served weapons are employed in direct action activities against targets on the island. Small arms firing can produce peak noise levels of 90 to 100 dB at 500 ft (152 m) and 80 to 90 dB at 1,000 ft (305 m) for the most common types of small arms. Peak sound levels from grenades can reach 164 dBA at 50 ft. Participation in Tactical Air Control Party/Forward Air Control (TACP/FAC) training in conjunction with a BOMBEX-Land also occurs. Because of the remoteness of the FDM area, the ambient wind noise, and the lack of sensitive human receptors, any noise impacts would be less than minimal for the No Action Alternative.

3.5.3.3 Alternative 1

Alternative 1 is a proposal designed to meet the Services' current and foreseeable training requirements. If Alternative 1 were to be selected, in addition to accommodating the No Action Alternative, it would include increased training as a result of upgrades and modernization of existing capabilities, and include establishment of a permanent danger zone and restricted area around FDM (a 10-nm zone around FDM to be established in accordance with C.F.R. Title 33 Part 334; see Figure 2-3). Alternative 1 also includes training associated with ISR/Strike and other Andersen AFB initiatives. Training will also increase as a result of the acquisition and development of new Portable Underwater Tracking Range (PUTR) capabilities. PUTR trains personnel in undersea warfare including conducting TRACKEX and TORPEX activities. Helicopter, ship, and submarine sonar systems will use this capability. Small arms range capability improvements and MOUT training facility improvements would also increase training activities. Table 2-8 summarizes these increases in training activities. These increased capabilities will result in increased multi-national and/or joint exercises.

Environmental impacts associated with ISR/Strike have been analyzed in the *2006 Establishment and Operation of an Intelligence, Surveillance and Reconnaissance Strike, Andersen Air Force Base, EIS*. Noise from aircraft overflights would affect Mariana fruit bat and Mariana crow recovery efforts, as well as current populations. Based on current literature and field observations presented in the EIS, habituation by Marianas fruit bats and Mariana crows to an incremental increase of overflights would be expected. Further, adverse effects that do become apparent due to aircraft activities would initiate modifications to aircraft ground tracks and profiles over sensitive areas through an adaptive management strategy. This adaptive management strategy involves multiyear monitoring of noise effects using up-to-date standards for acoustical studies on sensitive species that would affect operational changes.

In general, under Alternative 1, the number of noise-generating training activities would increase. This increase in many of activities listed in Section 3.5.2.2 would not result in general increases in noise levels. As with the No Action Alternative, sound-generating events under Alternative 1 are intermittent, occur in remote or off-limit areas, and do not expose a substantial number of human receptors to high noise levels. Very few sensitive receptors are likely to be exposed to sound from such military activities.

Aircraft Overflights

Tactical Insertion/Extraction. Under Alternative 1, the number of Tactical Insertion/Extractions is expected to increase and the majority of insertion/extraction exercises will continue to occur in the Guam Commercial Harbor and within the Apra Harbor Naval Complex, both of which are at distances from public lands where operational noise would not contribute to community noise levels. As this operational increase is expected to be minimal, the contribution to community noise levels would remain nearly the same and not likely to affect non-human sensitive receptors. Activities occurring outside the Guam Commercial Harbor or Apra Harbor Naval Complex would take place infrequently and would not be a significant contributor to community noise levels.

Direct Action. Under Alternative 1, the number of Direct Action activities will increase by no more than 32 activities annually. The majority of these Direct Action activities will continue to occur at the OPCQC House in the Apra Harbor Naval Complex. Noise from helicopter insertions is expected to be transient and of short duration. Combined with the distance between training areas and adjacent public land use, influences on the community noise environment or other terrestrial sensitive receptors from Direct Action activities is expected to be the same as those described under the No Action Alternative.

Assault Support. The number of Assault Support activities is expected to increase occur nine times at Polaris Point Field and Orote Point KD Range sites from which the MEU commander can provide assault support activities to his forces within the MIRC. Assault support activities also occurred eight times annually on Tinian at the EMUA.

Parachute Insertions and Air Assault. These air activities are conducted to insert troops and equipment by parachute and/or air land by fixed or rotary wing aircraft to a specified objective area. Typical aircraft will include from one to four H-60, H-46, H-53, V-22, or C-130 variants. Under the No Action Alternative, 26 of these activities occur annually at Orote Point Triple Spot, Polaris Point Field Ordnance Annex Breacher House, or Northwest Field at AAFB. Additionally, Orote Point Airfield/Runway supports personnel, equipment, and Container Delivery System airborne parachute insertions. Noise from aircraft utilized in this operation are typically less than those presented in the previous section, as aircraft are not expected to remain in the same area for an extended period of time, and operation altitudes are typically above 1,500 feet AGL. At these altitudes, peak sound levels would be expected to be approximately 80 dBA from H-60 or H-46 helicopters. Fixed-wing aircraft, while producing louder sounds, typically operate at higher altitude, thus reducing the amount of sound that propagates to the ground and related impacts to sensitive receptors. Given these estimated sound levels, approximately 20 minutes of operations producing these sound levels during an hour would raise the hourly L_{eq} to 75 dBA. However, as the majority of parachute insertion activities take less than two hours, rarely involve four aircraft and aircraft locations during each operation vary in elevation and proximity to each other, it is highly unlikely that this level of intensity is reached during these activities for a duration long enough to affect community noise levels, even at the base boundary northwest of Northwest Field.

Airlift. Airlift activities are expected to approximately double in occurrence from the current level of 77 annual activities. Training associated with airlift activities will continue to utilize Northwest Field on AAFB. Dependent on the distribution of the proposed activities over time, the potential for community DNLs to exceed 65 dBA exists in the non-military land-use area that is northwest of the training area. As described under the No Action Alternative, a training activity would need to produce two hours of nearly constant sound (approximately 75 dBA) to raise the community noise level in this public area above 65 dB, assuming a typical ambient noise level of 55 dBA. Scheduling two activities in a single day period that have this level of activity would potentially raise the DNL to over 68 dBA which would result in a small proportion of the civilian population in the area being annoyed by the noise. However, it is not anticipated that the infrequent noise level elevation caused by these activities would have any lasting effect on human-receptors outside of annoyance. Restricting the total number of activities per day and scheduling high intensity activities for periods between 0700 and 2200 would minimize the contribution to DNLs in this public area from airlift noise.

Seize Airfield. Seize Airfield activities are expected to increase only slightly and will continue to utilize Northwest Field on AAFB The increase in activities would not produce long-term ambient noise levels appreciably greater than the No Action Alternative. Thus, no impact changes are expected under this Alternative and effects are the same as described under the No Action Alternative.

Offshore Operations. Under Alternative 1, the number of activities occurring within W-517 and FDM are expected to increase from 552 activities to 2,542 annually. Offshore major exercises are expected to increase as well, though not expected to contribute (outside of aircraft overflights over land and ordnance use) to community noise levels. The majority of these activities are expected to be associated with BOMBEX activities. The ordnance used in this training is expected to remain similar and include inert training munitions (e.g., MK-76, BDU-45, BDU-48, BDU-56), and live MK-80-series bombs. As previously stated, the loudest sounds would be from live MK-80-series bombs, with SELs ranging between 110 dBA and 125 dBA, with peak sound levels being much higher. While the total number of annual activities is high, the average number of daily activities is less than ten and would still not contribute to equivalent noise levels. For example, assuming ten activities occur an hour, each involving the use of a live MK-80 series bomb, and respective detonations occurring in the same location, this operation would produce a hourly L_{eq} of approximately 65 dBA at a distance of 55 m. This increase in number of activities and detonations may affect non-human sensitive receptors on FDM from increased numbers of potentially disturbing impulse noises. However, current practices of targeting areas that are the least sensitive for nesting and roosting (eastern cliffs, northern portion of island) of sensitive species aim to reduce any direct effect from ordnance activities, though there may still be acoustic signatures that cause temporary disturbance. Impacts to human receptors would be minimal because the offshore areas are remote from populated areas, participants are all beyond safe distances, and there are no sensitive human receptors in the vicinity.

Breaching. Breaching activities are expected to increase slightly under Alternative 1 from 11 to no more than 26 activities annually. Breaching activities are expected to occur at OPCQC and the Ordnance Annex Breacher House. The increases in activities would not produce long-term ambient noise levels appreciably greater than the No Action Alternative. Thus, no impact changes are expected under this Alternative and effects are the same as described under the No Action Alternative for human sensitive receptors.

EOD Training. Under Alternative 1, the number of land demolition activities is expected to increase at Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point Airfield/Runway, OPCQC House, Ordnance Annex Breacher House, Ordnance Annex Detonation Range, Fire Break # 3, Ordnance Annex Galley Building 460, Southern Land Navigation Area, and Barrigada Housing. The number of activities that neutralize ordnance or mine-shapes with explosives is anticipated to increase from 82 to 100 activities annually. If activities that culminate in the actual detonation of ordnance remain limited to the Ordnance Annex Demolition Range, contributions to the community noise levels will remain minimal, as the explosive events are extremely brief. While the increase in these impulsive noise sources may affect non-human sensitive receptors, the infrequency of this activity limits any potential impacts to sensitive receptors and effects of noise from EOD training are the same as described under the No Action Alternative for human sensitive receptors.

Marksmanship. Marksmanship activities under Alternative 1 would increase, from approximately 570 to over 750 annual activities. Small arms include but are not limited to 9-mm pistol, 12-gauge shotgun, and 7.62-mm rifles. These exercises will continue to occur at the Orote Point and Finegayan small arms ranges, and Orote Point KD range which are restricted to general public use and are well away from surrounding community land use (greater than one mile).

Small arms firing can produce peak noise levels of 90 to 100 dB at 500 ft (152 m) and 80 to 90 dB at 1,000 ft (305 m) for the most common types of small arms. While the use of these arms can produce received sound levels up to 90 dBA SEL at 50 ft for each round fired, the received sound levels on adjacent lands may be at or near ambient noise levels. In addition, propagation of noise from small arms fire is in the direction of the firing activity, in these cases, away from public land-use, further minimizing their contribution to hourly L_{eq} values or community DNLs. These activities would not contribute to the community noise levels of adjacent non-military land and no human sensitive receptors would be affected by the sound from such activities.

MOUT. MOUT activities under Alternative 1 are expected to double from the current level of activities presented in the No Action Alternative. Of these activities, almost half would occur under the proposed activities at Andersen South Training Area (ASTA). The remaining activities are spread out between Orote Point QCQ, and the Ordnance Annex Breacher House. The minimal increase in these activities at these training areas would not likely contribute significantly to the ambient noise levels. Therefore, impacts associated with Alternative 1 would be the same as those described above for the No Action Alternative for MOUT activities not occurring at the ASTA.

The U.S. Marine Corps prepared an Environmental Assessment (EA) for MOUT Training at Andersen South, Guam (USMC, 2003). The EA analyzed the potential impacts from the development of a MOUT training facility at Andersen South, along with basic infantry skills training, maneuver exercises, and aviation and related training. The analysis indicated that noise from helicopters approaching the training area from the north would potentially impact residential communities. Noise effects from simulated close air support with fixed wing aircrafts would likely affect human sensitive receptors outside of the training area. Noise modeling, based on a worst case scenario of flying as low as 500 feet (152 m) AGL, indicated noise levels above 65 dB. However, as fixed wing aviation training was projected to be infrequent and of short duration (approximately four times a year to support a three day major exercise), the potential impact from such activities would be minimal. To further avoid or minimize disruption, helicopters would be required to approach from the south during night-time hours to reduce effect on nearby public use lands. While the proposed activities were not implemented, this reference indicates the potential for high levels of activity with only minimal effects on sensitive receptors, which can be further reduced with mitigation. The increase in activities at ASTA under Alternative 1 is less than was analyzed under EA described above. As such, the effects of noise from MOUT activities under Alternative 1 is expected to remain the same as those described under that No Action Alternative.

3.5.3.4 Alternative 2

Implementation of Alternative 2 would include all the actions proposed for MIRC in Alternative 1 and increased training activity associated with major at-sea exercises. Additional major at-sea exercises would provide additional ships and personnel maritime training including additional use of sonar that may improve the level of joint operating skill and teamwork between the Navy, Joint Forces, and Partner Nations. Submarine, ship, and aircraft crews train in tactics, techniques, and procedures required in carrying out the primary mission areas of maritime forces. The additional maritime exercises would take place within the MIRC and would focus on carrier strike group training and ASW activities similar to training conducted in other Seventh Fleet locations, including a Fleet Strike Group Exercise, an Integrated ASW Exercise, and a Ship Squadron ASW Exercise.

One type of ASW exercise is conducted by deployed Navy Strike Groups (CSGs and ESGs) to assess their ASW proficiency while located in the Seventh Fleet area of activities. This ASW exercise is designed to assess the Strike Groups' ability to conduct ASW in the most realistic environment, against the level of threat expected, in order to effect changes to both training and capabilities (e.g., equipment, tactics, and changes to size and composition) of Navy Strike Groups. Along with the assessment goal, CSGs and ESGs receive significant training value in this type of ASW exercise, as training is inherent in all at-sea exercises.

Another major ASW exercise is a Chief of Naval Operations (CNO) chartered program with the overall objective to collect and analyze high-quality data to quantitatively "assess" surface ship ASW readiness and effectiveness. This ASW exercise will typically involve multiple ships, submarines, and aircraft in several coordinated events over a period of a week or less.

The number of activities and the types of effects on humans of sound generated by military activities under Alternative 2 would be similar to those under Alternative 1 for terrestrial activities. Under Alternative 2, there would be a 15% increase of activities in at sea exercises, which are removed from human receptors. As with the No Action Alternative and Alternative 1, sound-generating events under Alternative 2 are intermittent, occur in remote or off-limit areas, and do not expose a substantial number of human receptors to high noise levels.

3.5.4 Unavoidable Significant Environmental Effects

Under either proposed action alternative, increased training activities within the MIRC would result in irregular, minor, and short-term disturbances from military activity noise, but would have no unavoidable significant environmental effects.

3.5.5 Summary of Effects (NEPA and EO 12114)

Airborne noise generated by the Proposed Action under the No Action Alternative, Alternative 1, or Alternative 2 would have no substantial environmental effects on human sensitive receptors because:

- Noise from training activities in the MIRC would be dispersed and intermittent, so it would not contribute to public long-term noise levels;
- Training areas on FDM are remote and isolated from the general public, so no sensitive receptors (non-participants) would be exposed to noise events occurring on FDM;
- No new public areas would be exposed to noise from training and testing activities.
- Land-based ordnance detonations occur mostly in FDM, a designated restricted area; and
- The incremental increases in the numbers of range events would not considerably increase long-term average noise levels; hourly average equivalent noise levels are and would remain relatively low.

Table 3.5-4 summarizes noise effects for the No Action, Alternative 1, and Alternative 2.

Table 3.5-4: Summary of Environmental Effects of Airborne Noise for the Alternatives in the MIRC Study Area

Alternative	NEPA (Land and U.S. Territorial Waters, < 12 nm)	EO 12114 (Non-U.S. Territorial Waters, > 12 nm
No Action Alternative	Sound-generating events are intermittent, occur in remote 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 for such military activities.	Sound-generating events are intermittent, occur in remote 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 for such military activities.
Alternative 1	Increases in training activities generally are not of a magnitude that would result in a perceptible increase in the ambient noise level. Therefore, impacts would be the same as under the No Action Alternative.	Increases in training activities generally are not of a magnitude that would result in a perceptible increase in the ambient noise level. Therefore, impacts would be the same as under the No Action Alternative.
Alternative 2	Increases in training activities generally are not of a magnitude that would result in a perceptible increase in the ambient noise level. Therefore, impacts would be the same as under the No Action Alternative.	Increases in training activities generally are not of a magnitude that would result in a perceptible increase in the ambient noise level. Therefore, impacts would be the same as under the No Action Alternative.

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3.6 MARINE COMMUNITIES

3.6.1 Introduction and Methods

3.6.1.1 Regulatory Framework

A community is an assemblage of plants and/or animal populations sharing a common environment and interacting with each other and with the physical environment. This section specifically addresses the following marine communities occurring within the MIRC Study Area: primary and secondary production communities, benthic communities (including seamounts, hydrothermal vents, abyssal plain, and the Marianas Trench), and coastal habitats (including intertidal zone, coral communities and reefs, soft bottom habitats, estuaries, lagoons, seagrasses and submerged aquatic vegetation, and mangroves), and artificial habitats (including artificial reefs, shipwrecks, and fish aggregating devices [FADs]). Marine mammals are addressed in subsection 3.7, sea turtles are addressed in subsection 3.8, fish and essential fish habitat are addressed in subsection 3.9, and seabirds and migratory birds are addressed in subsection 3.10. Marine species listed under the ESA are addressed in subsections 3.7 through 3.9, as applicable.

The various federal laws and regulations that afford protection and management of marine communities are primarily aimed at specific community components such as ESA-listed species and designated critical habitat; marine mammals; federally managed fish species and essential fish habitat; and migratory birds. Compliance with EO 13089 and the Marine Protection, Research, and Sanctuaries Act (MPRSA) serve as the threshold for significance in the NEPA analysis of potential impacts associated with the No Action, Alternative 1, and Alternative 2.

3.6.1.1.1 Federal Laws and Regulations

Executive Order 13089, Coral Reef Protection. EO 13089, Coral Reef Protection, was issued on June 11, 1998, "to preserve and protect the biodiversity, health, heritage, and social and economic value of U.S. coral reef ecosystems and the marine environment." EO 13089 instructs federal agencies whose actions may affect U.S. coral reef ecosystems to (1) identify actions that may affect coral reef ecosystems; (2) utilize their programs and authorities to protect and enhance the conditions of such ecosystems; and (3) to the extent permitted by law, ensure that any actions they authorize, fund, or carry out will not degrade the conditions of such ecosystems.

Marine Protection, Research, and Sanctuaries Act. Another regulation protecting the underwater environment is the MPRSA, which was enacted in 1972 by Congress. This Act prohibits dumping material into the ocean that would unreasonably degrade or endanger human health or the marine environment. Where dredging and ocean dumping of the dredged materials occur, a permit must be issued by the U.S. Army Corp of Engineers (USACE), which is subject to USEPA approval.

Unless authorized by a permit, MPRSA generally prohibits (1) transportation of material from the U.S. for the purpose of ocean dumping ; (2) transportation of material from anywhere for the purpose of ocean dumping by U.S. agencies or U.S.-flagged vessels; and (3) dumping of material transported from outside the U.S. into the U.S. territorial sea or into the contiguous zone (12 nm [22 km] from the base line) to the extent that it may affect the territorial sea or the territory of the United States.

3.6.1.2 Assessment Methods and Data Used

General Approach to Analysis. This EIS/OEIS analyzes warfare areas (e.g., Mine Warfare, Air Warfare) which include multiple types of training activities (e.g., Mine Neutralization, Air-to-Surface Missile Exercise). These training activities include such events as ship maneuvers, aircraft overflights, and weapons firing and are considered to be the environmental stressors when analyzing impacts to biological resources.

The following general steps were used to analyze the potential environmental consequences to marine communities and biological resources as a whole:

- Identify those aspects of the Proposed Action that are likely to act as stressors to biological resources by having a direct or indirect effect on the physical, chemical, and biotic environment of the Study Area. 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 and defined the MIRC Study Area.
- Identify the biological 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 biological resources are likely to respond given their exposure and available data (response analysis).
- Determine the risks those responses pose to biological resources and the significance of those risks.

Study Area. The Study Area for marine communities consists of surface areas and targets of the MIRC as shown on Figure 1-1.

Data Sources. A comprehensive and systematic review of relevant literature and data has been conducted in order to complete this analysis for marine communities. 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 training reports, EISs, Range Complex 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 on the occurrence of marine resources within the Study Area. The primary sources of information used to describe the affected environment for marine communities were in the Navy's Marine Resources Assessment (MRA) report for the Marianas Operating Area (DoN, 2005). The MRA report provides a compilation of the most recent data and information on the occurrence of marine resources in the Study Area. Descriptions of literature and data searches conducted during preparation of the MRA are described in detail in that report.

Factors Used to Assess the Significance of Effects. The factors used to assess significance of the effects to marine communities include the extent or degree to which implementation of an alternative would result in permanent loss or long-term degradation of the physical, chemical, and biotic components that make up a marine community.

3.6.1.3 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 communities. Navy subject matter experts de-constructed the warfare areas and training activities described in Chapter 2 of this EIS/OEIS 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. As summarized in Table 3.6-1, potential stressors to marine communities include vessel movements (disturbance and collisions), weapons firing/non-explosive ordnance use (strikes), underwater detonations and explosive ordnance (explosions), and expended materials (ordnance related materials, targets, chaff, self-protection flares, and marine markers). The potential effects of these stressors on marine communities are analyzed in detail in subsection 3.6.3.

As discussed in subsection 3.2 (Hazardous Materials and Waste) and subsection 3.4 (Air Quality), some water and air pollutants would be released into the environment as a result of the Proposed Action. The analyses presented in those sections indicate that any increases in water or air pollutant concentrations resulting from Navy training in the MIRC Study Area would be negligible and localized, and impacts to water and air quality would be less than significant. Based on the analyses presented in those sections, water and air quality changes would have no effect or negligible effects on marine communities. Accordingly, the effects of water and air quality changes on marine communities are not addressed further in this EIS/OEIS.

Table 3.6-1: Summary of Potential Stressors to Marine Communities

Training Type/ Training Area	Training Name	Potential Stressor	Potential Activity Effect on Marine Communities
Army Training			
Surveillance and Reconnaissance (S & R)		None	N/A
Field Training Exercise (FTX)		None	N/A
Live Fire		None	N/A
Parachute Insertions and Air Assault		None	N/A
Military Training in Urban Terrain (MOUT)		None	N/A
Marine Corps Training			
Ship to Objective Maneuver (STOM)/ Tinian EMUA		Vessel Movements	Localized disturbance, injury, and mortality to plankton in nearshore waters, and possible collisions with coral communities (<3 nm [5.6 km] from the shore). Localized disturbance, injury, and mortality to plankton, benthic community features, and possible collisions with coral communities in non-territorial waters.
Training Maneuver		None	N/A
Non-Combatant Evacuation Order (NEO)		None	N/A
Assault Support (AS)		None	N/A
Reconnaissance and Surveillance (R & S)		None	N/A
MOUT		None	N/A
Direct Fires		None	N/A
Exercise Command and Control (C2)		None	N/A
Protect and Secure Area of Training		None	N/A

Table 3.6-1: Summary of Potential Stressors to Marine Communities (Continued)

Training Type/ Training Area	Training Name	Potential Stressor	Potential Activity Effect on Marine Communities
			Navy Training
Anti-Submarine Warfare (ASW)/ Open Ocean		Vessel Movements Underwater explosions Expended Materials	Localized disturbance, injury, and mortality to plankton in nearshore waters, and possible collisions with coral communities (<3 nm [5.6 km] from the shore). Localized disturbance, injury, and mortality to plankton, benthic community features, and possible collisions with coral communities in non-territorial waters. Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities.
Mine Warfare (MIW)/ Agat Bay, Inner Apra Harbor		Vessel Movements Underwater explosions Expended Materials	Localized disturbance, injury, and mortality to plankton in nearshore waters, and possible collisions with coral communities (<3 nm [5.6 km] from the shore). Localized disturbance, injury, and mortality to plankton, benthic community features, and possible collisions with coral communities in non-territorial waters. Short-term, localized disturbance to soft bottom benthic communities. Localized disturbance, injury, and mortality to plankton. Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities.
Air Warfare (AW)/ W-517, R-7201		Expended Materials	Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities.
Surface Warfare (SUW)/ FDM, R-7201	Surface to Surface Gunnery Exercise (GUNEX)	Expended Materials Weapons Firing	Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities. Short-term, localized disturbance to soft bottom benthic communities. Localized disturbance, injury, and mortality to plankton.
	Air to Surface Gunnery Exercise	Expended Materials Weapons Firing	Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities. Short-term, localized disturbance to soft bottom benthic communities. Localized disturbance, injury, and mortality to plankton.
	Visit Board Search and Seizure (VBSS)	None	N/A

Table 3.6-1: Summary of Potential Stressors to Marine Communities (Continued)

Training Type/ Training Area	Training Name	Potential Stressor	Potential Activity Effect on Marine Communities
Navy Training (Continued)			
Strike Warfare (STW)/ FDM	Air to Ground Bombing Exercises (Land)(BOMBEX-Land)	Expended Materials	Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities.
	Air to Ground Missile Exercises (MISSILEX)	Expended Materials	Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities
Naval Special Warfare (NSW)/ Orote Point Training Areas, Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field, Reserve Craft Beach, Polaris Point Field, Dan Dan Drop Zone	Naval Special Warfare (NSW OPS)	Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Localized disturbance, injury, and mortality to plankton in nearshore waters, and possible collisions with coral communities (<3 nm [5.6 km] from the shore). Localized disturbance, injury, and mortality to plankton, benthic community features, and possible collisions with coral communities in non-territorial waters. Short-term, localized disturbance to soft bottom benthic communities. Localized disturbance, injury, and mortality to plankton. Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities.
	Insertion/Extraction	Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Localized disturbance, injury, and mortality to plankton in nearshore waters, and possible collisions with coral communities (<3 nm [5.6 km] from the shore). Localized disturbance, injury, and mortality to plankton, benthic community features, and possible collisions with coral communities in non-territorial waters. Short-term, localized disturbance to soft bottom benthic communities. Localized disturbance, injury, and mortality to plankton. Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities.
	Direct Action	Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Localized disturbance, injury, and mortality to plankton in nearshore waters, and possible collisions with coral communities (<3 nm [5.6 km] from the shore). Localized disturbance, injury, and mortality to plankton, benthic community features, and possible collisions with coral communities in non-territorial waters. Short-term, localized disturbance to soft bottom benthic communities. Localized disturbance, injury, and mortality to plankton. Long-term minor and localized accumulation of expended materials in soft bottom benthic communities.

Table 3.6-1: Summary of Potential Stressors to Marine Communities (Continued)

Training Type/ Training Area	Training Name	Potential Stressor	Potential Activity Effect on Marine Communities
Navy Training (Continued)			
Naval Special Warfare (NSW)/ Orote Point Training Areas, Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field, Reserve Craft Beach, Polaris Point Field, Dan Dan Drop Zone	MOUT	None	N/A
	Airfield Seizure	None	N/A
	Over the Beach (OTB)	Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Localized disturbance, injury, and mortality to plankton in nearshore waters, and possible collisions with coral communities (<3 nm [5.6 km] from the shore). Localized disturbance, injury, and mortality to plankton, benthic community features, and possible collisions with coral communities in non-territorial waters. Short-term, localized disturbance to soft bottom benthic communities. Localized disturbance, injury, and mortality to plankton. Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities.
	Breaching	None	
	Naval Surface Fire Support (FIREX Land)	Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Localized disturbance, injury, and mortality to plankton in nearshore waters, and possible collisions with coral communities (<3 nm [5.6 km] from the shore). Localized disturbance, injury, and mortality to plankton, benthic community features, and possible collisions with coral communities in non-territorial waters. Short-term, localized disturbance to soft bottom benthic communities. Localized disturbance, injury, and mortality to plankton. Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities.
Amphibious Warfare (AMW)/ FDM, Orote Point and Finegayan Small Arms Ranges, Orote Point KD Range, Reserve Craft Beach, Outer Apra Harbor, Tipalao Cove, Tinian EMUA	Marksmanship	None	
	Expeditionary Raid	Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Localized disturbance, injury, and mortality to plankton in nearshore waters, and possible collisions with coral communities (<3 nm [5.6 km] from the shore). Localized disturbance, injury, and mortality to plankton, benthic community features, and possible collisions with coral communities in non-territorial waters. Short-term, localized disturbance to soft bottom benthic communities. Localized disturbance, injury, and mortality to plankton. Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities.
	Hydrographic Surveys	Vessel Movements Amphibious Landings	Localized disturbance, injury, and mortality to plankton in nearshore waters, and possible collisions with coral communities (<3 nm [5.6 km] from the shore). Localized disturbance, injury, and mortality to plankton, benthic community features, and possible collisions with coral communities in non-territorial waters.

Table 3.6-1: Summary of Potential Stressors to Marine Communities (Continued)

Training Type/ Training Area	Training Name	Potential Stressor	Potential Activity Effect on Marine Communities
Navy Training (Continued)			
Explosive Ordnance Disposal (EOD)	Land Demolition/ Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point (Airfield/Runway, CQC, Small Arms Range/ Known Distance Range, Triple Spot), Ordnance Annex Breacher House, Ordnance Annex Emergency Detonation Site, SLNA, Ordnance Annex SLNA, Barrigada Communications Annex	None	N/A
	Underwater Demolition/ Outer Apra Harbor, Piti Floating Mine Neutralization Area, Agat Bay	Vessel Movements Explosive Ordnance Expended Materials	Localized disturbance, injury, and mortality to plankton in nearshore waters, and possible collisions with coral communities (<3 nm [5.6 km] from the shore). Localized disturbance, injury, and mortality to plankton, benthic community features, and possible collisions with coral communities in non-territorial waters. Short-term, localized disturbance to soft bottom benthic communities. Localized disturbance, injury, and mortality to plankton. Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities.

Table 3.6-1: Summary of Potential Stressors to Marine Communities (Continued)

Training Type/ Training Area	Training Name	Potential Stressor	Potential Activity Effect on Marine Communities
Navy Training (Continued)			
Logistics and Combat Services Support/Orote Point Airfield/ Runway, Reserve Craft Beach	Combat Mission Area	Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Localized disturbance, injury, and mortality to plankton in nearshore waters, and possible collisions with coral communities (<3 nm [5.6 km] from the shore). Localized disturbance, injury, and mortality to plankton, benthic community features, and possible collisions with coral communities in non-territorial waters. Short-term, localized disturbance to soft bottom benthic communities. Localized disturbance, injury, and mortality to plankton. Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities.
	Command and Control (C2)	None	N/A
Combat Search and Rescue (CSAR)	Embassy Reinforcement	None	N/A
	Anti-Terrorism (AT)	None	N/A
Air Force Training			
Counter Land		None	
Counter Air (Chaff)/ W-517, ATCAAs 1 and 2		Expended Materials	Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities.
Airlift		None	N/A
Air Expeditionary		None	N/A
Force Protection		None	N/A
Intelligence, Surveillance, Reconnaissance (ISR) and Strike Capacity	Air-to-Air Training	None	N/A
	Air-to-Ground Training	None	N/A
Rapid Engineer Deployable Heavy Operational Repair Squadron Engineer (RED HORSE)	Silver Flag Training	None	N/A
	Commando Warrior Training	None	N/A
	Combat Communications	None	N/A

3.6.2 Affected Environment

3.6.2.1 Primary Production Communities

Primary production is a rate at which the biomass of organisms changes and is defined as the amount of carbon fixed by organisms in a fixed volume of water through the synthesis of organic matter using energy derived from solar radiation or chemical reactions (Thurman, 1997). The major process through which primary production occurs is photosynthesis. The intensity and quality of light, the availability of nutrients, and seawater temperature all influence primary productivity as generated through photosynthesis (Valiela, 1995). Chemosynthesis will also be mentioned in this section since it is another form of primary production occurring at hydrothermal vent communities along ocean spreading centers in the MIRC Study Area.

Overall, the upper portion of the water column within the MIRC Study Area is nutrient depleted, which greatly limits the presence of organisms associated with primary productivity, such as phytoplankton. Phytoplankton are single-celled organisms that are similar to plants because they photosynthesize using sunlight and chlorophyll. Phytoplankton are at the base of the marine food chain, and are essential to the overall productivity of the ocean. In regions in which overall nutrient concentrations are low, the phytoplankton communities are dominated by small nanoplankton and picoplankton (Le Bouteiller *et al.*, 1992; Higgins and Mackey, 2000). This is true for the Study Area, as phytoplankton communities in the western Pacific are dominated by cyanobacteria (*Synechococcus* spp.), prochlorophytes, haptophytes, and chlorophytes (Higgins and Mackey, 2000).

Two regions within the MIRC Study Area show elevated primary production, off the southwest coast of Guam and in the region surrounding Tinian and Saipan. These areas of localized increased primary production have been attributed to the interaction of island masses and currents, where the currents will eddy and concentrate phytoplankton (NASA, 1998).

Another potentially significant source of biological productivity does not occur in the light of the surface, but rather at great depths within the ocean. In some locations, including the Mariana Trough, hydrothermal springs can support vast benthic communities (Hessler and Lonsdale, 1991; Hashimoto *et al.*, 1995; Galkin, 1997). Many organisms live in association with bacteria capable of deriving energy from hydrogen sulfide that is dissolved in the hydrothermal vent water (Thurman, 1997). Since these bacteria are dependent upon the release of chemical energy, the mechanism responsible for this production is called chemosynthesis. Little is known regarding the significance of bacterial productivity on the ocean floor on a global scale. Hydrothermal indicators and vents have been found within the Study Area (Embley *et al.*, 2004) and locations are described in further detail in subsequent sections.

3.6.2.2 Secondary Production Communities

Secondary production refers to the production (change in biomass) of organisms that consume primary producers, i.e., the production of bacteria and animals through heterotrophic processes (Scavia, 1988; Strayer, 1988). Marine zooplankton are aquatic organisms that range from microscopic sizes to large shrimp (Parsons *et al.*, 1984), and can be separated into two distinct categories based upon their dependence to coastal proximity. Oceanic zooplankton includes organisms such as salps and copepods typically found at a distance from the coast and over great depths in the open sea. Neritic zooplankton (found in waters overlying the island shelves), include such species as fish and benthic invertebrate larvae, and are usually only found short distances from the coast (Uchida, 1983).

The North Equatorial Current (NEC), which provides the bulk of water passing the Mariana archipelago, is composed primarily of plankton-poor water. Zooplankton biomass at the surface examined for the western Pacific and adjacent seas found that zooplankton biomass was low within the NEC, and even lower at a station nearest the MIRC Study Area (Vinogradov and Parin, 1973).

Studies on the neritic plankton have centered around Apra Harbor and Piti Reef on Guam. However, the majority of studies have been performed in conjunction with more general environmental surveys, and thus no long-term surveys have been conducted. In general, abundance of zooplankton is highly variable with respect to location and time (both throughout the day and month to month) (Uchida, 1983). In Apra Harbor, the commercial port contains the highest levels of zooplankton abundance and is dominated by copepods (Uchida, 1983). Other organisms in the harbor include fish larvae, decapod zoeae (freeswimming larvae), and pteropods (Uchida, 1983). In Tanapag Harbor, Saipan, the diurnal zooplankton community is dominated by copepods and the nocturnal zooplankton community by larval crustaceans (Uchida, 1983).

3.6.2.3 Benthic Communities

Benthic or bottom-dwelling communities are strongly dependent on the type of bottom habitat or substrate that exists in an area. Deep sea benthic habitats include seamounts, hydrothermal vents, the abyssal plain, and trenches. The bottom sediments covering the sea floor in much of the Study Area are volcanic or marine in nature (Eldredge, 1983). In the Marianas Trench, the seabed is composed mostly of sand and clays (Ogawa *et al.,* 1997). Sediments found on the narrow shelves along the Marianas archipelago are a combination of volcanic and calcareous sediments derived from calcareous animal skeletons (Eldredge, 1983).

Seamounts. Seamounts are undersea mountains that rise steeply from the ocean floor to an altitude greater than 3,300 ft (1,000 m) above the ocean basin (Thurman, 1997). Generally, seamounts tend to be conical in shape and volcanic in origin, although some seamounts are formed by tectonic movement and converging plates (Rogers, 1994). The MIRC Study Area contains seamounts of both types. The seamount topography is a striking difference to the surrounding flat, sediment covered abyssal plain, and the effects seamounts can impart on local ocean circulation are complex and poorly understood (Rogers, 1994). However, around seamounts increased levels of phytoplankton, primary production, and pelagic and demersal fish (Fedorov and Chistikov, 1985; Rogers, 1994) are correlated with current pattern alterations and Taylor columns (circulation vortices) (Boehlert and Genin, 1987; Rogers 1994).

The large ranges in depth, hard substrate, steep vertical gradients, cryptic topography, variable currents, clear oceanic waters, and geographic isolation all combine to make seamounts a unique habitat for both deep-sea and shallow water organisms (Rogers, 1994). Thus, seamounts are capable of supporting a wide range of organisms (Wilson and Kaufman, 1987). To date, Richer de Forges *et al.* (2000) conducted the most extensive species identification on seamounts. Richer de Forges *et al.* (2000) found a range of 108 to 516 species of fish and macro-invertebrates from three areas of seamounts in the southwest Pacific (Tasman Sea, Coral Sea). Approximately one third of species found were new to science and potentially endemic. The number of species encountered versus the sampling effort showed that more species are probably present on the seamounts they investigated. Richer de Forges *et al.* (2000) noted that there were significant differences in the species composition between groups of seamounts found at the same latitude and approximately 620 mi (1,033 km) apart. Such differences in seamount communities suggest that species dispersal is limited to clustered seamounts and that seamount species have localized distributions (Richer de Forges *et al.,* 2000).

Hydrothermal Vents. Deep-sea hydrothermal vents occur in areas of crustal formation near mid-ocean ridge systems both in fore-arc and back-arc areas (Humphris, 1995). Seawater permeating and entrained through the crust and upper mantle is superheated by hot basalt and is chemically altered to form hydrothermal fluids as it rises through networks of fissures in newly-formed seafloor (Humphris, 1995; McMullin et al., 2000). The temperature of the hydrothermal fluid is characteristically 400° to 750°F (204° to 399°C) in areas of focused flows and less than 400°F (204°C) in areas of diffuse flow. Other than being hot, hydrothermal fluids are typically poor in oxygen content, and contain toxic reduced chemicals including hydrogen sulfide and heavy metals (McMullin et al., 2000). As the hot hydrothermal fluids come in contact with seawater overlying the vent, heavy metals precipitate out of the fluid and accumulate to form chimneys and mounds. In complete darkness, under the high ambient pressure of the deep sea, in nutrient-poor conditions, and under extreme thermal and chemical conditions, metazoans (multicellular animals) are able to adapt and colonize these sites. Chemosynthetic bacteria use the reduced chemicals of the hydrothermal fluid (hydrogen sulfide) as an energy source for carbon fixation and generate a chemosynthetic-based primary production. In turn, vent organisms (metazoans) consume the chemosynthetic bacteria or form symbiotic relationships with them, and use numerous morphological, physiological, and behavioral adaptations to flourish in this extreme deep-sea environment. These chemosynthetic organisms produce communities typically characterized by a high biomass and low diversity.

A number of hydrothermal vents have been located in the Study Area. Evidence of active hydrothermal venting has been identified near more than 12 submarine volcanoes and at two sites along the back-arc spreading center off of the volcanic arc (Kojima, 2002; Embley *et al.*, 2004) with the potential for more systems yet to be discovered. Hydrothermal vents located in the Mariana Trough experience high levels of endemism due to their geographic isolation from other vent systems, with at least 8 of the 30 identified genera only known to occur in western Pacific hydrothermal vent systems (Hessler and Lonsdale, 1991; Paulay, 2003). Hydrothermal vents at Esmeralda Bank, one of the active submarine volcanoes in the MIRC Study Area, span an area greater than 0.08 mi^2 (0.2 km^2) on the seafloor and expel water with temperatures exceeding 172°F (78°C) (Stüben *et al.*, 1992). West of Guam and on the Mariana Ridge, there are three known hydrothermal vent fields: Forecast Vent site (13°24'N, 143°55'E; depth: 4,750 feet [1,450 meters]), TOTO Caldera (12°43'N, 143°32'E), and the 13°N Ridge (13°05'N, 143°41'E) (Kojima, 2002). The gastropod *Alviniconcha hessleri* is the most abundant chemosynthetic organism found in hydrothermal vent fields of the Mariana Trough. Vestimentiferan tube worms are also found in these sites west of Guam (Kojima, 2002).

Abyssal Plain. The Mariana Trough is comprised of a large relatively flat abyssal plain with water depths ranging approximately from 11,500 to 13,100 ft (3,500 to 4,100 m) (Thurman, 1997). Very little data regarding the Mariana Trough within the study region has been investigated. However, in general abyssal plains can be described as large and relatively flat regions covered in a thick layer of fine silty sediments with the topography interrupted by occasional mounds and seamounts (Kennett, 1982; Thurman, 1997). It is host to thousands of species of invertebrates and fish (Mariana Trench, 2003).

Mariana Trench. The seafloor contains numerous hydrothermal vents formed by spreading tectonic plates (Mariana Trench, 2003). Away from the hydrothermal vents, the seafloor is covered with soft brown sediments devoid of rock formations (Kato et al., 1998). Sediments that lack carbonate and silica shells appear to be dissolving, suggesting that the ocean floor lies below the carbonate compensation depth and at or near the silicate compensation depth (Ogawa et al., 1997). In addition, sediments appear to be affected by local currents, which can transport sandy or silty sediments along the trench floor (Ogawa et al., 1997). The trench is host to numerous hydrothermal vent systems supporting a wide variety of chemosynthetic organisms. In addition, the deep waters of the Mariana Trench support barophilic organisms capable of surviving in the cold, dark, high pressure environment. One mud sample taken from Challenger Deep by oceanographers yielded over 200 different microorganisms (Mariana Trench, 2003).

3.6.2.4 Coastal Communities

Coastal habitats of the Study Area encompass part of the subneritic zone, which extends from the shoreline at high tide to the edge of the insular shelf (656 ft [200 m] isobath) (Kennett, 1982; Thurman, 1997). The following discussion of shoreline habitats will focus on the intertidal zone (region of shoreline covered by water between the high and low tidal extremes), coral communities and reefs, soft bottom habitats (sand beaches, mudflats, and sand flats), lagoons (semi-enclosed bays found around the islands), seagrass beds, mangroves, and artificial reefs. Since the tidal range in the Study Area is less than 3.3 ft [1 m] (Paulay, 2003), the shoreline intertidal zone is very narrow around the Mariana Islands.

Biodiversity is high throughout the subneritic zone due to the high variability existing within the habitat (Thurman, 1997). Organisms residing on or in the benthos (epifauna and infauna, respectively) can be greatly affected by sedimentation, sediment resuspension, vertical mixing, regeneration (recycling of nutrients), and light penetration (turbidity) (Valiela, 1995).

Intertidal Zone. Within the intertidal zone, the shoreline can be divided into three subzones: the high-tide zone, the mid-tide zone, and the low-tide zone. In the high-tide zone, benthic organisms are covered by water only during the highest high tides. Organisms in this zone spend the majority of the day exposed to the atmosphere. In the mid-tide zone, benthic organisms spend approximately half of the time submerged. Organisms residing in this zone are exposed during periods of low tides, but are covered with water during all high tides. Organisms in the low-tide zone are submerged most of the time but may be exposed to the air during the lowest of low tides.

The islands within the Study Area are volcanic in nature and thus the overall geology reflects this origin (Eldredge, 1983). The intertidal regions along the majority of the coastlines of islands in the Study Area are rocky in nature (Rock, 1999). Coastlines within the Study Area are generally lined with rocky intertidal areas, steep cliffs and headlands, and the occasional sandy beach or mudflat (Eldredge, 1983). The water erosion of rocky coastlines in the Study Area has produced wave-cut cliffs (produced by undercutting and mass wasting), and sea-level benches (volcanic and limestone and wave-cut notches at the base of the cliffs (Eldredge, 1979, 1983). Large blocks and boulders often buttress the foot of these steep cliffs in the Marianas. Wave-cut terraces also occur seaward of the cliffs (Eldredge, 1983; Myers, 1999).

Coral Communities and Reefs. Islands within the Study Area (Guam to FDM) support reefs (biogenic or hermatypic coral reefs) as do islands north of FDM (Anatahan, Sarigan, Guguan, Alamagan, Maug, and Farrallon de Pajaros). Reefs are also found on offshore banks including Tatsumi Reef located 1.3 mi (2 km) southeast of Tinian, Arakane Bank located 200 mi (322 km) west-northwest of Saipan, Pathfinder Bank located 170 mi (274 km) west of Anahatan, and Supply Reef located 11.5 mi (18.5 km) northwest of Maug Island (Starmer, 2005). The degree of reef development depends on a number of environmental controls including the age of the islands, volcanic activity, the availability of favorable substrates and habitats, weathering caused by groundwater discharge, sedimentation and runoff accentuated by the overgrazing of feral animals, and varying levels of exposure to wave action, trade winds, and storms (Eldredge, 1983; Randall, 1985, 1995; Randall et al., 1984; Paulay, 2003; Starmer, 2005).

The southern islands (Guam to FDM) are inactive volcanic islands that have subsided and are covered by massive limestone deposits dating back more than 40 million years (Birkeland, 1997; Randall, 2003). The substrate of the younger islands to the north of FDM dates back to 1.3 million years and is not characterized by substantial limestone deposits (Randall, 1995, 2003). In the southern islands, faulting and erosion caused by groundwater discharge have produced large, oblique, and shallow areas (lagoons, bays) favorable to extensive reef development. This contrasts with the vertical profile of the uplifted younger islands, where less favorable and fewer macrohabitats are available for reef development (Randall, 1995).

Softbottom Habitats. Softbottom habitats are those habitats in which the benthos is covered with a layer of fine sediment (Nybakken, 1997). Commonly identified habitats are beaches, sand flats, and mudflats. Sand flats differ from sand beaches in that beaches are intertidal pile-ups along coasts, while sandflats can be found anywhere away from the coasts. Softbottom habitats can occur on a sloped seafloor and not only on a flat, horizontal surface (Paulay personal communication, as cited in DoN, 2005).

Softbottom substrates in coastal regions of the Study Area are not common. This is due to the fact that the intertidal and subtidal regions are often characterized by limestone pavement interspersed with coral colonies and submerged boulders (Kolinski *et al.,* 2001). Shorelines are often rocky with interspersed sand beaches or mud flats (Eldredge, 1983; PBEC, 1985).

On the island of Guam, the majority of the coastline is comprised of rocky intertidal regions. Interspersed among this rocky shoreline are 58 beaches composed of calcareous or volcanic sands (Eldredge, 1983). On Rota, the rare beaches are found scattered among limestone patches and are composed of rubble and sand (Eldredge, 1983). The submarine topography surrounding Tinian and Aguijan can be described as limestone pavement with interspersed coral colonies and submarine boulders (Kolinski *et al.,* 2001).

While the island of Aguijan contains no beaches (Kolinski *et al.,* 2001), the island of Tinian contains 13 beaches (10 located on the west coast and three on the east coast). These beaches are not well developed (except Tinian Harbor on the southwest coast, and Unai Dankulo along the east coast) and are comprised mainly of medium to course grain calcareous sands, gravel, and coral rubble ("coral-algalmollusk rubble") (Eldredge, 1983; Kolinski *et al.,* 2001). The west coast of Saipan contains well developed fine-sand beaches protected by the Saigon and Tanapag Lagoons (Scott, 1993). All other beaches of Saipan consist of coral-algal-mollusk rubble. The coastal area of FDM contains two small intertidal beaches that are inundated by high tide on the northeastern and western coastlines. Offshore of FDM, at approximately 65 ft (20 m), a softbottom, sandy slope extends downward onto the abyssal plain (DoN, 2003a). Most of the other islands in the Marianas also have sandy slopes below the fore reef, typically starting at 100 to 130 ft (30 to 40 m), with some variation (Paulay personal communication, as cited in DoN, 2005).

Estuarine Habitats. Estuaries are bodies of water along coasts and are formed where there is an interaction between freshwater, saltwater, land, and the atmosphere (Day et al., 1989). Estuaries are among the most productive natural systems on earth, producing more food per acre than the richest farmland (RAE/ERF, 1999). The dominant feature of the estuarine environment is the fluctuating salinity. Within the Study Area, estuarine habitats are found in lagoons, embayments, and river mouths.

Steep slopes and complex shorelines of the Mariana Islands (Guam to FDM) form relatively sheltered coastal bays characterized by silty sediments and turbid waters. Often, these bays are associated with riverine freshwater discharge (Myers, 1999). Bordering estuaries and coastal embayments throughout the world are unique plant associations. In temperate and subpolar regions, this association is found in the form of a salt marsh. A salt marsh develops wherever sediment has accumulated to form a transition area between aquatic and terrestrial ecosystems (Nybakken, 1997). They are composed of beds of intertidal rooted vegetation which are alternately inundated and drained by the tides (Day *et al.,* 1989). While salt marshes can occasionally form in tropical regions along salt flats, they are not known to occur in the Study Area (Day *et al.*, 1999). Rather, mangroves, the tropical equivalent of salt marshes, occur within the Study Area. Mangroves often line the shores of coastal embayments and the banks of rivers to the upper tidal limits in tropical environments, especially where the slope is gentle (Myers, 1999). Mangroves possess large roots that spread laterally and consolidate sediments, eventually transforming local mudflats into dry land (Myers, 1999). The extensive root system and nutrient rich waters found in mangroves make them among the richest of nursery grounds for marine life (Scott, 1993; Myers, 1999).

On Guam, estuarine habitats occur in areas of tidal intrusion or brackish water, and consist primarily of mangroves and the lower channels of rivers that are inundated by tides (Scott, 1993). Nine of Guam's 46 rivers that empty into the ocean have true estuarine habitats with elevated salinity levels extending upstream (Scott, 1993). While estuarine habitats in the CNMI are not as widely studied, there are a number of bays and lagoons that probably function as estuarine habitats.

Lagoons. A lagoon within the Study Area can be described as a semi-enclosed bay found between the shoreline and the landward edge of a fringing reef or barrier reef (NCCOS/NOAA, 2005). By definition, true lagoons lie only behind barrier reefs, while moats (a shallow analogue of lagoons) can lie behind fringing reefs. A lagoon is formed when a sandbar (or barrier reef) is built up parallel to the coastline and cuts off the inland waters to the sea, creating a shallow region of water. A lagoon typically contains three distinct zones: freshwater zone, transitional zone, and saltwater zone (Thurman, 1997). Yet, most tropical reef-associated lagoons are not brackish and lack significant freshwater influence.

The Study Area contains numerous relatively shallow lagoons (depth ranging from 3 to 50 ft [1 to 15 m]) and one deep lagoon, Apra Harbor (NCCOS/NOAA, 2005). The bottoms of the lagoons are mostly sandy and flat or undulatory. Coral rubble, coral mounds (patch reefs), seagrass, and algae are found within the lagoons. Coral mounds tend to be more abundant in the outer lagoons and are widely scattered or absent in the inner lagoons (PBEC, 1985; NCCOS/NOAA, 2005).

Lagoons of coastal Guam are associated with Apra Harbor (Inner Harbor, Outer Harbor and Sasa Bay), Cocos Lagoon, and numerous embayments along the western coastline. Apra Harbor is the only deep lagoon on Guam and is the busiest port in the Mariana Islands. The Outer Harbor is enclosed by the Glass Breakwater. Sasa Bay, located on the edge of the Outer Harbor, is a shallow coastal lagoon populated with patchy corals (Scott, 1993). The Inner Apra Harbor is a lagoon created by dredging in the 1940s. Cocos Lagoon, a shallow lagoon (40 ft [12 m] water depth) located on the southern tip of Guam is also encompassed by a series of barrier reefs (Paulay *et al.*, 2002). Embayments along the entire western coastline except for the small regions spanning from Oca Point to Ypao Point and from Orote Point to Apuntua Point have developed behind fringing reefs and may possess physical characteristics similar to a lagoon (USGS, 1978; Paulay *et al.*, 2002). A similar situation occurs on the eastern coastline with fringing reefs occurring along the eastern coastline from Fadian Point to Cocos Lagoon (USGS, 1978).

The western coastline of Saipan is lined with sandy beaches protected by a barrier reef which forms Tanapag and Saipan Lagoons (Scott, 1993). Tanapag Lagoon is a typical high-island barrier reef lagoon. Tanapag Lagoon is located on the northwestern coast of Saipan. Also, on the western coastline of Saipan, the barrier reefs form two additional lagoons, creating the largest lagoon system in the Mariana Islands, Garapan Lagoon and Chalan Kanoa Lagoon (Duenas and Associates, 1997). The maximum width of Saipan Lagoon is approximately 330 ft (100 m), and the maximum depth is 46 ft (14 m) in the Tanapag Harbor channel, although average depth is only 10 ft (3 m) (PBEC, 1985).

Seagrass Beds. Seagrasses are flowering plants adapted to living in a saline environment and grow completely submerged (Phillips and Menez, 1988). Seagrasses are unique as they are land plants that spend their entire life cycle underwater. Seagrasses grow in muddy or sandy substrates and can develop into extensive undersea meadows (Phillips and Menez, 1988). Seagrass beds are among the most highly productive ecosystems in the world and are an important ecosystem of shallow-water tropical regions (Nybakken, 1997). Beds are often used as protective habitats or nursery grounds for many organisms that live in/on sandy or muddy bottoms, in the surrounding waters, or on the plants themselves (Phillips and Menez, 1988; Daniel and Minton, 2004). While seagrasses are consumed by only a few species (including dugongs, sea turtles, mollusks, and some urchins), many organisms feed on the epiphytic algae growing on the plant structure (Nybakken, 1997).

Currently, three species of seagrasses (*Enhalus acoroides*, *Cymodocea rotundata*, and *Thalassia hemprichii*) are known to occur in the Mariana Islands (McKenzie and Rasheed, 2006). Seagrass beds are widely distributed within the Study Area. Both Guam and Saipan have extensive seagrass meadows surrounding the coastlines (NCCOS/NOAA, 2005), including extensive beds in Agat Bay (including the Agat Unit of the War in the Pacific National Historical Park; Daniel and Minton, 2004), south of Apra Harbor, and Cocos Lagoon on Guam (Eldredge *et al.*, 1977; Daniel and Minton, 2004). Rota is known to posses a small seagrass bed off its southern shore (Abraham *et al.*, 2004). Tinian possesses seagrass beds along the northwestern, the northeastern, the southwestern and the eastern coastlines (DoN, 2003a). Seagrasses are more scattered on the island of Saipan, with seagrass beds reported along Tanapag Beach (along the northwest coast) and in the Puerto Rico Mudflats (northwest shoreline, south of Tanapag Beach) (Tsuda *et al.*, 1977; Scott,1993). Seagrasses have vanished off the southern coast of Saipan (Abraham *et al.*, 2004). There is no record of seagrass beds occurring on the islands north of Saipan (Tsuda, 2003).

Mangroves. Mangroves are a type of wetland that borders estuaries or shores protected from the open ocean (Scott, 1993). They are composed of salt-tolerant trees and other plant species and they provide critical habitat for both marine and terrestrial life. Species diversity is usually high in mangroves, and like seagrasses, can act as a filter to remove sediments before they can be transported onto an adjacent coral reef (Scott, 1993; Nybakken, 1997).

Mangrove forests are native to the MIRC Study Area, however, are only present on the islands of Guam and Saipan, with the mangroves of Guam being the most extensive and diverse, totaling approximately 170 acres (68 hectares) (Scott, 1993). There are 125.3 acres (50.7 hectares) of mangrove forests on ten sites within the Navy lands on Guam (DoN, 1999). The largest of these mangrove sites (88.7 acres [35.9 hectares]) is located along the eastern shoreline of the Apra Inner Harbor (DoN, 1999). Four sites near Abo Cove at the southern tip of the Inner Apra Harbor amount to 30.6 acres (12.4 hectares) of mangrove forests. There are two mangrove sites near Dry Dock Island and two more sites near Polaris Point. Along the southern shore of Apra Harbor, there is a mangrove area which covers a 1.7 acres (0.7 hectares) area (DoN, 1999). Achang Bay Mangroves is centered on Achang Bay at the southern end of Guam. This area is the only sizable area of mangrove forest in southern Guam (Wilder, 1976). The forest is owned by the Government of Guam and is a 65 to 200 ft (20 to 61 m) wide strip lining the shore.

Mangroves in the CNMI are restricted to Saipan. These mangroves can only be found in a few small stands (Scott, 1993) in two locations: Puerto Rico Mudflats and American Memorial Park. American Memorial Park is located within the CNMI on the western side of the island of Saipan. Within the 133-acre park boundary are beaches, sports fields, picnic sites, boat marinas, playgrounds, walkways, and a 30-acre wetland and mangrove forest. Puerto Rico Mudflats (15°13’N, 145°43’E) is a series of mudflats bounded by National Park Service lands (American Memorial Park) and a landfill. Within these mudflats is a broken fringe of mangrove trees. The largest stands of mangroves are found north of the landfill.

3.6.2.5 Artificial Habitats

Artificial habitats (shipwrecks, artificial reefs, jetties, pontoons, docks, and other man-made structures) are physical alterations to the naturally-occurring marine environment. In addition to artificial structures intentionally or accidentally placed on the seafloor, FADs are suspended in the water column and anchored on the seafloor to attract fish. Artificial structures provide a substrate upon which a marine community can develop. Navigational, meteorological, and oceanographic buoys suspended in the water column potentially function like artificial habitats. Epibenthic organisms will settle on artificial substrates (including algae, sponges, corals, barnacles, anemones, and hydroids) to eventually provide a biotope suitable for large motile invertebrates (e.g., starfish, lobster, crabs) and demersal and pelagic fishes (Bohnsack *et al.*, 1991).

Artificial Reefs. An artificial reef consists of one or more submerged structures of natural or man-made origin that are purposefully deployed on the seabed to influence the physical, biological, or socioeconomic processes related to living marine resources (Baine, 2001). Artificial reefs are defined both physically, by the design and arrangement of materials used in construction, and functionally according to their purpose (Seaman and Jensen, 2000). A large number of items are used for the creation of artificial reefs including natural objects, such as wood (weighted tree trunks) and shells; quarry rock; or man-made objects, like vehicles (automobile bodies, railroad cars, and military tanks), aircraft, steel-hulled vessels (Liberty ships, landing ship tanks, barges, and tug boats), home appliances, discarded construction materials (concrete culverts), scrap vehicle tires, oil/gas platforms, ash byproducts (solid municipal incineration, and coal/oil combustion), and prefabricated concrete structures (reef balls) (Artificial Reef Subcommittee, 1997). The purpose of deploying artificial reefs in the marine environment is to (Seaman and Jensen, 2000):

(1) enhance commercial fishery production/harvest;

(2) enhance recreational activities (fishing, SCUBA diving, and tourism);

(3) restore/enhance water and habitat quality;

(4) provide habitat protection and aquaculture production sites; and,

(5) control fish mortality.

Dedicated artificial reefs are currently found in two locations of the Study Area: Agat Bay, Guam and Apra Harbor, Guam. In 1969, 357 tires were tied together and scattered over a 5,000 ft^2 (463 m^2) area in Cocos Lagoon (Eldredge, 1979). In the early 1970s, a second reef consisting of 2,500 tires was also placed in Cocos lagoon (Eldredge, 1979). These tire reefs disintegrated and no longer serve as artificial reefs. In 1977, a 52.5 ft (16 m) barge was modified to enhance fish habitat and was sunk in 60 ft (20 m) of water in Agat Bay. Fish abundance has increased with time, and herbivorous and carnivorous communities have thrived (Eldredge, 1979). In Apra Harbor, the "American Tanker" was sunk in 1944 at the entrance of Apra Harbor to act as a breakwater (Micronesian Divers Association, Inc., 2005). In 1944, the 76th Naval Construction Battalion (SEABEES) built the Glass Breakwater which forms the north and northwest sides of Apra Harbor (Thompson, 2005). The enormous seawall is made of 1,200 acre-feet of soil and coral extracted from Cabras Island (Thompson, 2005). The Glass Breakwater is the largest artificial substrate in the Marianas.

Shipwrecks. Many shipwrecks are found within the Study Area including grounded vessels and military wreckage. Vessels have probably wrecked upon the shores of the Mariana Islands since Spanish galleons sailed to these islands during the seventeenth century. There are abundant WWII-era remains (including sunken ships, airplanes, and tanks) along the shores of the Marianas that resulted from the battles of Guam, Tinian, and Saipan (Commonwealth of the Northern Mariana Islands Coastal Resources Management, 2001). Many of the shipwrecks have become an environmental resource providing a foundation for coral growth and habitat for fish; resultantly, many of the shipwrecks along the shorelines of the Study Area have become popular dive sites. The groundings of ships can also create numerous hazards for navigation or the environment including the formation of large scars through seagrass beds or coral reefs, blockage of entry into ports or harbors, and the release of engine oil and fuel into the surrounding waters (NOAA, 2004). The submerged cultural resources within the Study Area are further discussed in subsection 3.13.

FADs. FADs consist of single or multiple floating devices (Samples and Hollyer, 1989) connected to the ocean floor by ballast or anchors. Usually prefabricated, FADs are designed to attract fish species to them (Klima and Wickham, 1971). Even though a naturally floating log attracts fish, it is not considered a FAD because humans did not intentionally place it in the ocean (Blue Water, 2002). Two fundamentally different types of FADs have been employed since the 1970s: large floating FADs and small mid-water FADs. Large FADs have been deployed in water depths exceeding 4,000 ft (1,200 m) for ocean pelagic commercial and recreational fisheries. Small FADs have been used in more nearshore and coastal environments for recreational fisheries in water depths ranging from 50 to 100 ft (15 to 30 m) (Rountree, 1990).

Currently, Guam maintains 16 FADs within 20 nm (37 km) of the shoreline (Chapman, 2004; DAWR, 2004). Lost FADs are replaced within two weeks (Chapman, 2004). CNMI DFW manages the FAD program in waters off Rota, Saipan, and Tinian, which includes 10 FAD locations (Chapman, 2004; CNMI DFW, 2005). The CNMI FAD program began in 1990 (CNMI DFW, 2008).

3.6.2.6 Marianas Trench Marine National Monument

The Marianas Trench Marine National Monument (the ‘Monument’) was established in January 2009 by Presidential Proclamation under the authority of the Antiquities Act (16 U.S.C. 431). The Monument consists of approximately 71,897 square nautical miles (246,600 square kilometers) of submerged lands and waters of the Mariana Archipelago and was designated with the purpose of protecting the submerged volcanic areas of the Mariana Ridge, the coral reef ecosystems of the waters surrounding the islands of Farallon de Pajaros, Maug, and Asuncion in the Commonwealth of the Northern Mariana Islands, and the Mariana Trench. The Monument includes the waters and submerged lands of the three northernmost Mariana Islands (the ‘Islands Unit’) and only the submerged lands of designated volcanic sites (the ‘Volcanic Unit’) and the Mariana Trench (the ‘Trench Unit’) to the extent described as follows: The seaward boundaries of the Islands Unit of the monument extend to the lines of latitude and longitude depicted on Figure 3.6-1, which lie approximately 50 nautical miles (93 kilometers) from the mean low water line of Farallon de Pajaros (Uracas), Maug, and Asuncion.

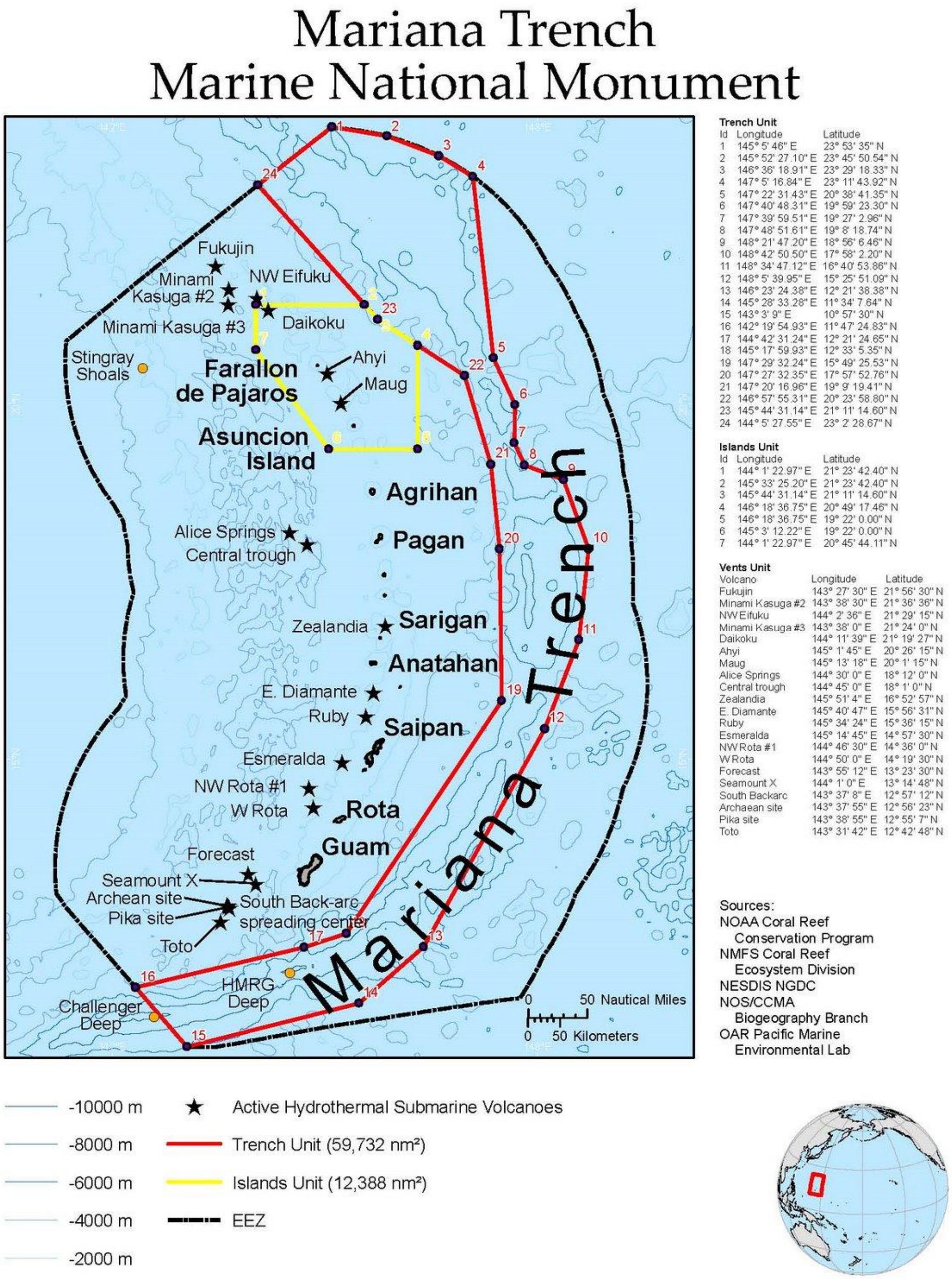


Figure 3.6-1: Marianas Trench Marine National Monument

The inland boundary of the Islands Unit of the monument is the mean low water line. The boundary of the Trench Unit of the Monument extends from the northern limit of the Exclusive Economic Zone of the United States in the Commonwealth of the Northern Mariana Islands to the southern limit of the Exclusive Economic Zone of the United States in Guam approximately following the points of latitude and longitude identified in Figure 3.6-2. The boundaries of the Volcanic Unit of the Monument include a circle drawn with a 1 nautical mile radius centered on each of the volcanic features identified in Figure 3.6-3 and its legend.

The Monument contains objects of scientific interest, including the largest active mud volcanoes on Earth. The Champagne vent, located at the Eifuku submarine volcano, produces almost pure liquid carbon dioxide. This phenomenon has only been observed at one other site in the world. The Sulfur Cauldron, a pool of liquid sulfur, is found at the Daikoku submarine volcano. The only other known location of molten sulfur is on Io, a moon of Jupiter. Unlike other reefs across the Pacific, the northernmost Mariana reefs provide unique volcanic habitats that support marine biological communities requiring basalt. Maug Crater represents one of only a handful of places on Earth where photosynthetic and chemosynthetic communities of life are known to come together.

The waters of the Monument's northern islands are among the most biologically diverse in the Western Pacific and include the greatest diversity of seamount and hydrothermal vent life yet discovered. These volcanic islands are ringed by coral ecosystems with very high numbers of apex predators, including large numbers of sharks. They also contain one of the most diverse collections of stony corals in the Western Pacific. The northern islands and shoals in the Monument have substantially higher large fish biomass, including apex predators, than the southern islands and Guam. The waters of Farallon de Pajaros (also known as Uracas), Maug, and Asuncion support some of the largest biomass of reef fishes in the Mariana Archipelago. A portion of the Monument lies within the MIRC, including a small area on the northern border of the MIRC as well as the Volcanic Unit and the Trench Unit. Any of the activities identified under the Proposed Action could take place within areas included in the Monument, where they overlap. (See Figure 3.6-4).

The Presidential Proclamation establishing the Monument includes the following language regarding military activities in the area:

> <u>Armed Forces Actions</u>
>
> 1. The prohibitions required by the Proclamation shall not apply to activities and exercises of the Armed Forces (including those carried out by the United States Coast Guard).
>
> 2. The Armed Forces shall ensure, by the adoption of appropriate measures not impairing operations or operational capabilities, that its vessels and aircraft act in a manner consistent, so far as is reasonable and practicable, with the Proclamation.
>
> 3. In the event of threatened or actual destruction of, loss of, or injury to a monument living marine resource resulting from an incident, including but not limited to spills and groundings, caused by a component of the Department of Defense or the United States Coast Guard, the cognizant component shall promptly coordinate with the Secretary of the Interior or Commerce, as appropriate, for the purpose of taking appropriate actions to respond to and mitigate any actual harm and, if possible, restore or replace the monument resource or quality.

> 4. Nothing in the Proclamation or any regulation implementing it shall limit or otherwise affect the Armed Forces' discretion to use, maintain, improve, manage, or control any property under the administrative control of a Military Department or otherwise limit the availability of such property for military mission purposes.

The Secretaries of Commerce, through the National Oceanic and Atmospheric Administration, and the Interior, shall manage the Monument pursuant to applicable legal authorities and in consultation with the Secretary of Defense.

Under the Proclamation the Secretaries of the Interior and Commerce shall, within 2 years of the date of the Proclamation, prepare management plans within their respective authorities and promulgate implementing regulations that address any further specific actions necessary for the proper care and management of the objects identified in the Proclamation. In developing and implementing any management plans and any management rules and regulations, the Secretaries shall designate and involve as cooperating agencies the agencies with jurisdiction or special expertise, including the Department of Defense, the Department of State, and other agencies through scoping in accordance with the National Environmental Policy Act (42 U.S.C. 4321 *et seq*.), its implementing regulations and with Executive Order 13352 of August 26, 2004, Facilitation of Cooperative Conservation, and shall treat as a cooperating agency the Government of the Commonwealth of the Northern Mariana Islands, consistent with these authorities. The monument management plans shall ensure that the monument will be administered in accordance with the Proclamation.

According to the Proclamation, the management plans and their implementing regulations shall impose no restrictions on innocent passage in the territorial sea or otherwise restrict navigation, overflight, and other internationally recognized lawful uses of the sea, and shall incorporate the provisions of the Proclamation regarding Armed Forces actions and compliance with international law.

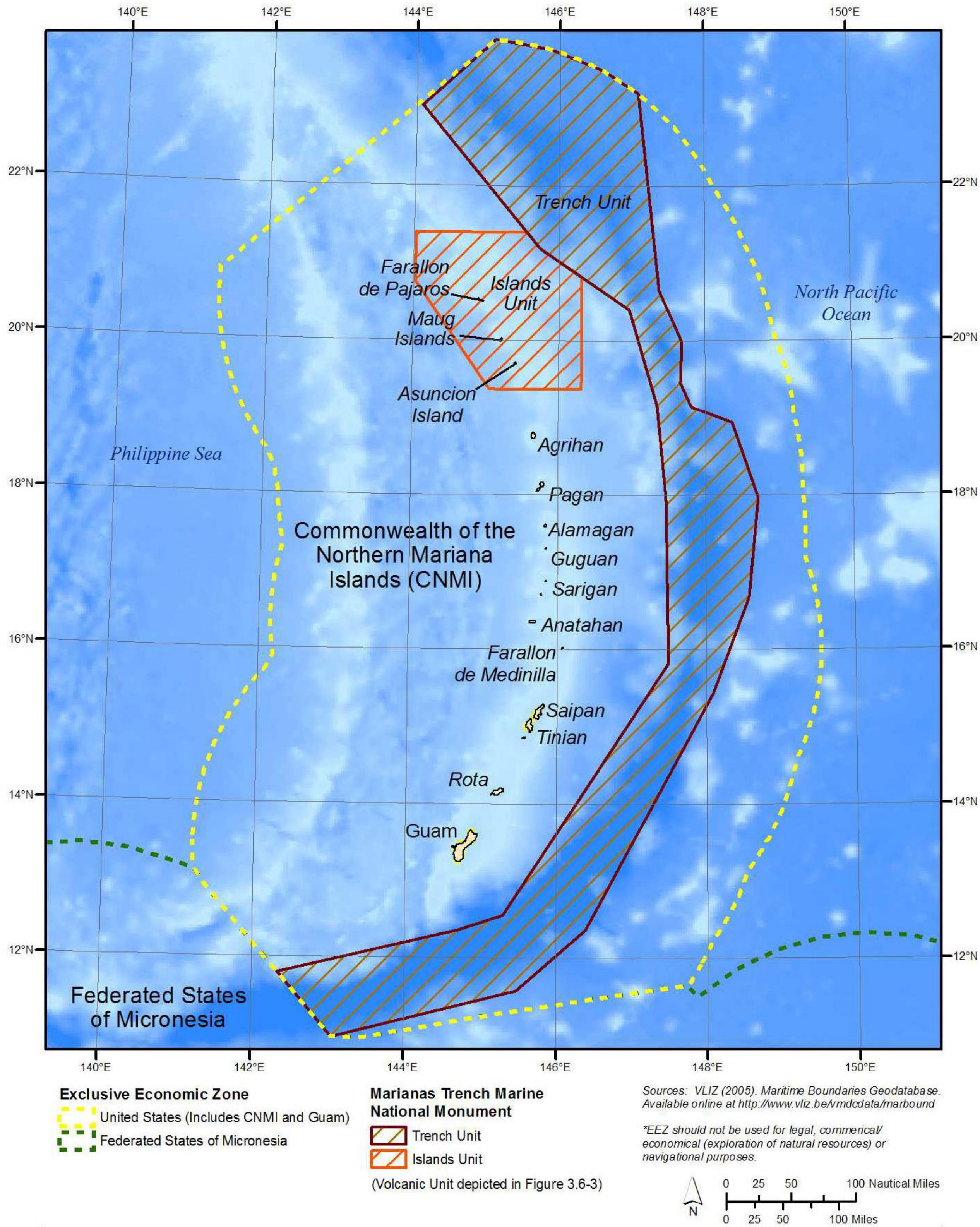


Figure 3.6-2: Marianas Trench Marine National Monument Trench and Islands Units

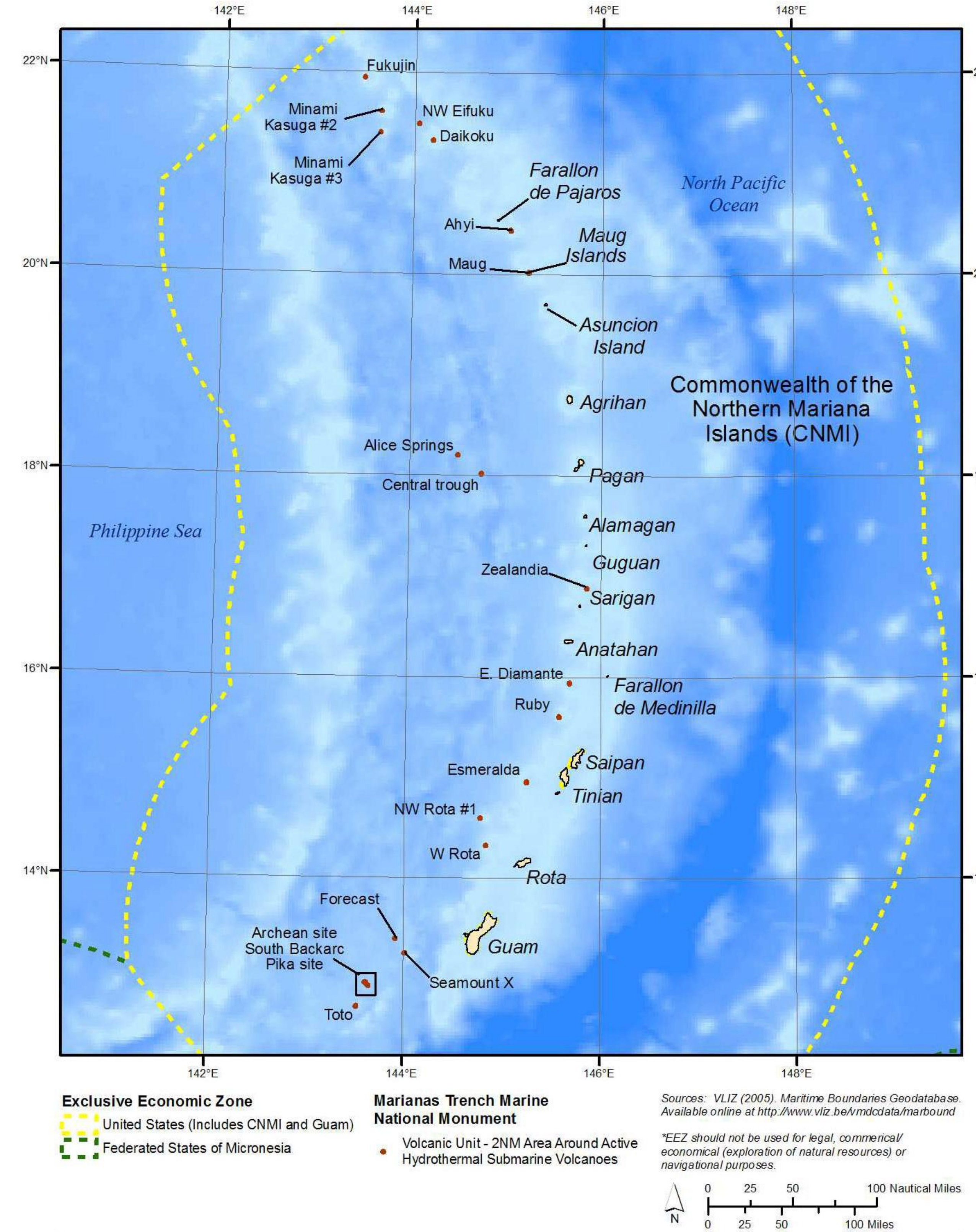


Figure 3.6-3: Marianas Trench Marine National Monument Volcanic Unit

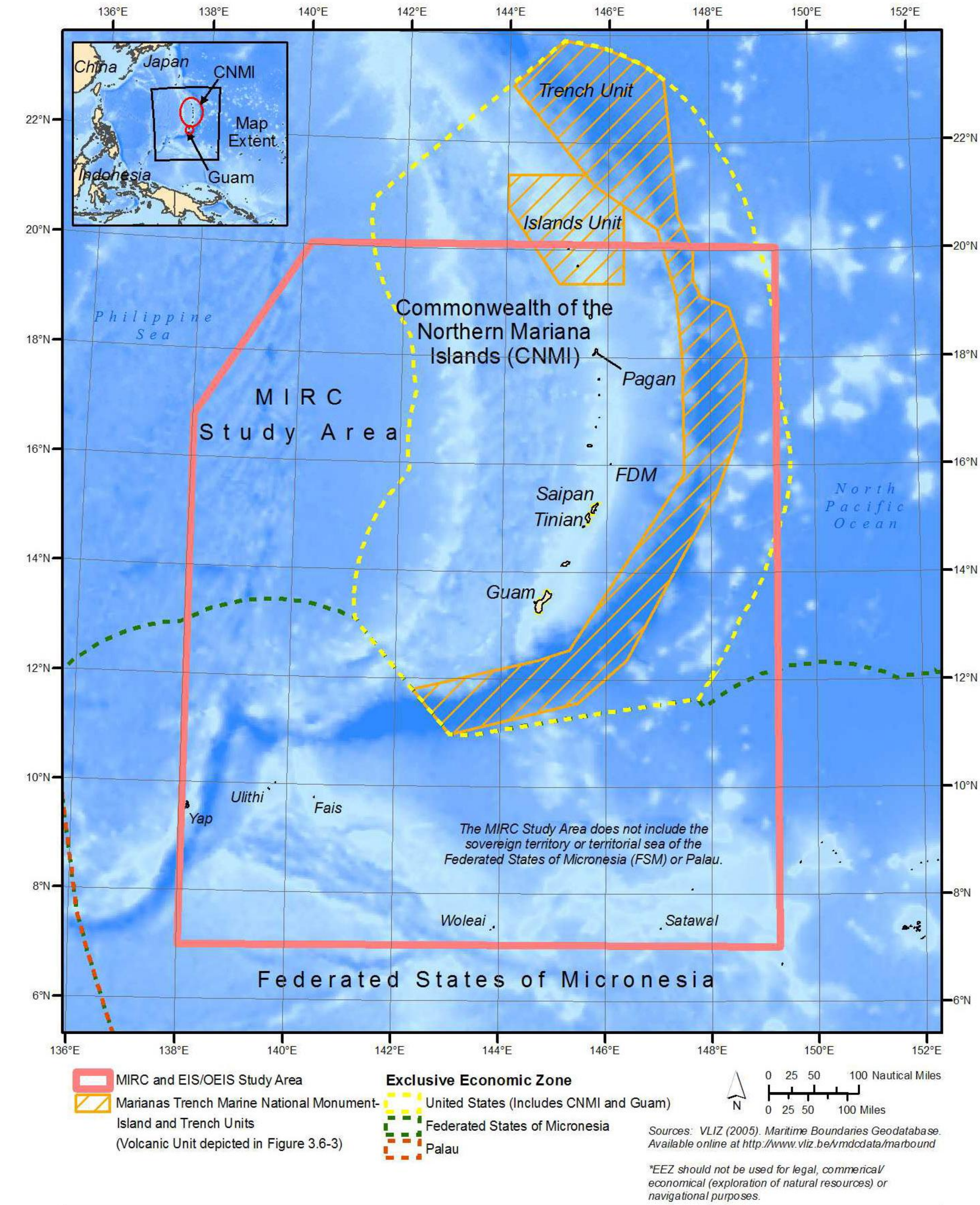


Figure 3.6-4: MIRC Study Area and Marianas Trench Marine National Monument

3.6.3 Environmental Consequences

3.6.3.1 No Action Alternative

Vessel Movements. Vessel movements associated with training in the MIRC occur mostly during a major exercise, which can last up to two or three weeks. Elements of this activity are widely dispersed throughout the Study Area, which is a vast area encompassing 501,873 nm^2 (1,299,851 km^2). The Navy logs about 1,000 total vessel days within the Study Area during a typical year. Vessel movements would have no direct effect on benthic communities or artificial habitats because Navy vessels are operated in relatively deep waters and have navigational capabilities to avoid contact with these habitats.

Vessel movements would result in short-term and localized disturbances to the water column. Phytoplankton and zooplankton in the upper portions of the water column could be displaced, injured, or killed by vessel and propeller movements. However, no measurable effects on plankton populations would occur because the majority of the MIRC Study Area is considered to contain relatively low levels of plankton due to decreased nutrient levels. In the areas where currents and islands interact to aggregate plankton, the number of organisms exposed to vessel movements would be low relative to total plankton biomass. Vessel movements in territorial waters would have no significant impact on marine communities under the No Action Alternative. Similarly, vessel movements in non-territorial waters would not cause significant harm to marine communities under the No Action Alternative.

Aircraft Overflights. Various types of fixed-wing aircraft and helicopters are used in training exercises throughout the MIRC Study Area. These aircraft overflights would produce airborne noise and some of this energy would be transmitted into the water. The potential effects of aircraft noise on various marine community components are analyzed in subsections 3.7 (Marine Mammals), 3.8 (Sea Turtles), and 3.9 (Fish and Essential Fish Habitat). Based on the analyses presented in those sections, aircraft overflights over territorial waters would have no significant impact on marine communities under the No Action Alternative. In addition, aircraft overflights over non-territorial waters would not cause significant harm to marine communities under the No Action Alternative.

Weapons Firing / Non-Explosive Practice Munitions. Current Navy training activities in the Study Area include firing a variety of weapons and employ a variety of non-explosive training rounds and explosive rounds, including bombs, missiles, naval gun shells, cannon shells, and small caliber ammunition. The analysis presented in this section focuses on non-explosive training rounds, while potential effects of explosive ordnance and underwater detonations are analyzed in the High Explosive Ordnance subsection below.

Fired ordnance has the potential to directly strike marine life and marine habitats as they travel through the water column and come into contact with the sea floor. The potential environmental consequences of direct ordnance strikes at or near the sea surface and within the water column are analyzed in subsections 3.7 (Marine Mammals), 3.8 (Sea Turtles), and 3.9 (Fish and Essential Fish Habitat). The analysis presented here focuses on the potential effects of ordnance strikes on benthic communities and artificial habitats. Ordnance use is not authorized in nearshore areas (0 to 3 nm [0 to 5.6 km] offshore).

The potential for ordnance strikes to adversely affect benthic communities depends on several factors, including the size and speed of the ordnance, water depth, the number of rounds delivered, the frequency of training, and the presence/absence of sensitive benthic communities. As described in subsection 3.6.2.3, benthic communities occur within the MIRC Study Area. While a broad area of soft and hard bottom benthic habitat could be exposed to direct ordnance strikes, the training exercises are intermittent and widely dispersed, which decreases the likelihood that a given area would be subjected to repeated exposure. Most ordnance firing occurs in areas greater than 12 nm (22 km) offshore. The velocity of ordnance would rapidly decrease upon contact with the water. As a result, expended ordnance would be moving at slow speeds by the time it travels through the water column and reaches the sea floor. Consequently, ordnance strikes would cause little or no physical damage to benthic habitat and any damage would be localized. The probability of ordnance striking an artificial reef or shipwreck is extremely low based on the widely dispersed nature of these resources and the training exercises. If ordnance were to strike these resources, little or no damage to the overall community would be expected based on the slow speed the ordnance would be traveling upon contact. Ordnance strikes in territorial waters would have no significant impact on marine communities under the No Action Alternative. Similarly, ordnance strikes in non-territorial waters would not cause significant harm to marine communities under the No Action Alternative.

Underwater Detonations and High Explosive Ordnance. Explosions that occur in the MIRC are associated with training exercises that use high explosive ordnance, including BOMBEX, MISSILEX, and naval gun shells, as well as underwater detonations associated with MINEX and SINKEX. Underwater detonation and high explosive ordnance use is limited to specific training areas (Table 2-8 for current annual training levels, and Table 2-9 for total ordnance use by training area locations) and does not occur within 3 nm from the shoreline of islands within the MIRC Study Area. The potential effects of explosions on marine mammals, sea turtles, fish, and their habitat are analyzed in subsections 3.7.3, 3.8.3, and 3.9.3, respectively. Aplin (1947) found that fish with air bladders are much more likely to be killed by explosives than those without. Explosives do not appear to harm lobsters but abalones may be damaged (Aplin, 1947). This section analyzes the potential effects of underwater detonations and high explosive ordnance use on benthic communities and artificial habitats.

Explosions associated with BOMBEX, MISSILEX, and GUNEX occur at or near the water's surface in areas where depths range from 65 ft (20 m) to over 2,900 ft (880 m). Therefore, these explosions are expected to have minimal effects on benthic communities and artificial habitats. Underwater detonations would be associated with mine neutralization training exercises, where explosive ordnance disposal detachments place explosive charges next to or on inert practice mines. Under the No Action Alternative, approximately 32 mine neutralization training events would occur. Some charges would be detonated directly on the bottom and the others would be detonated in the water column.

The Navy activities would not result in any direct impacts on the coral or degradation of water/sediment quality in the vicinity of the corals. The probability of intercept debris from a MISSILEX or expended materials from GUNEX, BOMBEX, SINKEX, or EER/IEER/AEER affecting any coral is extremely small. In addition, the debris and expended materials are spread out over a wide area so that even in the unlikely event the debris or expended material lands on the coral, the pieces would be diffused and negligible. There is no deep water coral located in the area where SINKEX is typically conducted.

The Navy will continue to work with regulatory agencies to minimize the potential for impacts on hard bottom / coral communities. As a result, only unconsolidated, soft bottom habitats would be exposed to impacts from underwater detonations. Potential cratering of soft bottom seafloor is the only habitat disruption that would result from underwater detonations. For a specific size of explosive charge, crater depths and widths would vary depending on depth of the charge and sediment type, but crater dimensions generally decrease as bottom depth increases. A 20-pound charge detonated on the bottom can create depressions in the substrate up to 4 to 5 ft (approximately 1.5 m) in diameter and 1 ft (0.3 m) deep (DoN, 2000). Assuming a worst-case scenario where all underwater detonations occurred on the bottom, about 863 ft^2 (80 m^2) of benthic habitat would be affected per year. Crater effects are usually temporary in sand and mud bottoms. Only short-term increases in turbidity and resuspension of bottom sediments would be expected. There have been no studies of sediment deposition rates in the area of the Proposed Action, but the Minerals Management Service (2002) indicates that sandy sediments are quickly redeposited within

1,300 ft (396 m) of oil well blowouts, and finer sediments are widely dispersed and redeposited over a period of 30 days or longer within a few thousand meters. Repopulation of displaced sediments should be relatively rapid compared to hard bottom areas (NRC, 2002). The impact to the seafloor following underwater explosive detonations would be much less traumatic than from oil well blowouts or fish trawling (Auster and Langton, 1998; Hamilton, 2000; Barnette, 2001; Johnson, 2002; Morgan and Chuenpagdee, 2003).

Explosions would result in short-term disruptions to soft bottom benthic communities and would not affect artificial reefs or shipwrecks. Explosions in territorial waters would have no significant impact on marine communities under the No Action Alternative. Furthermore, explosions in non-territorial waters would not cause significant harm to marine communities under the No Action Alternative.

Sonar. Sonar may be used during a major exercise. Very little information is available regarding the hearing capability of marine invertebrates (NRC, 2003). Squid and crustaceans may detect low frequencies below 1,000 Hz; however, they are not able to detect mid or high frequency active sonar. Lovell et al. (2005) indicated that the prawn Palaemon serratus is responsive to sounds ranging in frequency from 100 to 3,000 Hz. No effects to marine invertebrates are anticipated from active sonar since they would most likely not be able to detect mid or high frequency active sonar and because acoustic transmissions are brief in nature.

Expended Materials. The Navy uses a variety of materials during training exercises conducted in the MIRC. Materials expended under the No Action Alternative include targets, sonobuoys, parachutes, inert munitions, unexploded munitions and fragments from exploded munitions including missiles, bombs, and shells.

Soft bottom benthic communities throughout the MIRC would be exposed to expended materials because use is widely dispersed and a majority of the materials rapidly sink to the sea floor. Expended materials would become encrusted by natural processes and incorporated into the sea floor, with no significant accumulations in any particular area and no negative effects to water quality. Some of the materials are the same as those often used in artificial reef construction (e.g., concrete and metal) and would be colonized by benthic organisms that prefer hard substrate. This colonization could result in localized increases in species richness and abundance, but no significant changes in community structure or function would be anticipated based on the limited amount and dispersed nature of the materials.

Deposition of expended training materials on the ocean bottom is judged to have negligible impacts because expended materials are distributed widely across open ocean areas and the majority of items are inert and would have little impact. Benthic habitat could be disrupted locally, however, over the long-term, deposited material could provide new, hard substrate for benthic communities to utilize. As discussed in subsection 3.2, hazardous material use may become physical hazards to marine life. Expended material use in territorial waters would have no significant impact on marine communities under the No Action Alternative. Furthermore, expended material use in non-territorial waters would not cause significant harm to marine communities under the No Action Alternative.

3.6.3.2 Alternative 1

Vessel Movements. An additional major exercise involving vessel movements will be added under Alternative 1. Unlike the Multiple Strike Group exercise, the additional exercise will be an Amphibious Assault exercise, which will not involve as many vessel movements as a Multiple Strike Group exercise. These changes would result in increased potential for planktonic organisms associated with primary and secondary productivity in the upper portions of the water column to be displaced, injured, or killed by vessel and propeller movements compared to baseline conditions. However, no measurable effects on plankton populations would occur because the number of organisms exposed to vessel movements would continue to be low relative to total plankton biomass. Vessel movements in territorial waters would have no significant impact on marine communities under Alternative 1. Similarly, vessel movements in non-territorial waters would not cause significant harm to marine communities under Alternative 1.

Aircraft Overflights. Fixed-wing aircraft and helicopter sorties will increase in the Study Area (Table 2-7). The potential effects of aircraft noise on various marine community components are analyzed in subsections 3.7 (Marine Mammals), 3.8 (Sea Turtles), and 3.9 (Fish and Essential Fish Habitat). Based on the analyses presented in those sections, aircraft overflights over territorial waters would have no significant impact on marine communities under Alternative 1. In addition, aircraft overflights over non-territorial waters would not cause significant harm to marine communities under Alternative 1.

Weapons Firing / Non-Explosive Practice Munitions. The amount of non-explosive ordnance fired would increase in the Study Area under Alternative 1. These changes would result in increased potential for ordnance to strike benthic communities and artificial habitats compared to baseline conditions. The velocity of ordnance would rapidly decrease upon contact with the water. As a result, expended ordnance would be moving at slow speeds by the time it travels through the water column and reaches the sea floor. Consequently, ordnance strikes would cause little or no physical damage to benthic habitat and any damage would be localized. The probability of ordnance striking an artificial reef or shipwreck would continue to be extremely low based on the widely dispersed nature of these resources and the training exercises. If ordnance were to strike these resources, little or no damage to the overall community would be expected based on the slow speed the ordnance would be traveling upon contact. Although the increased training frequency will represent a slight increase in overall impacts to marine environments, non-explosive ordnance strikes in territorial waters would have no significant impact on marine communities under Alternative 1. Similarly, non-explosive ordnance strikes in non-territorial waters would not cause significant harm to marine communities under Alternative 1.

Underwater Detonations and High Explosive Ordnance. The number of explosions occurring in the Study Area would change under Alternative 1. Table 2-8 shows annual training levels proposed under Alternative 1, and Table 2-9 lists the total ordnance use by training area locations. Assuming a worst-case scenario where all underwater detonations occurred on the bottom, about 1,216 ft^2 (113 m^2) of benthic habitat would be affected per year under Alternative 1. Explosions in territorial waters would have no significant impact on marine communities under Alternative 1. Furthermore, explosions in non-territorial waters would not cause significant harm to marine communities under Alternative 1.

Expended Materials. The amount of expended materials entering the marine environment would increase in the Study Area under Alternative 1. These changes would result in increased exposure of benthic communities to expended materials. However, the analysis for hazardous materials indicates that no significant accumulations of expended materials would occur in any particular area and water quality would not be negatively affected by expendable materials. Some of the materials would be colonized by benthic organisms that prefer hard substrate, resulting in localized increases in species richness and abundance. No significant changes in community structure or function would be anticipated based on the limited amount and dispersed nature of the materials. Expended material use in territorial waters would have no significant impact on marine communities under Alternative 1. Furthermore, expended material use in non-territorial waters would not cause significant harm to marine communities under Alternative 1.

3.6.3.3 Alternative 2

All Stressors. As detailed in Chapter 2 and Table 2-8, implementation of Alternative 2 would include all the actions proposed for MIRC, including the No-Action Alternative and Alternative 1, and additional major exercises. All stressors would increase under Alternative 2, resulting in similar, increased effects as in Alternative 1. Despite the increases in the number of training events and the NEW deployed during training events (Table 2-9), effects to the marine environment are expected to be short term and recoverable. Therefore, in accordance with NEPA, impacts associated with Alternative 2 will not be significant. In accordance with EO-12114, Alternative 2 will result in no significant harm to marine communities in non-territorial waters.

3.6.4 Unavoidable Significant Environmental Impacts

The analysis presented above indicates that Alternatives 1 and 2 would not result in unavoidable significant adverse effects to marine communities.

3.6.5 Summary of Environmental Impacts

Table 3.6-2 summarizes the effects of the No Action Alternative, Alternative 1, and Alternative 2 on marine communities. For purposes of analyzing such effects in accordance with NEPA and E.O. 12114, this table summarizes effects on a jurisdictional basis (i.e., under NEPA for actions or effects within U.S. Territory, and under E.O. 12114 for actions or effects outside of U.S. Territories).

Table 3.6-2: Summary of Environmental Effects of the Alternatives on Marine Communities in the MIRC Study Area

Alternative and Stressor	NEPA (Land and Territorial Waters, < 12 nm)	Executive Order 12114 (Non-Territorial Waters, >12 nm)
No Action Alternative, Alternative 1, and Alternative 2		
Vessel Movements	Localized disturbance, injury, and mortality to plankton. No long-term population or community-level effects.	Localized disturbance, injury, and mortality to submerged benthic features. No long-term population or community-level effects.
Amphibious Landings	Localized disturbance at specific landing areas with coralline exposures. Surge wave generated by slow moving craft could break off coral heads. No long-term population or community level effects.	Not Applicable. Amphibious landings occur exclusively within territorial waters.
Aircraft Overflights	Potential exposure to aircraft noise. No long-term population or community-level effects.	Potential exposure to aircraft noise. No long-term population or community-level effects.
Weapons Firing/Non-Explosive Ordnance Use	Localized disturbance to soft bottom benthic communities. No long-term population or community-level effects.	Localized disturbance to soft bottom benthic communities. No long-term population or community-level effects.
Underwater Detonations and Explosive Ordnance	Short-term, localized disturbance to soft bottom benthic communities. Localized disturbance, injury, and mortality to plankton. No long-term population or community-level effects.	Short-term, localized disturbance to soft bottom benthic communities. Localized disturbance, injury, and mortality to plankton. No long-term population or community-level effects.
Expended Materials	Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities. No long-term changes in community structure or function.	Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities. No long-term changes in community structure or function.
Impact Conclusion	No significant impact to marine communities.	No significant harm to marine communities.

3.7 MARINE MAMMALS

3.7.1 Introduction and Methods

3.7.1.1 Regulatory Framework

3.7.1.1.1 Federal Laws and Regulations

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 (*i.e.*, the high seas) by vessels or persons under U.S. jurisdiction. The term "take," as defined in Section 3 (16 U.S.C. 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 (NDAA) of Fiscal Year (FY) 2004 (Public Law [PL] 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 U.S.C. 1374 (c)(3)]. The FY 2004 NDAA adopted the definition of "military readiness activity" as set forth in the FY 2003 NDAA (PL 107-314). Military training activities within the MIRC Study Area constitute military readiness activities as that term is defined in PL 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, harassment may be defined as either "Level A harassment" or "Level B harassment." These definitions are included below:

- ***Level A Harassment***—injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment"). Injury is defined as the destruction or loss of biological tissue resulting in the alteration of physiological function that exceeds the normal daily physiological variation of the intact tissue.
- ***Level B Harassment***—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 (16 U.S.C. 1362 [18][B][i][ii]). For the purposes of the analysis in this EIS/OEIS, Level B harassment may be considered (1) temporary disturbance, where a marine mammal would suffer a temporary reduction in hearing sensitivity and temporarily impeded from responding in a normal manner to an acoustic stimulus; or (2) harassment that does not include permanent injury.

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 that set forth the permissible methods of taking and requirements pertaining to the mitigation, monitoring and reporting 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.

Thirty-two marine mammal species, stocks or populations have confirmed or possible occurrence in the marine waters of the MIRC Study Area, including 29 cetaceans (whales, dolphins, and porpoises), two pinnipeds (Hawaiian monk seal and northern elephant seal), and one sirenian, the dugong (DoN 2005; DoN 2007b; SMMC 2007). Of these 32, there are approximately 22 that are regularly found in the area, four that are rare and four that are extralimital (DoN 2005). The Navy is meeting its MMPA regulatory obligations by requesting a five-year Letter of Authorization (LOA) for the incidental harassment of marine mammal species found within the MIRC Study Area. The Navy's LOA request is requesting mortality takes because of the uncertain cause of strandings. As discussed in this section, the training events may expose marine mammals to sound from mid-frequency and high-frequency active tactical sonar or to pressures from underwater detonations during training, research and development, and testing and evaluation.

Endangered Species Act. The 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 the NMFS jointly administer the ESA and are also responsible for the listing of species (*i.e.*, the labeling of 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. Section 7 of the ESA directs all Federal agencies to use their existing authorities to conserve threatened and endangered species and to consult with USFWS and/or NMFS to ensure that its actions will not jeopardize the continued existence of any listed species. The ESA specifically requires agencies not to "jeopardize" the continued existence of any endangered or threatened species, or to destroy or adversely modify habitat critical to any endangered or threatened species. Section 9 of the ESA prohibits the take of ESA-listed species; "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect. Take is permitted through the issuance of an Incidental Take Permit by USFWS and/or NMFS. 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.

Five cetacean species regularly occur within the Mariana Islands and are listed as endangered under the ESA (DoN 2005; DoN 2008). Marine mammals that are ESA listed are considered "depleted" under the MMPA. These ESA-listed species include the blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), sei whale (*Balaenoptera borealis*) and sperm whale (*Physeter macrocephalus*). No Critical Habitat for marine mammals protected under the ESA has been designated within the MIRC Study Area.

The Navy has initiated the ESA Section 7 consultation process with NMFS for the five ESA-listed marine mammals, in addition to sea turtles discussed in section 3.8. Copies of correspondence with NMFS are provided in Appendix C of this EIS/OEIS.

3.7.1.1.2 Territory and Commonwealth Laws and Regulations

Guam. Pursuant to Section 6 of the ESA, a cooperative agreement exists between GovGuam DAWR and USFWS and NMFS that provides for funding and implementation of programs for endangered species research and recovery. GovGuam DAWR administers the Guam Endangered Species Act (Guam Public Law 15-36) and the Fish, Game, Forestry, and Conservation Act (5 GCA 63101-63117). Although

GovGuam does not specifically list marine mammals under Public Law 15-36, marine mammals are considered species of concern. Other GovGuam resource agencies, such as Guam's Bureau of Statistics and Plans (BSP), have specific mandates in relation to marine mammal conservation. GovGuam BSP administers the Guam Coastal Management Plan (GCMP) through the Coastal Zone Management Act of 1972 (Guam Public Law 92-583 and Public Law 94-370). The GCMP guides the use, protection, and development of land and ocean resources within Guam's coastal zone, which includes all non-Federal property and all submerged lands and waters out to 3 nm from the shoreline.

Commonwealth of the Northern Mariana Islands. Similar to Guam, the CNMI Department of Fish and Wildlife (CNMI DFW) receives Federal assistance to implement Federal and CNMI natural resource programs through Section 6 ESA agreements with USFWS. Although the CNMI does not have specific listings of marine mammal species, CNMI Public Law 2-51 considers all cetacean species within CNMI waters to be species of concern.

3.7.1.2 Assessment Methods and Data Used

3.7.1.2.1 General Approach to Analysis

Each alternative analyzed in this EIS/OEIS includes several warfare areas (*e.g.*, Mine Warfare, Air Warfare, *etc*.) and most warfare areas include multiple types of training events (*e.g.*, Mine Neutralization, Air-to-Surface Missile Exercise, *etc*.). Likewise, several activities (*e.g.*, vessel movements, aircraft overflights, weapons firing, *etc*.) are accomplished under each training activity, and those activities typically are not unique to that training activity. For example, many of the training activities involve Navy vessel movements and aircraft overflights. Accordingly, the analysis for marine mammals is organized by specific activity and/or stressors associated with that activity, rather than warfare area or training events.

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 biological resources 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 resources that may occur in the MIRC.
- Identify those biological 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 biological resources are likely to respond given their exposure and available scientific knowledge of their responses (response analysis).
- Determine the risks those responses pose to biological resources and the significance of those risks.

3.7.1.2.2 Study Area

The MIRC Study Area for marine mammals is described in subsection 1.5 and is shown in Figure 1.1-1. The Study Area is analogous to the "action area," for purposes of analysis under Section 7 of the ESA.

3.7.1.2.3 Data Sources

A comprehensive and systematic review of relevant literature and data has been conducted to complete this analysis for marine mammals. 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 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. The scientific literature was also consulted during the search for geographic location data (geographic coordinates) on the occurrence of marine resources within the MIRC Study Area.

Eldredge (1991) compiled the first list of published and unpublished records for the greater Micronesia area, reporting 19 marine mammal species. Some of these species accounts were based on unsubstantiated reports and may not reflect true species distribution in the region. Eldredge (2003) refined this list specifically for 13 cetacean species thought to occur around Guam (Eldredge 2003). The first comprehensive marine mammal survey of waters off the Mariana Islands was conducted from mid-January to mid April of 2007 (DoN 2007b). Given the survey's seasonal coverage and relatively low number of sightings, density estimates derived from the survey data are augmented by density and abundance estimates from the western North Pacific and the NMFS Southwest Fisheries Science Center (SWFSC) surveys of the eastern tropical Pacific and Hawaiian Islands (Ferguson and Barlow 2001, 2003; Barlow 2003; 2006). Guam references currently available are Kami and Lujan (1976), Donaldson (1983), and Eldredge (1991, 2003).

The Mariana Islands Marine Resource Assessment (MRA) (DoN 2005) includes a summary of scientific literature on marine species occurrence within the MIRC. For the purposes of this EIS/OEIS, the information from the MRA was supplemented with additional citations derived from new survey efforts, and scientific publications. Literature searches were conducted using the search engines: Biosis, Cambridge Abstract's Aquatic Sciences, University of California Melvyl, Biosis, and Zoological Record Plus. Searches were also conducted on peer reviewed journals that regularly publish marine mammal related articles (*e.g.*, Marine Mammal Science, Canadian Journal of Zoology, Journal of Acoustical Society of America, Journal of Zoology, and Aquatic Mammals). Additional references were also obtained from previous U.S. Navy environmental documents, and other regionally based reports.

Recent advances in marine mammal tagging and tracking have contributed to the growth of biological information including at-sea movements and diving behavior. Given the development of this new technology and difficulties in placing tags on marine mammals in the wild, the body of literature and sample size, while growing, is still relatively small. For difficult to study marine mammals such as an audiogram from a single Gervais beaked whale stranded from natural causes (Cook *et al.* 2006), even a sample size of one contributes new information that had not been available previously. Additional information was also solicited from acknowledged experts within academic institutions and government agencies such as NMFS SWFSC, with expertise in marine mammal biology, distribution, and acoustics.

3.7.1.2.4 Factors Used to Assess the Significance of Effects

This EIS/OEIS analyzes potential effects to marine mammals in the context of the MMPA, ESA (listed species only), 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, and if these effects would have a negligible impact on the species or stock. 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").
- 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 U.S.C. 1362 (18)(B)(i)(ii)].

For purposes of ESA compliance, effects of the action were analyzed to make a determination of effect for listed species (*e.g.*, 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 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 (*i.e*., 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 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.

The factors outlined above were also considered in determining the significance of effects under NEPA and EO 12114.

3.7.1.3 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 de-constructed the warfare areas and training 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. As shown in Table 3.7-1, potential stressors to marine mammals include vessel movements (disturbance or collisions), aircraft overflights (disturbance), sonar (harassment), weapons firing/ordnance use (disturbance and strikes), use of high explosive ordnance (disturbance, strike, habitat alteration), and expended materials (ingestion or entanglement). The potential effects of these stressors on marine mammals are analyzed in detail in Section 3.7.3.

Table 3.7-1: Summary of Potential Stressors to Marine Mammals

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Marine Mammals
Army Training			
Surveillance and Reconnaissance (S&R)		None	None
Field Training Exercise (FTX))/ Polaris Point Field, Orote Point Airfield & Runway, Fire Break #3, Northwest Field, Andersen South, Tinian EMUA		None	None
Parachute Insertions and Air Assault/ Orote Point Triple Spot, Polaris Point Field, Ordnance Annex Breacher House		None	None
Military Operations in Urban Terrain (MOUT) /Orote Point CQC House, Ordnance Annex Breacher House, Barrigada Housing, Andersen South		Aircraft Overflights	Potential for short-term behavioral responses to overflights within Apra Harbor. Potential exposure to aircraft noise inducing short-term behavior changes.
Field Training Exercise (FTX) / Polaris Point Field, Orote Point Airfield & Runway, Fire Break #3, Northwest Field, Andersen South, Tinian EMUA		None	None

Table 3.7-1: Summary of Potential Stressors to Marine Mammals (Continued)

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Marine Mammals
Marine Corps Training			
Ship to Objective Maneuver (STOM)		Vessel Movements	Potential for short-term behavioral responses; potential for vessel collision with marine mammals.
Operational Maneuver		None	None
Noncombatant Evacuation Order (NEO) /Tinian EMUA		None	None
Assault Support (AS) / Polaris Point Field, Orote Point KD Range, Tinian EMUA		Aircraft Overflights	Potential for short-term behavioral responses to overflights to access insertion locations in the Waterfront Annex and within the EMUA on Tinian. Potential exposure to aircraft noise inducing short-term behavior changes.
Reconnaissance and Surveillance (R&S) / Tinian EMUA		None	None
MOUT/ Ordnance Annex Breacher House, Andersen South		None	None
Direct Fires		Aircraft Overflights Weapons Firing Expended Materials	Potential for short-term behavioral responses to overflights to access firing sights at FDM and Orote Point KD Range. Potential for direct strike of marine mammals. Potential for ingestion of chaff and/or flare plastic end caps and pistons.
Exercise Command and Control (C2)		None	None
Protect and Secure Area of Operations		None	None

Table 3.7-1: Summary of Potential Stressors to Marine Mammals (Continued)

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Marine Mammals
Navy Training			
Anti-Submarine Warfare (ASW)		Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
		Aircraft Overflights	Potential for short-term behavioral responses to overflights.
		Sonar	Potential occurrences of temporary behavioral disturbance, or injury associated with MFA sonar. Potential occurrences of temporary behavioral disturbance associated with major exercises that use SURTASS LFA.. No injuries are anticipated from LFA use.
		Underwater explosions	Potential for short-term behavioral responses from explosive noise and pressure changes. Potential for injury or mortality within limited ZOI.
		Expended Materials	Potential for ingestion of chaff and/or flare plastic end caps and pistons.
Mine Warfare (MIW)		Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions within Agat Bay.
		Underwater explosions	Potential for vessel collision with marine mammals, potential for short term behavioral responses due to vessel traffic, potential for masking of underwater noise due to noise associated with vessel traffic.
		Expended Materials	Potential for short-term behavioral responses from explosive noise and pressure changes. Potential for injury or mortality within limited ZOI.
			Potential for ingestion of chaff and/or flare plastic end caps and pistons.
Air Warfare (AW)		Expended Materials	Potential for ingestion of chaff and/or flare plastic end caps and pistons.
		Weapons Firing	Potential for direct strike of marine mammals.

Table 3.7-1: Summary of Potential Stressors to Marine Mammals (Continued)

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Marine Mammals
Navy Training (continued)			
Surface Warfare (SUW)	Surface to Surface Gunnery Exercise (GUNEX)	Weapons Firing Expended Materials	Potential for direct strike of marine mammals. Potential for ingestion of chaff and/or flare plastic end caps and pistons, potential for entanglement of marine mammals with expended materials.
	Air to Surface GUNEX	Aircraft Overflights Weapons Firing Expended Materials	Potential for short-term behavioral responses to overflights in W-517. Potential for direct strike of marine mammals. Potential for ingestion of chaff and/or flare plastic end caps and pistons.
	Visit Board Search and Seizure (VBSS)	Aircraft Overflights Vessel Movements	Potential for short-term behavioral responses to overflights. Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
Strike Warfare (STW)/ FDM	Air to Ground Bombing Exercises (Land)(BOMBEX-Land)	Aircraft Overflights Expended Materials	Potential for short-term behavioral responses to overflights to marine mammals near FDM. Potential for direct strike of marine mammals. Potential for ingestion of chaff and/or flare plastic end caps and pistons.
	Air to Ground Missile Exercises (MISSILEX)	Aircraft Overflights Expended Materials	Potential for short-term behavioral responses to overflights to marine mammals near FDM. Potential for ingestion of ordnance related materials and chaff and/or flare plastic end caps and pistons.

Table 3.7-1: Summary of Potential Stressors to Marine Mammals (Continued)

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Marine Mammals
Navy Training (continued)			
Naval Special Warfare (NSW) / Orote Point Training Areas, House, Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field	Naval Special Warfare (NSW)	Aircraft Overflights	Potential for short-term behavioral responses to overflights.
		Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
		Amphibious Landings	Short-term behavioral responses from landing activity associated with landing craft approaching beaches.
		Weapons Firing	Potential for direct strike of marine mammals.
		Expended Materials	Potential for ingestion of chaff and/or flare plastic end caps and pistons.
	Insertion/Extraction	Aircraft Overflights	Potential for short-term behavioral responses to overflights.
		Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
		Amphibious Landings	Short-term behavioral responses from landing activity associated with landing craft approaching beaches.
		Weapons Firing	Potential for direct strike of marine mammals.
		Expended Materials	Potential for ingestion of chaff and/or flare plastic end caps and pistons.
	Direct Action	Aircraft Overflights	Potential for short-term behavioral responses to overflights.
		Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
		Amphibious Landings	Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches.
		Weapons Firing	Potential for direct strike of marine mammals.
		Expended Materials	Potential for ingestion of chaff and/or flare plastic end caps and pistons.
	BreachingAirfield Seizure	None	None

Table 3.7-1: Summary of Potential Stressors to Marine Mammals (Continued)

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Marine Mammals
Navy Training (continued)			
Naval Special Warfare (NSW) / Orote Point Training Areas, House, Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field	MOUT	None	None
	Airfield Seizure	None	None
	Over the Beach (OTB)	Aircraft Overflights Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Potential for short-term behavioral responses to overflights. Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions. Short-term behavioral responses from landing activity associated with landing craft approaching beaches. Potential for direct strike of marine mammals. Potential for ingestion of chaff and/or flare plastic end caps and pistons.
	Breaching	None	None

Table 3.7-1: Summary of Potential Stressors to Marine Mammals (Continued)

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Marine Mammals
Navy Training (continued)			
Amphibious Warfare (AMW) / FDM, Orote Point and Finegayan	Naval Surface Fire Support (FIREX Land)	Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
		Amphibious Landings	Short-term behavioral responses from landing activity associated with landing craft approaching beaches.
		Weapons Firing	Potential for direct strike of marine mammals.
		Expended Materials	Potential for ingestion of chaff and/or flare plastic end caps and pistons.
Small Arms Ranges, Orote Point KD Range, Reserve Craft Beach, Outer Apra Harbor, Tipalao Cove, Tinian EMUA	Marksmanship	None	None
	Expeditionary Raid	Aircraft Overflights	Potential for short-term behavioral responses to overflights.
		Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
		Amphibious Landings	Short-term behavioral responses from landing activity associated with landing craft approaching beaches.
		Expended Materials	Potential for ingestion of chaff and/or flare plastic end caps and pistons.
	Hydrographic Surveys	Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
		Amphibious Landings	Short-term behavioral responses from landing activity associated with landing craft approaching beaches.

Table 3.7-1: Summary of Potential Stressors to Marine Mammals (Continued)

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Marine Mammals
Navy Training (continued)			
Explosive Ordnance Disposal (EOD) / (refer to specific event)	Land Demolition/ Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point Training Areas, Ordnance Annex Breacher House, Ordnance Annex Detonation Range, Fire Break #3, Ordnance Annex Galley Building 460, SLNA, Barrigada Housing	None	None
	Underwater Demolition	Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
		Explosive Ordnance	Potential for short-term behavioral responses from explosive noise and pressure changes. Potential for injury or mortality within limited ZOI.
		Expended Materials	Potential for ingestion of chaff and/or flare plastic end caps and pistons.

Table 3.7-1: Summary of Potential Stressors to Marine Mammals (Continued)

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Marine Mammals
Navy Training (continued)			
Logistics and Combat Services Support	Combat Mission Area	Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
		Amphibious Landings	Short-term behavioral responses from landing activity associated with landing craft approaching beaches.
		Weapons Firing	Potential for direct strike of marine mammals.
		Expended Materials	Potential for ingestion of chaff and/or flare plastic end caps and pistons.
	Command and Control (C2)	None	None
Combat Search and Rescue (CSAR)	Embassy Reinforcement	None	None
	Anti-Terrorism (AT)	None	None
Air Expeditionary		None	None

Table 3.7-1: Summary of Potential Stressors to Marine Mammals (Continued)

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Marine Mammals
Air Force Training			
Counter Land		None	None
Counter Sea (Chaff)		Expended Materials	Potential for ingestion of chaff and/or flare plastic end caps and pistons.
Airlift		None	None
Air Expeditionary		None	None
Force Protection		None	None
Intelligence, Surveillance, Reconnaissance (ISR) and Strike Capacity/ R-7201, FDM, Andersen AFB	Air-to-Air Training	None	None
	Air-to-Ground Training	None	None
Rapid Engineer Deployable Heavy Operational Repair Squadron Engineer (RED HORSE) / Northwest Field	Silver Flag Training	None	None
	Commando Warrior Training	None	None
	Combat Communications	None	None

3.7.2 Affected Environment

3.7.2.1 Overview of Marine Mammals within the MIRC Study Area

Table 3.7-2 provides a list of marine mammal species that have confirmed or potential occurrence in the MIRC Study Area.

3.7.2.1.1 Factors Influencing Marine Mammal Occurrence

Marine mammal distribution within the MIRC Study Area and throughout the world is affected by demographic, evolutionary, ecological, habitat-related, and anthropogenic factors (Bjørge 2002; Bowen *et al.* 2002; Forcada 2002; Stevick *et al.* 2002). Movement of individuals is generally associated with feeding or breeding activity (Stevick *et al.* 2002). Some baleen whale species, such as the humpback whale, make extensive annual migrations in the northern hemisphere to low-latitude mating and calving grounds in the winter and to high-latitude feeding grounds in the summer (Corkeron and Connor 1999). Migrations likely occur during these seasons due to the presence of highly productive waters and associated cetacean prey species at high latitudes and of warm water temperatures at low latitudes (Corkeron and Connor 1999; Stern 2002). However, not all baleen whales migrate. Cetacean movements can also reflect the distribution and abundance of prey (Gaskin 1982; Payne *et al.* 1986; Kenney *et al.* 1996). Cetacean movements are linked to indirect indicators of prey, such as temperature variations, sea-surface chlorophyll concentrations, and bottom depth (Fiedler 2002).

3.7.2.1.2 Marine Mammals Excluded from Analysis

Seven species (North Pacific right whale, Hawaiian monk seal, dugong, Hubb's beaked whale, Indo-Pacific bottlenose dolphin, and northern elephant seal) are excluded from further analysis. Brief descriptions of these marine mammals follow, along with reasons why the Navy is not including them in the EIS/OEIS.

North Pacific Right Whale. The likelihood of a North Pacific right whale being present in the MIRC Study Area is extremely low. It may be the most endangered of the large whale species (Perry *et al.* 1999), and currently, there is no reliable population estimate, although the population in the eastern North Pacific Ocean is considered to be very small, perhaps in the tens to low hundreds of animals (Wade *et al.* 2006). The North Pacific right whale has been listed as endangered under the ESA since 1973 when it was listed as the "northern right whale." It was originally listed as endangered under the Endangered Species Conservation Act, the precursor to the ESA, in June 1970. The species is also designated as depleted under the MMPA. In 2008, NMFS listed the endangered northern right whale (*Eubalaena* spp.) as two separate, endangered species, North Pacific right whale (*E. japonica*) and North Atlantic right whale (*E. glacialis*) (73 FR 12024).

In April 2008, because the North Pacific right whale was listed as a separate, endangered species (the "northern right whale"), and because this was a newly listed entity, NMFS was required to designate critical habitat for the North Pacific right whale. The same two areas, within the Gulf of Alaska and within the Bering Sea, that were previously designated as critical habitat (71 FR 38277) for the northern right whale are now designated as critical habitat for the North Pacific right whale (73 FR 19000).

Despite many years of systematic aerial and ship-based surveys for marine mammals off the western coast of the U.S., only seven documented sightings of right whales were made from 1990 through 2000 (Waite *et al.* 2003). Based on this information, it is highly unlikely for this species to be present in the MIRC Study Area, so consequently, this species will not be considered in greater detail in the remainder of the EIS/OEIS.

Table 3.7-2: Summary of Marine Mammal Species, Listing Status, and Potential Occurrence in the MIRC Study Area

Common Name	Species Name	Status[1]			Occurrence[2]	
		IUCN	ESA	MMPA	Summer July-Nov	Winter Dec-June
ESA Species						
Mysticetes						
Blue whale	*Balaenoptera musculus*	E	E	D	Rare	Rare
Fin whale	*Balaenoptera physalus*	E	E	D	Rare	Regular
Sei whale	*Balaenoptera borealis*	E	E	D	Rare	Regular
Humpback whale	*Megaptera*	V	E	D	Rare	Regular
North Pacific right whale	*Eubalaena japonica*	E	E	D	Rare	Rare
Odontocetes						
Sperm whale	*Physeter*	V	E	D	Regular	Regular
Pinniped						
Hawaiian monk seal	*Monachus*	E	E	D	Extra-limital	Extra-limital
Sirenia						
Dugong	*Dugong dugon*	E	E	D	Extra-limital	Extra-limital
Non ESA Species						
Mysticetes						
Bryde's whale	*Balaenoptera edeni*	DD	-	ND	Regular	Regular
Minke whale	*Balaenoptera*	LR	-	ND	Rare	Regular
Odontocetes						
Blainville's beaked	*Mesoplodon*	DD	-	ND	Regular	Regular
Bottlenose dolphin	*Tursiops truncatus*	DD	-	ND	Regular	Regular
Cuvier's beaked whale	*Ziphius cavirostris*	DD	-	ND	Regular	Regular
Dwarf sperm whale	*Kogia sima*	LR	-	ND	Regular	Regular
False killer whale	*Pseudorca crassidens*	LR	-	ND	Regular	Regular
Fraser's dolphin	*Lagenodelphis hosei*	DD	-	ND	Regular	Regular
Ginkgo-tooth beaked	*Mesoplodon*	DD	-	ND	Rare	Rare
Hubbs beaked whale	*Mesoplodon carlhubbsi*	DD	-	ND	Extra-limital	Extra-limital
Indo-Pacific bottlenose	*Tursiops aduncus*	DD	-	ND	Extra-limital	Extra-limital
Killer whale offshore	*Orcinus orca*	LR	-	ND	Regular	Regular
Longman's beaked	*Indopacetus pacificus*	DD	-	ND	Regular	Rare
Melon-headed whale	*Peponocephala electra*	LR	-	ND	Regular	Regular
Pantropical spotted	*Stenella attenuata*	LR	-	ND	Regular	Regular
Pygmy killer whale	*Feresa attenuata*	DD	-	ND	Regular	Regular
Pygmy sperm whale	*Kogia breviceps*	LR	-	ND	Regular	Regular
Risso's dolphin	*Grampus griseus*	DD	-	ND	Regular	Regular
Rough-toothed dolphin	*Steno bredanensis*	DD	-	ND	Regular	Regular
Short-beaked common	*Delphinus delphis*	LR	-	ND	Rare	Rare
Short-finned pilot whale	*Globicephala*	LR	-	ND	Regular	Regular
Spinner dolphin	*Stenella longirostris*	LR	-	ND	Regular	Regular
Striped dolphin	*Stenella coeruleoalba*	LR	-	ND	Regular	Regular
Pinniped						
Northern elephant seal	*Mirounga angustirostris*	LR	-	ND	Extra-limital	Extra-limital

Notes (1) IUCN Listing Status: E = Endangered, V = Vulnerable, LR = Least Risk, DD = Data Deficient
ESA Listing Status: E = Endangered, T = Threatened
MMPA Listing Status D = Depleted Stock, ND = Not Depleted
(2) Extralimital: Species that has occurred rarely in the past, may be only one or several documented sightings

Hawaiian Monk Seal. The likelihood of a Hawaiian monk seal (*Monachus schauinslandi*) being present in the MIRC Study Area is extremely low. The Hawaiian monk seal is listed as endangered under the ESA (41 FR 51611) and depleted under the MMPA (Ragen and Lavigne 1999; Carretta *et al.* 2007). Hawaiian monk seals are managed as a single stock within the Hawaiian Islands and breed there exclusively (Ragen and Lavigne 1999; Carretta *et al.* 2004).

The best estimate of the total population size is 1,247 individuals (Carretta *et al.* 2007). In 2001, there were an estimated 77 seals in the main Hawaiian Islands (Baker and Johanos 2004; Carretta *et al.* 2004); the vast majority of the population occurs in the Northwestern Hawaiian Islands. The trend in abundance for the population over the past 20 years has mostly been negative (Baker and Johanos 2004; Carretta *et al.* 2004).

There are no confirmed records of Hawaiian monk seals in the Micronesia region; however, Reeves *et al.* (1999) and Eldredge (1991; 2003) have noted occurrence records for seals (unidentified species) in the Marshall and Gilbert islands. It is possible that Hawaiian monk seals wander from the Hawaiian Islands to appear at the Marshall or Gilbert Islands in the Micronesia region (Eldredge 1991). However, given the extremely low likelihood of this species occurrence in the MIRC Study Area, the Hawaiian monk seal will not be considered in the remainder of the EIS/OEIS.

Dugong. The likelihood of a dugong being present in the MIRC Study Area is extremely low. The dugong is listed as endangered under the ESA throughout its entire range (39 FR 1171) and is designated as vulnerable by The World Conservation Union (IUCN) Red List (Marsh *et al.* 2003). A total of 27 individuals were counted during the course of the 2003 aerial survey at Palau, the only location in the Micronesia region with a dugong population (Davis 2004). The likelihood of a dugong occurring in the MIRC Study Area is extremely low. Consequently, this species will not be considered in the remainder of the EIS/OEIS.

Hubbs Beaked Whale. The likelihood of a Hubbs beaked whale (*Mesoplodon carlhubbsi*) occuring in the MIRC Study Area is extremely low. There are no occurrence records for the Mariana Islands and the nearest records are from strandings in Japan (DoN 2005). Recent data suggests that the distribution is likely north of 30^{o}N (MacCleod *et al.* 2006). Given the extremely low likelihood of this species occurrence in the MIRC Study Area, the Hubbs beaked whale will not be considered in the remainder of this analysis.

Indo-Pacific Bottlenose Dolphin. The likelihood of an Indo-Pacific bottlenose dolphin (*Tursiops aduncas*) occuring in the MIRC Study Area is extremely low. The Indo-Pacific bottlenose dolphin is generally associated with continental margins and does not appear to occur around offshore islands that are great distances from a continent, such as the Marianas (Jefferson personal communication as cited in DoN 2005). Given the extremely low likelihood of this species occurrence in the MIRC Study Area, the Indo-Pacific bottlenose dolphin will not be considered in the remainder of this analysis.

Northern Elephant Seal. Northern elephant seals (*Mirounga angustirostris*) are common on islands and mainland haul-out sites in Baja California, Mexico north through central California. Elephant seals spend several months at sea feeding and travel as far as the Gulf of Alaska. Ocassionally juveniles wander great distances with several individuals being observed in Hawaii and Japan. Although elephant seals may wander great distances it is very unlikely that they would travel to Japan or Hawaii and then continue traveling to the MIRC. Given the extremely low likelihood of this species occurrence in the MIRC Study Area, the northern elephant seal will not be considered in the remainder of this analysis.

3.7.2.1.3 Density of Marine Mammals in the MIRC Study Area

Prior to 2007 there was little information available on the abundance and density of marine mammals in the MIRC. Most information on the occurrence of marine mammals came from short surveys (several days) and opportunistic sightings (NMFS Platform of Opportunity, oceanographic cruises or strandings). The first comprehensive survey of the area, Mariana Islands Sea Turtle and Cetacean Survey (MISTCS), was funded by the Navy to gather data in support of this analysis and was conducted in early 2007 covering mid January to mid April (DoN 2007b). Densities were calculated for 13 species observed during this survey and are the only published densities derived for this area that are based upon actual sightings. In order to conduct the analysis needed for the purposes of the MIRC EIS, the Navy compiled published densities from other geographical areas with existing survey data and similar oceanography (*e.g.*, sea surface temperature) such as the Hawaiian Islands (Barlow 2003, 2006), warm water areas of the eastern tropical Pacific (Ferguson and Barlow 2001, 2003) and Miyashita (1993).

The draft MISTCS density report was reviewed by local biologists at NMFS-Pacific Fisheries Science Center (PIFSC) and Pacific Islands Regional Office (PIRO), whose recommendations were incorporated into the final document. The methods used in the final MISTCS report was approved by NMFS PIFSC and PIRO for use in preparation of environmental planning documents for the Mariana Islands.

Navy 2007 Mariana Islands Sea Turtle and Cetacean Survey. The MISTCS was conducted from 13 January 2007 to 13 April 2007 in the Mariana Islands area which included most of the MIRC. The survey was conducted using the systematic line transect survey protocol developed by the NMFS Southwest Fisheries Science Center (Kinsey *et al.* 1998; Barlow 2003, 2006; Barlow and Ferguson 2001, 2003). Both visual and acoustic detection methods were used during the survey (DoN 2007b). This first systematic marine mammal survey of the Mariana Islands and Guam area was conceived and paid for by the Navy to provide data to support an analysis of potential effects from ongoing military readiness activities in the Mariana Islands.

Observers visually surveyed 6,063 nm (11,033 km) of trackline during the MISTCS cruise. On-effort distances ranged from 119 nm to 1,782 nm (220 km to 3,300 km) per leg (four 21 day legs to the survey). Visual survey effort was stopped at Beaufort sea state (BSS) >7. The original intent was to stop visual effort at BSS>5; however, poor sea conditions would have prevented any survey effort on several days during the first half of the survey. Therefore, all survey effort and sightings in BSS≤6 were included in the density estimation analyses.

There were 148 total sightings of 12 marine mammal species. The sperm whale was the most frequently seen species (21 sightings) followed by Bryde's and sei whales (18 and 16 sightings, respectively). The pantropical spotted dolphin was the most frequently encountered delphinid species (16 sightings) followed by the false killer whale and the striped dolphin (both 10 sightings). There were also three sightings of beaked whales (two *Mesoplodon* spp. and one ziphiid whale). Group size varied by species and ranged from 1 to 115 individuals. The range of bottom depth for sightings was highly variable and was species-dependent.

Species with similar sighting characteristics (*e.g.*, body size, group size, surface behavior, blow visibility) were pooled to estimate $f_i(0)$ for three categories: *Balaenoptera* spp., blackfish (medium size odontocetes such as pilot and melon headed whales), and delphinids. This was done because there were insufficient numbers of sightings (<20) to model the detection function for individual species.

The marine mammal densities calculated from MISTCS sighting data are the only densities for this area based on actual sighting. However, to ensure that they represented the best available science for use in acoustic effects modeling, they were compared with those derived from other geographical areas. As shown in Table 3.7-3, for every estimate provided by MISTCS data, all are either mid-range or higher in comparison. Therefore, it was concluded that they represent the best available data, and they were used as the primary source for acoustic effects modeling. For species with no density calculations from MISTCS, published densities from other areas with similar oceanographic conditions (*e.g.*, bathymetry and sea surface temperature) were used.

3.7.2.1.4 Densities Derived from Other Areas

Given the absence of systematic survey data, density estimates derived from survey data collected in other regions were used to provide some indication of how many animals may be present in the MIRC Study Area. Information on density estimates were taken from several sources depending on the species. Density estimates from the Hawaiian Islands, the eastern tropical Pacific (ETP), and southern Japan/east Taiwan, were examined. Information on the occurrence or anticipated distribution of species was also analyzed as available. Although some species have not been observed within the Guam and Mariana Islands area, their overall distribution, habitat preference or proximity to known areas of occurrence suggest that they could use or transit this area. In addition, oceanographic changes such as shifts in sea surface temperature or current/gyre patterns, or changes in population, may cause animals to alter their normal migration patterns or ranges.

Hawaii Offshore (Barlow 2003, 2006). Marine mammal density estimates for the Hawaiian offshore area are reported in Barlow (2003). During the last 30 years, SWFSC has refined the techniques for conducting visual observations from ships using line transect methods (Smith 1979; Holt and Powers 1982; Hiby and Hammond 1989; Buckland *et al.* 2001; 1993). The methods used in the Hawaiian Islands offshore surveys are similar to those described for the Mariana Islands survey.

The outer EEZ of the Hawaiian Islands, 25 nm beyond the coast of the islands, was surveyed during the summer and fall of 2002 (Barlow 2003, 2006). The low number of cetaceans sighted in this area made density estimates difficult (Barlow 2003, 2006). Barlow developed a method using detection probabilities of cetaceans from this study and previous line transect studies in Hawaiian waters to estimate cetacean density and abundance.

If a density was not available for a species from the MISTCS report then the Hawaiian Islands survey (Barlow 2003, 2006) was used because of the similarity of habitat and species to the MIRC. This was followed by densities from the Eastern Tropical Pacific survey (Ferguson and Barlow 2001, 2003). This method of providing marine mammal density estimates for the MIRC was provided to and approved by fisheries biologists from the NMFS-PIFSC.

Eastern Tropical Pacific – Water Areas (Ferguson and Barlow 2001, 2003). The SWFSC has conducted marine mammal surveys in the ETP since the 1970s. During the last 30 years, SWFSC has refined the techniques for conducting visual observations from ships using line transect methods (Smith 1979; Holt and Powers 1982; Hiby and Hammond 1989; Buckland *et al.* 2001, 1993).

Ferguson and Barlow (2001; 2003) provide density estimates and associated coefficients of variation (CVs) for geographic regions within the ETP. Marine mammal density estimates from the offshore strata with similar sea surface temperatures to the MIRC were used in the MIRC analysis because these areas are oceanographically more similar to the Mariana Islands area. Areas adjacent to the coast were not used because of the higher productivity associated with coastal areas in the ETP (Hardy 1993; Burtenshaw *et al.* 2004).

Table 3.7-3: Summary of Marine Mammal Densities

Common Name	Marine Mammal Densities (animals/km^2)			
	Navy 2007 Mariana Islands Survey	Hawaii Offshore	Eastern Tropical Pacific	Japan/Western Pacific
ESA Listed Species				
Blue whale ***Balaenoptera musculus***	N/A	N/A	**0.0001 (CV = 0.43-1.00)**	N/A
Fin whale ***Balaenoptera physalus***	N/A	N/A	**0.0003 (CV = 0.72)**	N/A
Humpback whale ***Megaptera novaeangliae***	N/A	N/A	**0.0069 (CV = 1.00)**	N/A
Sei whale ***Balaenoptera borealis***	**0.00029 (CV = 0.49)**	N/A	N/A	N/A
Sperm whale ***Physeter macrocephalus***	**0.00123 (CV = 0.60)**	0.00282 (CV = 0.81)	0.0001-0.0035 (CV = 0.47–1.00)	N/A
Non ESA Listed Species				
Bryde's whale ***Balaenoptera edeni***	**0.00041 (CV = 0.45)**	0.00019 (CV = 0.45)	0.0001-0.0029 (CV = 0.47-1.00)	N/A
Minke whale ***Balaenoptera acutorostrata***	**N/A**	N/A	**0.0003 (CV = 0.71)**	N/A
Blainville's beaked whale ***Berardius bairdii***	N/A	**0.00117 (CV =1.25)**	0.0013 (CV = 0.71)	N/A
Bottlenose dolphin ***Tursiops truncatus***	**0.00021 (CV = 0.99)**	0.00131 (CV = 0.59)	0.0001 -0.0311 (CV = 0.36-1.0)	0.0146
Cuvier's beaked whale ***Ziphius cavirostris***	N/A	**0.00621 (CV = 1.43)**	0.0003-0.054 (CV = 0.55-1.00)	N/A
Dwarf sperm whale ***Kogia sima***	N/A	**0.00714 (CV = 0.74)**	0.0017-0.0173 (CV = 0.52-1.00)	N/A
False killer whale ***Pseudorca crassidens***	**0.00111 (CV = 0.74)**	0.0001 (CV = 1.08)	0.0004-0.0147 (CV = 0.58-1.00)	N/A
Fraser's dolphin ***Lagenodelphis hosei***	N/A	**0.00417 (CV = 1.16)**	0.005-0.1765 (CV = 0.58-1.00)	N/A
Ginkgo-toothed beaked whale ***Mesoplodon ginkgodens***	N/A	N/A	**0.0005 (CV = 0.45-1.00)**	N/A
Killer whale ***Orcinus orca***	N/A	**0.00014 (CV = 0.98)**	0.0001-0.003 (CV = 0.58-1.00)	N/A
Longman's beaked whale ***Indopacetus pacificus***	N/A	**0.00041 (CV = 1.26)**	0.0002-0.0004 (CV = 1.00)	N/A
Melon-headed whale ***Peponocephala electra***	**0.00428 (CV = 0.88)**	0.0012 (CV = 1.10)	0.0007-0.0167 (CV = 0.71-1.00)	N/A

Table 3.7-3: Summary of Marine Mammal Densities (Continued)

Common Name	Marine Mammal Densities (animals/km^2)			
	Navy 2007 Mariana Islands Survey	Hawaii Offshore	Eastern Tropical Pacific	Japan/Western Pacific
Pantropical spotted dolphin *Stenella attenuata*	**0.0226 (CV = 0.70)**	0.00366 (CV = 0.48)	0.0574-0.4208 (CV = 0.24-0.95)	0.0137
Pygmy killer whale *Feresa attenuata*	**0.00014 (CV = 0.88)**	0.00039 (CV = 0.83)	0.0014-0.0156 (CV = 0.44-1.00)	N/A
Pygmy sperm whale *Kogia breviceps*	N/A	**0.00291 (CV = 1.12)**	0.0018-0.0031 (CV = 0.71-1.00)	N/A
Risso's dolphin *Grampus griseus*	N/A	**0.00097 (CV = 0.65)**	0.0006-0.0178 (CV = 0.39-1.0)	0.0106
Rough-toothed dolphin *Steno bredanensis*	**0.00029 (CV = 0.89)**	0.00355 (CV = 0.45)	0.0002-0.0576 (CV = 0.40-1.00)	N/A
Short-beaked common dolphin *Delphinus delphinus*	N/A	N/A	**0.0021 (CV = 0.28)**	N/A
Short-finned pilot whale *Globicephala macrorhynchus*	**0.00159 (CV = 0.68)**	0.00362 (CV = 0.38)	0.0007-0.0208 (CV = 0.36-1.00)	N/A
Spinner dolphin *Stenella longirostris*	**0.00314 (CV = 0.95)**	0.00137 (CV = 0.74)	0.0001-0.2191 (CV = 0.31-1.00)	N/A
Striped dolphin *Stenella coeruleoalba*	**0.00616 (CV = 0.54)**	0.00536 (CV = 0.48)	0.0019-0.3825 (CV = 0.24-1.46)	0.0329

Notes:
Densities in **bold** were used in the effects modeling, described in section 3.7.3 (Environmental Consequences).
CV = Coefficient of Variation
Density Sources:
Navy 2007 Mariana Islands Sea Turtle and Cetacean Survey – DoN 2007b
Hawaii Offshore survey – Barlow 2006
Eastern Tropical Pacific - Ferguson and Barlow 2003
Japan/Western Pacific - Miyashita *et al.*, 1993

Western Pacific (Miyashita et al. 1993). Miyashita *et al.* (1996) reported on the winter distribution and abundance of cetaceans in the western north Pacific. Data were collected using ship based surveys but were not conducted in the same systematic line transect manner as the NMFS surveys in Hawaii and the ETP. Ship surveys were conducted relative to the Japanese small cetacean drive fisheries (commercial cetacean fisheries) and occurred while searching for cetaceans.

3.7.2.2 Overview of Marine Mammal Hearing and Vocalization

In general, marine mammals hear sounds much like humans and other mammals, with some changes to adapt to the demands of hearing in the sea. The typical mammalian ear is divided into an outer ear, middle ear, and inner ear. The outer ear is separated from the inner ear by a tympanic membrane, or eardrum. In terrestrial mammals, the outer ear, eardrum, and middle ear transmit airborne sound to the inner ear, where the sound waves are propagated through the cochlear fluid. Since the impedance of water is close to that of the tissues of a cetacean, the outer ear is not required to transduce sound energy as it does when sound waves travel from air to fluid (inner ear). Sound waves traveling through the inner ear cause the basilar membrane to vibrate. Specialized cells, called hair cells, respond to the vibration and produce nerve pulses that are transmitted to the central nervous system. Acoustic energy causes the basilar membrane in the cochlea to vibrate. Sensory cells at different positions along the basilar membrane are excited by different frequencies of sound (Pickles 1998). Baleen whales have inner ears that appear to be specialized for low-frequency hearing. Conversely, dolphins and porpoises have ears that are specialized to hear high frequencies.

Marine mammal vocalizations often extend both above and below the range of human hearing; vocalizations with frequencies lower than 18 Hertz (Hz) are labeled as infrasonic and those higher than 20 kilohertz (kHz) as ultrasonic. Measured data on the hearing abilities of whales and dolphins are sparse, and are virtually nonexistent for the larger cetaceans such as the baleen whales. The auditory thresholds of some of the smaller odontocetes have been determined in captivity. It is generally believed that cetaceans should at least be sensitive to the frequencies of their own vocalizations. Comparisons of the anatomy of cetacean inner ears and models of the structural properties and the response to vibrations of the ear's components in different species provide an indication of likely sensitivity to various sound frequencies. The ears of small toothed whales are optimized for receiving high-frequency sound, while baleen whale inner ears are best in low to infrasonic frequencies (Ketten 1992, 1997, 1998).

Southall *et al.* (2007) has provided a comprehensive review of marine mammal acoustics including designating functional hearing groups. Table 3.7-4 presents the functional hearing groups and representative species or taxonomic groups for each.

Table 3.7-4: Summary of the Five Functional Hearing Groups of Marine Mammals (from Southall *et al.* 2007)

Functional Hearing Group	Estimated Auditory Bandwidth	Species or Taxonomic Groups
Low frequency cetaceans (Mysticetes–Baleen whales)	7 Hz to 22 kHz (best hearing is generally below 1000 Hz, higher frequencies result from humpback whales)	All baleen whales
Mid-frequency cetaceans (Odontocetes)	150 Hz to 160 kHz (best hearing is from approximately 10-120 kHz)	Most delphinid species including rough-toothed, bottlenose, spinner, common, Fraser's, dusky, hourglass, Peale, white-beaked and white-sided, Risso's and right whale dolphins; medium and large odontocete whales including melon-headed pygmy killer, false killer, killer whale, pilot sperm whale, beluga whale, narwhal and beaked whales
High-frequency cetaceans (Odontocetes)	200 Hz to 180 kHz (best hearing is from approximately 10-150 kHz)	Porpoise species including the harbor, finless, and Dell's porpoise; river dolphins including the Baiji, Ganges, Amazon river dolphins; the dwarf and pygmy sperm whales; and Commerson's, Heaviside and Hector's dolphins
Pinnipeds in water	75 Hz to 75 kHz (best hearing is from approximately 1-30 kHz)	All seals, fur seals, sea lions and walrus
Pinnipeds in air	75 Hz to 30 kHz (best hearing is from approximately 1-16 kHz)	All seals, fur seals, sea lions and walrus

General reviews of marine mammal sound production and hearing may be found in Richardson *et al.* (1995), Edds-Walton (1997), Wartzok and Ketten (1999), Au *et al.* (2000), and May-Collado *et al.* (2007). For a discussion of acoustic concepts, terminology, and measurement procedures, as well as underwater sound propagation, Urick (1983) and Richardson *et al.* (1995) are recommended.

3.7.2.3 ESA-Listed Marine Mammals in the MIRC Study Area

The ESA-listed blue whale, fin whale, humpback whale, sei whale, and sperm whale are expected to regularly occur, although seasonally, in the MIRC and each species is described below. Species are also designated according to the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species using the following terms:

- **Endangered:** a taxon is Endangered when the best available evidence indicates that it is facing a very high risk of extinction in the wild.
- **Vulnerable:** considered to be facing a high risk of extinction in the wild.
- **Near Threatened:** is close to qualifying for or is likely to qualify for a threatened category in the near future.
- **Lower Risk:** a taxon is categorized as Lower Risk when it does not qualify for Critically Endangered, Endangered, Vulnerable, or Near Threatened. Widespread and abundant taxa are included in this category.
- **Data Deficient:** A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking.

3.7.2.3.1 Blue whale (*Balaenoptera musculus*) Western North Pacific Stock

Listing Status—In the North Pacific, the International Whaling Commission (IWC) began management of commercial whaling for blue whales in 1969; blue whales were fully protected from commercial whaling in 1976 (Allen 1980). Blue whales were listed as endangered under the ESA in 1973, therefore they are considered depleted and strategic under the MMPA. They are also protected by the Convention on International Trade in Endangered Species (CITES) of wild flora and fauna and the MMPA. Blue whales are listed as “endangered” on the IUCN Red List of Threatened Animals (Baillie and Groombridge, 1996). Critical habitat has not been designated for blue whales.

Population Status—The blue whale was severely depleted by commercial whaling in the twentieth century (NMFS 1998a). In the North Pacific, pre-exploitation population size is speculated to be approximately 4,900 blue whales and the current population estimate is a minimum of 3,300 blue whales (Wade and Gerrodette 1993, NMFS 2006c). No blue whales were visually or acoustically detected during the MISTCS winter survey cruise (DoN 2007b); however ship noise required the acoustic system to set a filter above the frequency of infrasonic calls. There was no density estimate for blue whales available from Hawaii (Barlow 2006), therefore, a density estimate of 0.0001 animals per km^2 (CV = 0.43-1.00) derived from the ETP was used (Ferguson and Barlow 2001, 2003).

A clear population trend for blue whales is difficult to detect under current survey methods. An increasing trend between 1979/80 and 1991 and between 1991 and 1996 was suggested by available survey data, but it was not statistically significant (Carretta *et al.* 2006). Although the population in the North Pacific is expected to have grown since being given protected status in 1966, the possibility of continued unauthorized takes by Soviet whaling vessels after 1966, and the existence of incidental ship strikes and gillnet mortality makes this uncertain (Yablokov 1994).

Distribution—The blue whale has a worldwide distribution in circumpolar and temperate waters. Blue whales undertake seasonal migrations and were historically hunted on their summer, feeding areas. It is assumed that blue whale distribution is governed largely by food requirements and that populations are seasonally migratory. Poleward movements in spring allow the whales to take advantage of high zooplankton production in summer. Movement toward the subtropics in the fall allows blue whales to reduce their energy expenditure while fasting, avoid ice entrapment in some areas, and engage in reproductive activities in warmer waters. The timing varied, but whalers located few blue whales in wintering areas from December to February. The NMFS Biological Opinion for Valiant Shield (NMFS 2007) stated that observations made after whaling was banned revealed a similar pattern: blue whales spend most of the summer foraging at higher latitudes where the waters are more productive (Sears 1990; Calambokidis et al. 1990; Calambokidis 1995). Like the other baleen whales, individual blue whales may migrate south prematurely into the MIRC; however, the occurrence of blue whales during summer months is not likely.

There are no occurrence records for the blue whale in the MIRC and vicinity, though this area is in the distribution range for this species. Blue whales would be most likely to occur in the Mariana Islands area during the winter (Jefferson personal communication, cited in DoN 2005) although none were observed during a recent marine mammal survey (January through April 2007) of the area (DoN 2007b).

Reproduction/Breeding—Blue whales move south in the fall and calving primarily occurs in the winter (Yochem and Leatherwood 1985).

Diving Behavior—Blue whales spend more than 94 percent of their time below the water's surface (Lagerquist *et al.* 2000). Croll *et al.* (2001a) determined that blue whales dived to an average of 462 ft (141 m) and for 7.8 minutes (min) when foraging and to 222 ft (68 m) and for 4.9 min when not foraging. Calambokidis *et al.* (2003) deployed tags on blue whales and collected data on dives as deep as about 984 ft (300 m). Lunge-feeding at depth is energetically expensive and likely limits the deeper diving capability of blue whales. Foraging dives are deeper than traveling dives; traveling dives were generally to ~ 100 ft (30 m). Typical dive shape is somewhat V-shaped, although the bottom of the V is wide to account for the vertical lunges at bottom of dive. Blue whales also have shallower foraging dives.

Acoustics—Blue whale vocalizations are long, patterned low-frequency sounds with durations up to 36 sec (Richardson *et al.* 1995) repeated every 1 to 2 min (Mellinger and Clark 2003). Their frequency range is 12 to 400 hertz (Hz), with dominant energy in the infrasonic range at 12 to 25 Hz (Ketten 1998; Mellinger and Clark 2003). Source levels (1 uPa @ 1 m) are up to 188 decibels (dB) re 1 µPa-m (Ketten 1998; McDonald *et al.* 2001). During the Magellan II Sea Test (at-sea exercises designed to test systems for antisubmarine warfare), off the coast of California in 1994, blue whale vocalization source levels at 17 Hz were estimated in the range of 195 dB re 1 µPa-m (Aburto *et al.* 1997). Širović *et al.* (2007) reported that blue whales produced vocalizations with a source level of 189 ± 3 dB re:1 Pa-1 m over a range of 25–29 Hz and could be detected up to 125 mi (200 km) away. A comparison of recordings between November 2003 and November 1964 and 1965, reveals a strong blue whale presence near San Nicolas Island (McDonald *et al.* 2006). McDonald *et al.* (2006) reported a long-term shift in the frequency of the blue whale calling is seen; in 2003 the spectral energy peak was 16 Hz, whereas in 1964-65 the energy peak was near 22.5 Hz, illustrating a more than 30 percent shift in call frequency over four decades.

Vocalizations of blue whales appear to vary among geographic areas (Rivers 1997), with clear differences in call structure suggestive of separate populations for the western and eastern regions of the North Pacific (Stafford *et al.* 2001). Stafford *et al.* (2005) recorded the highest calling rates when blue whale prey was closest to the surface during its vertical migration. Wiggins *et al.* (2005) reported the same trend of reduced vocalization during daytime foraging and then an increase in vocalizations at dusk as prey move up into the water column and disperse. Blue whales make seasonal migrations to areas of high productivity to feed and vocalize less in the feeding grounds than during the migration (Burtenshaw *et al.*,2004). Oleson *et al.* (2007) reported higher calling rates in shallow diving (<100 ft [30 m]) whales while deeper diving whales (> 165 ft [50 m]) were likely feeding and calling less.

As with other mysticete sounds, the function of vocalizations produced by blue whales is unknown. Hypothesized functions include: (1) maintenance of inter-individual distance, (2) species and individual recognition, (3) contextual information transmission (*e.g.*, feeding, alarm, courtship), (4) maintenance of social organization (*e.g.*, contact calls between females and offspring), (5) location of topographic features, and (6) location of prey resources (Thompson *et al.* 1992). Responses to conspecific sounds have been demonstrated in a number of mysticetes (Edds-Walton 1997), and there is no reason to believe that blue whales do not communicate similarly. While no data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing. Although no recent studies have directly measured the sound sensitivity in blue whales, experts assume that blue whales are able to receive sound signals in roughly the same frequencies as the signals they produce.

Blue whales continued foraging when exposed to low-frequency active (LFA) sonar sound at about 140 dB and changes in vocalizations were inconsistent and therefore could not be correlated to the LFA exposure (Croll *et al.* 2001a).

Impacts of Human Activity—Historic Whaling. Blue whales were occasionally hunted by the sailing-vessel whalers of the 19th century (Scammon 1874). The introduction of steam power in the second half of that century made it possible for boats to overtake large, fast-swimming blue whales and other rorquals. From the turn of the century until the mid-1960s, blue whales from various stocks were intensely hunted in all the world's oceans. Blue whales were protected in portions of the Southern Hemisphere beginning in 1939, but were not fully protected in the Antarctic until 1965. In 1955, they were given complete protection in the North Atlantic under the International Convention for the Regulation of Whaling; this protection was extended to the Antarctic in 1965 and the North Pacific in 1966 (Gambell 1979, Best 1993). The protected status of North Atlantic blue whales was not recognized by Iceland until 1960 (Sigurjonsson 1988). Only a few illegal kills of blue whales have been documented in the Northern Hemisphere, including three at Canadian east-coast whaling stations during 1966-69 (Mitchell 1974), some at shore stations in Spain during the late 1950s to early 1970s (Aguilar and Lens 1981, Sanpera and Aguilar 1992), and at least two by "pirate" whalers in the eastern North Atlantic in 1978 (Best 1992). Some illegal whaling by the USSR also occurred in the North Pacific; it is likely that blue whales were among the species taken by these operations, but the extent of the catches is not known. Since gaining complete legal protection from commercial whaling in 1966, some populations have shown signs of recovery, while others have not been adequately monitored to determine their status (NMFS 1998a). Removal of this significant threat has allowed increased recruitment in the population and, therefore, the blue whale population in the eastern North Pacific is expected to have grown.

Fisheries Interactions—Because little evidence of entanglement in fishing gear exists, and large whales such as the blue whale may often die later and drift far enough not to strand on land after such incidents, it is difficult to estimate the numbers of blue whales killed and injured by gear entanglements. In addition, the injury or mortality of large whales due to interactions or entanglements in fisheries may go unobserved because large whales swim away with a portion of the net or gear. Fishers have reported that large whales tend to swim through their nets without entangling and causing little damage to nets (Barlow *et al.* 1997).

Ship Strikes—Because little evidence of ship strikes exists, and large whales such as the blue whale may often die later and drift far enough not to strand on land after such incidents, it is difficult to estimate the numbers of blue whales killed and injured by ship strikes. In addition, a boat owner may be unaware of the strike when it happens. Ship strikes were implicated in the deaths of blue whales in 1980, 1986, 1987, 1993, and 2002 (Carretta *et al.* 2006). Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not always have obvious signs of trauma (Carretta *et al.* 2006).

Major shipping lanes pass through, or near, whale watching areas, and underwater noise by commercial ship traffic may have a much greater impact than that produced by whale watching. However, little is known about whether, or how, vessel noise affects blue whales.

3.7.2.3.2 Fin whale (*Balaenoptera physalus*)

Listing Status—In the North Pacific, the IWC began management of commercial whaling for fin whales in 1969; fin whales were fully protected from commercial whaling in 1976 (Allen 1980). Fin whales were listed as endangered under the ESA in 1973. They are also protected by the CITES and the MMPA. Fin whales are listed as "endangered" on the IUCN Red List of Threatened Animals (Baillie and Groombridge 1996). Critical habitat has not been designated for fin whales.

Population Status—In the North Pacific, the total pre-exploitation population size of fin whales is estimated at 42,000 to 45,000 whales (Ohsumi and Wada 1974). The most recent abundance estimate (early 1970s) for fin whales in the entire North Pacific basin is between 14,620 and 18,630 whales (NMFS 2006c). Fin whales have a worldwide distribution with two distinct stocks recognized in the North Pacific: the East China Sea Stock and "the rest of the North Pacific Stock" (Donovan 1991). No fin whales were detected visually or acoustically during the winter MISTCS cruise (DoN 2007b); however, ship noise required the acoustic system to set a filter above the frequency of infrasonic calls. There was no density estimate for fin whales available from the Mariana Islands (DoN 2007b) or Hawaii (Barlow 2006), therefore, a density estimate of 0.0003 animals per km^2 (CV = 0.72) that was derived from the ETP was used (Ferguson and Barlow 2001, 2003).

Distribution—Fin whales occur in oceans of both Northern and Southern Hemispheres between 20–75°N and S latitudes (Calambokidis *et al.* 2008). Fin whales are distributed widely in the world's oceans. In the northern hemisphere, most migrate seasonally from high Arctic feeding areas in summer to low latitude breeding and calving areas in winter. The fin whale is found in continental shelf and oceanic waters (Gregr and Trites 2001, Reeves *et al.* 2002). Globally, it tends to be aggregated in locations where populations of prey are most plentiful, irrespective of water depth, although those locations may shift seasonally or annually (Payne *et al.* 1986, 1990; Kenney *et al.* 1997; Notarbartolo-di-Sciara *et al.* 2003). Fin whales in the North Pacific spend the summer feeding along the cold eastern boundary currents (Perry *et al.* 1999).

Fin whales are typically not expected south of 20°N during summer, and less likely expected during summer near Guam (Miyashita *et al.* 1995, NMFS 2006b). Miyashita *et al.* (1995) presents a compilation of at-sea sighting results, from commercial fisheries vessels, by species in the Pacific Ocean from 1964-1990. For fin whales in August, Miyashita *et al.* (1995) reports no sightings south of 20°N, and significantly more sightings north of 40°N. Since, however, Miyashita (1995) shows limited search effort south of 20°N, while fin whales are not expected; there is a possibility of limited occurrence during the August exercise timeframe. There is no designated critical habitat for this species in the North Pacific.

No fin whales were detected acoustically or visually during the winter MISTCS cruise (DoN 2007b).

Life History Information—Fin whales become sexually mature between six to ten years of age, depending on density-dependent factors (Gambell 1985). Reproductive activities for fin whales occur primarily in the winter. Gestation lasts about 12 months and nursing occurs for 6 to 11 months (Perry *et al.* 1999). The age distribution of fin whales in the North Pacific is unknown. Natural sources and rates of mortality are largely unknown, but Aguilar and Lockyer (1987) suggest annual natural mortality rates may range from 0.04 to 0.06 (based on studies of northeast Atlantic fin whales). The occurrence of the nematode *Crassicauda boopis* appears to increase the potential for kidney failure in fin whales and may be preventing some fin whale stocks from recovering from whaling (Lambertsen 1992, as cited in Perry *et al.* 1999). Killer whale or shark attacks may result in serious injury or death in very young and sick whales (Perry *et al.* 1999). NMFS has no records of fin whales being killed or injured by commercial fisheries operating in the North Pacific (Ferrero *et al.* 2000).

Reproduction/Breeding—Reproductive activities for fin whales occur primarily in low latitude areas in the winter (Reeves 1999, Carretta *et al*. 2007).

Diving Behavior—Fin whales typically dive for 5 to 15 min, separated by sequences of 4 to 5 blows at 10 to 20 sec intervals (Cetacean and Turtle Assessment Program 1982, Stone *et al.* 1992, Lafortuna *et al.* 2003). Kopelman and Sadove (1995) found significant differences in blow intervals, dive times, and blows per hour between surface feeding and nonsurface-feeding fin whales. Croll *et al.* (2001) determined that fin whales dived to 321 ft (97 m) (Standard Deviation [SD] = ± 106.8 ft [32.4 m]) with a duration of 6.3 min (SD = ± 1.53 min) when foraging and to 168 ft (51 m) (SD = ± 97.3 ft [29.5m]) with a duration of 4.2 min (SD = ± 1.67 min) when not foraging. Goldbogen *et al.* (2006) reported that fin whales in California made foraging dives to a maximum of 748-889 ft and dive durations of 6.2-7.0 min. Fin whale dives exceeding 492 ft (149 m) and coinciding with the diel migration of krill were reported by Panigada *et al.* (1999). Fin whales feed on planktonic crustaceans, including *Thysanoessa* sp and *Calanus* sp, as well as schooling fish including herring, capelin and mackerel (Aguilar 2002). Depth distribution data from the Ligurian Sea in the Mediterranean are the most complete (Panigada *et al.* 2003), and showed differences between day and night diving; daytime dives were shallower (< 330 ft [100 m]) and night dives were deeper (> 1320 ft [400 m]), likely taking advantage of nocturnal prey migrations into shallower depths; this data may be atypical of fin whales elsewhere in areas where they do not feed on vertically-migrating prey.

Goldbogen *et al.* (2006) studied fin whales in southern California and found that 60 percent of total time was spent diving, with the other 40 percent near surface (< 165 ft [50 m]); dives were to > 743 ft (225 m) and were characterized by rapid gliding ascent, foraging lunges near the bottom of dive, and rapid ascent with flukes. Dives were somewhat V-shaped although the bottom of the V is wide. Based on information from Goldbogen *et al.* (2006), percentage of time at depth levels is estimated as 44 percent at < 165 ft (50 m), 23 percent at 165-743 ft (50-225 m) (covering the ascent and descent times) and 33 percent at > 743 ft (225 m).

Acoustics—Underwater sounds produced by fin whales are one of the most studied *Balaenoptera* sounds. Fin whales produce calls with the lowest frequency and highest source levels of all cetaceans. Infrasonic (10-200 Hz), pattern sounds have been documented for fin whales (Watkins *et al.* 1987, Clark and Fristrup 1997, McDonald and Fox 1999). Charif *et al.* (2002) estimated source levels between 159-184 dB re:1 µPa-1 m for fin whale vocalizations recorded between Oregon and Northern California. Fin whales can also produce a variety of sounds with a frequency range up to 750 Hz. The long, patterned 15 to 30 Hz vocal sequence is most typically recorded; only males are known to produce these (Croll *et al.* 2002). The most typical signals are long, patterned sequences of short duration (0.5-2s) infrasonic pulses in the 18-35 Hz range (Patterson and Hamilton 1964). Estimated source levels are as high as 190 dB (Patterson and Hamilton 1964; Watkins *et al.* 1987a, Thompson *et al.* 1992, McDonald *et al.* 1995). In temperate waters, intense bouts of long patterned sounds are very common from fall through spring, but also occur to a lesser extent during the summer in high latitude feeding areas (Clark and Charif 1998). Short sequences of rapid pulses in the 20-70 Hz band are associated with animals in social groups (McDonald *et al.* 1995). Each pulse lasts on the order of one second and at 20 Hz (Tyack 1999). Particularly in the breeding season, fin whales produce series of pulses in a regularly repeating pattern. These bouts of pulsing may last for longer than one day (Tyack 1999). The seasonality and stereotype of the bouts of patterned sounds suggest that these sounds are male reproductive displays (Watkins *et al.* 1987a), while the individual counter-calling data of McDonald *et al.* (1995) suggest that the more variable calls are contact calls. Some researchers feel there are geographic differences in the frequency, duration, and repetition of the pulses (Thompson *et al.* 1992). As with other mysticete sounds, the function of vocalizations produced by fin whales is unknown. Hypothesized functions include: (1) maintenance of inter-individual distance, (2) species and individual recognition, (3) contextual information transmission (*e.g.*, feeding, alarm, courtship), (4) maintenance of social organization (*e.g.*, contact calls between females and offspring), (5) location of topographic features, and (6) location of prey resources (review by Thompson *et al.* 1992). Responses to conspecific sounds have been demonstrated in a number of mysticetes, and there is no reason to believe that fin whales do not communicate similarly (Edds-Walton 1997). The low-frequency sounds produced by fin whales have the potential to travel over long distances, and it is possible that long-distance communication occurs in fin whales (Payne and Webb 1971; Edds-Walton 1997). Also, there is speculation that the sounds may function for long-range echolocation of large-scale geographic targets such as seamounts, which might be used for orientation and navigation (Tyack 1999).

The most typical fin whale sound is a 20 Hz infrasonic pulse (actually an FM sweep from about 23 to 18 Hz) with durations of about 1 sec and can reach source levels of 184 to 186 dB re 1 µPa (maximum up to 200) (Richardson *et al.* 1995; Charif *et al.* 2002). Croll *et al.* (2002) suggested that these long, patterned vocalizations might function as male breeding displays, much like those that male humpback whales sing. The source depth, or depth of calling fin whales, has been reported to be about 162 ft (49 m) (Watkins *et al.* 1987).

Although no studies have directly measured the sound sensitivity of fin whales, experts assume that fin whales are able to receive sound signals in roughly the same frequencies as the signals they produce. This suggests fin whales, like other baleen whales are more likely to have their best hearing capacities at low frequencies, including infrasonic frequencies, rather than at mid- to high-frequencies (Ketten 1997).

Impacts of Human Activity—As early as the mid-seventeenth century, the Japanese were capturing fin, blue, and other large whales using a fairly primitive open-water netting technique (Tønnessen and Johnsen 1982, Cherfas 1989). In 1864, explosive harpoons and steam-powered catcher boats were introduced in Norway, allowing the large-scale exploitation of previously unobtainable whale species. The North Pacific and Antarctic whaling operations soon added this modern equipment to their arsenal. After blue whales were depleted in most areas, the smaller fin whale became the focus of whaling operations and more than 700,000 fin whales were landed in the twentieth century. The incidental take of fin whales in fisheries is extremely rare. Anecdotal observations from fishermen suggest that large whales swim through their nets rather than get caught in them (NMFS 2000). Because of their size and strength, fin whales probably swim through fishing nets which might explain why these whales are rarely reported as having become entangled in fishing gear.

3.7.2.3.3 Humpback whale (*Megaptera novaeangliae*) Western North Pacific Stock

Listing Status—The IWC first protected humpback whales in the North Pacific in 1966. They are also protected under CITES. In the U.S., humpback whales were listed as endangered under the ESA in 1973 and are therefore classified as depleted and strategic stock under the MMPA. The IUCN Red List categorizes the humpback whale as “vulnerable.”

Population Status—Humpback whales live in all major ocean basins from equatorial to sub-polar latitudes migrating from tropical breeding areas to polar or sub-polar feeding areas (Jefferson *et al.*, 1993). Three Pacific stocks of humpback whales are recognized in the Pacific Ocean and include the western North Pacific stock, central North Pacific stock, and eastern North Pacific stock (Calambokidis *et al.* 1997; Baker *et al.* 1998). The Western North Pacific humpback whale stock is the one most likely to be encountered within the Mariana Islands. In the entire North Pacific Ocean prior to 1905, it is estimated that there were 15,000 humpback whales basin-wide (Rice 1978). In 1966, after heavy commercial exploitation, humpback abundance was estimated at 1,000 to 1,200 whales (Rice 1998), although it is unclear if estimates were for the entire North Pacific or just the eastern North Pacific. The current estimate for the entire North Pacific is 18,302 humpback whales in all feeding and wintering areas (Calambokidis *et al.* 2008).

Distribution—Although humpback whales typically travel over deep, oceanic waters during migration, their feeding and breeding habitats are mostly in shallow, coastal waters over continental shelves (Clapham and Mead 1999). Shallow banks or ledges with high sea-floor relief characterize feeding grounds (Payne *et al.* 1990; Hamazaki 2002). North Pacific humpback whales are distributed primarily in four more-or-less distinct wintering areas: the Ryukyu and Ogasawara (Bonin) Islands (south of Japan), Hawaii, the Revillagigedo Islands off Mexico, and along the coast of mainland Mexico (Calambokidis *et al.* 2001). The small winter aggregation of humpback whales observed by the Navy in 2007 (DoN 2007b), combined with acoustic detections of song indicate that there is at least a small wintering population in the Mariana Islands (DoN 2007b, Rivers *et al* 2007) as well. There is known to be some interchange of whales among different wintering grounds, and some matches between Hawaii and Japan, and between Hawaii and Mexico have been found (Salden *et al.* 1999; Calambokidis *et al.* 2000, 2001, 2008). During summer months, North Pacific humpback whales feed in a nearly continuous band from southern California to the Aleutian Islands, Kamchatka Peninsula, and the Bering and Chukchi seas (Calambokidis *et al.* 2001). Humpback whales summer throughout the central and western portions of the Gulf of Alaska, including Prince William Sound, around Kodiak Island (including Shelikof Strait and the Barren Islands), and along the southern coastline of the Alaska Peninsula. The northern Bering Sea, Bering Strait, and the southern Chukchi Sea along the Chukchi Peninsula, appear to form the northern extreme of the humpback whale's range (Nikulin 1946; Berzin and Rovnin 1966).

Humpback whales were observed during the MISTCS cruise 2.7 and 7.6 nm (5 and 14 km) (north of Tinian in deep water (2,625 to 3,940 ft [800 to 1,200 m]) and in shallow water (1234 ft [374 m]) 1.4 nm (2.6 km) north of Tinian (DoN 2007b). Acoustic detections of humpback song were made during these sightings as well as on other occasions (DoN 2007b, Norris *et al* 2007).

Life History—Humpbacks primarily feed on small schooling fish and krill (Caldwell and Caldwell 1983). While in California waters, humpback prey includes euphausiids and small schooling fish like anchovies, sardines, and mackerel (Wynne and Folkens 1992). It is believed that minimal feeding occurs in wintering grounds, such as the Hawaiian Islands but feeding may occur opportunistically (Balcomb 1987; Salden 1989).

Reproduction/Breeding—Western North Pacific humpback whales have been observed in the Philippine Sea from the northern Philippines, Taiwan, southern Japan and Mariana Islands area during winter months although there is little information and northern Mariana Islands may be south of the breeding areas (Mori *et al.* 1998; Yamaguchi *et al.* 2002).

Diving Behavior—Humpback whale diving behavior depends on the time of year (Clapham and Mead 1999). In summer, most dives last less than 5 min; those exceeding 10 min are atypical. In winter (December through March), dives average 10 to 15 min; dives of greater than 30 min have been recorded (Clapham and Mead 1999). Although humpback whales have been recorded to dive as deep as about

1,638 ft (500 m) (Dietz *et al.* 2002), on the feeding grounds they spend the majority of their time in the upper 400 ft (122 m) of the water column (Dolphin 1987; Dietz *et al.* 2002). Humpback whales on the wintering grounds do dive deeply; Baird *et al.* (2000) recorded dives to 577 ft (176 m).

Like other large mysticetes, they are a "lunge feeder" taking advantage of dense prey patches and engulfing as much food as possible in a single gulp. They also blow nets, or curtains, of bubbles around or below prey patches to concentrate the prey in one area, then lunge with mouths open through the middle. Dives appear to be closely correlated with the depths of prey patches, which vary from location to location. In the north Pacific, most dives were of fairly short duration (<4 min) with the deepest dive to 488 ft (148 m) (southeast Alaska; Dolphin, 1987), while whales observed feeding on Stellwagen Bank in the North Atlantic dove to < 132 ft (40 m) (Hain *et al.* 1995).

Acoustics—Humpback whales are known to produce three classes of vocalizations: (1) "songs" in the late fall, winter, and spring by solitary males; (2) sounds made within groups on the wintering (calving) grounds; and (3) social sounds made on the feeding grounds (Richardson *et al.* 1995). The best-known types of sounds produced by humpback whales are songs, which are thought to be breeding displays used only by adult males (Helweg *et al.* 1992). Humpback songs were recorded off Tinian during the Navy 2007 survey (DoN 2007b, Norris *et al.* 2007). Singing is most common on breeding grounds during the winter and spring months, but is occasionally heard outside breeding areas and out of season (Matilla *et al.* 1987; Clark and Clapham 2004). There is geographical variation in humpback whale song, with different populations singing different songs, and all members of a population using the same basic song. However, the song evolves over the course of a breeding season, but remains nearly unchanged from the end of one season to the start of the next (Payne *et al.* 1983). Social calls are from 50 Hz to over 10 kHz, with the highest energy below 3 kHz (Silber 1986). Female vocalizations appear to be simple; Simão and Moreira (2005) noted little complexity. The male song, however, is complex and changes between seasons. Components of the song range from under 20 Hz to 8 kHz and occasionally 24 kHz, with source levels of 144 to 174 dB re 1 µPa-m, with a mean of 155 dB re 1 µPa-m (Thompson *et al.* 1979; Payne and Payne 1985; Frazer and Mercado 2000; Au *et al.* 2006). Au *et al.* (2001) recorded high-frequency harmonics (out to 13.5 kHz) and source level (between 171 and 189 dB re 1 µPa-m) of humpback whale songs. Songs have also been recorded on feeding grounds (Mattila *et al.* 1987; Clark and Clapham 2004). Au *et al.* (2006) took recordings of whales off Hawaii and found high frequency harmonics of songs extending beyond 24 kHz, which may indicate that they can hear at least as high as this frequency.

"Feeding calls," unlike song and social sounds, are highly stereotyped series of narrow-band trumpeting calls. They are 20 Hz to 2 kHz, less than 1 second in duration, and have source levels of 175 to 192 dB re 1 µPa-m (DoN 2006a). The main energy lies between 0.2 and 3.0 kHz, with frequency peaks at 4.7 kHz. The fundamental frequency of feeding calls is approximately 500 Hz (D'Vincent *et al.* 1985).

Male calves were recorded in Hawaii producing sounds that were simple in structure, low frequency (mean of 220 Hz), brief in duration (mean duration of 170 ms) and occurred over a narrow bandwidth of 2 kHz (Zoidis *et al.* 2008).

No tests on humpback whale hearing have been made. Houser *et al.* (2001a) constructed a humpback audiogram using a mathematical model based on the internal structure of the ear and estimated sensitivity to frequencies from 700 Hz to 10 kHz, with maximum relative sensitivity between 2 and 6 kHz.

Research by Au *et al.* (2001, 2006) off Hawaii indicated the presence of high-frequency harmonics in humpback whale vocalizations at 24 kHz. While recognizing this was the upper limit of the recording equipment, it does not demonstrate that humpbacks can actually hear those harmonics, which may simply be correlated harmonics of the frequency fundamental in the humpback "song".. Maybaum (1989) reported that humpback whales showed a mild response to a hand held sonar marine mammal detection and location device (frequency of 3.3 kHz at 219 dB re 1µPa-m with a frequency sweep of 3.1-3.6 kHz) although this system is significantly different from the Navy's hull mounted sonars. In addition, the system had some low frequency components (below 1 kHz) which may be an artifact of the acoustic equipment. This may have affected the response of the whales to both the control and sonar playbacks.

In terms of functional hearing capability humpback whales belong to low-frequency cetaceans which have best hearing ranging from 7Hz and 22 kHz (Southall *et al.* 2007). There are no tests or modeling estimates of specific humpback whale hearing ranges. Recent information on the songs of humpback whales suggests that their hearing may extend to frequencies of at least 24 kHz and source levels of 151-173 dB re 1µPa (Au *et al*. 2006). Exposure to mid-frequency active sonar that is below or high-frequency active sonar that is above the functional hearing capability of humpback whales may not elicit a behavioral response since the respective frequencies are 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, humpback whale behavioral exposures discussed in Sections 3.7.3.8 (No Action Alternative), 3.7.3.9 (Alternative 1), and 3.7.3.10 (Alternative 2) may be overestimated.

Impacts of Human Activity—Historic whaling. Commercial whaling, the single most significant impact on humpback whales ceased in the North Atlantic in 1955 and in all other oceans in 1966. The humpback whale was the most heavily exploited by Soviet whaling fleets after World War II.

Fisheries Interactions—Entanglement in fishing gear poses a threat to individual humpback whales throughout the Pacific. Reports of entangled humpbacks whales found swimming, floating, or stranded with fishing gear attached, have been documented in the North Pacific. A number of fisheries based out of west coasts ports may incidentally take the ENP stock of humpback whale, and documented interactions are summarized in the U.S. Pacific Marine Mammal Stock Assessments: 2006 (Carretta *et al.* 2007). The estimated impact of fisheries on the ENP humpback whale stock is likely underestimated, since the serious injury or mortality of large whales due to entanglement in gear, may go unobserved because whales swim away with a portion of the net, line, buoys, or pots. According to Carretta *et al.* (2007) and the California Marine Mammal Stranding Network Database (U.S Department of Commerce 2006), 12 humpback whales and two unidentified whales have been reported as entangled in fishing gear (all crab pot gear, except for one of the unidentified whales) since 1997.

Ship Strikes—Humpback whales, especially calves and juveniles, are highly vulnerable to ship strikes and other interactions with nonfishing vessels. Younger whales spend more time at the surface, are less visible, and closer to shore (Herman *et al.* 1980; Mobley *et al.* 1999), thereby making them more susceptible to collisions. Humpback whale distribution overlaps significantly with the transit routes of large commercial vessels, including cruise ships, large tug and barge transport vessels, and oil tankers.

Ship strikes were implicated in the deaths of at least two humpback whales in 1993, one in 1995, and one in 2000 (Carretta *et al.* 2006). During 1999-2003, there were an additional five injuries and two mortalities of unidentified whales, attributed to ship strikes. Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not have obvious signs of trauma.

Whale watching boats and boats from which scientific research is being conducted specifically direct their activities toward whales and may have direct or indirect impacts on humpback whales. The growth of the whale-watching industry has not increased as rapidly for the ENP stock of humpback whales, as it has for the Central North Pacific stock (wintering grounds in Hawaii and summering grounds in Alaska), but whale-watching activities do occur throughout the ENP stock's range. There is concern regarding the impacts of close vessel approaches to large whales, since harassment may occur, preferred habitats may be abandoned, and fitness and survivability may be compromised if disturbance levels are too high. While a 1996 study in Hawaii measured the acoustic noise of different whale-watching boats (Au and Green 2000) and determined that the sound levels were unlikely to produce grave effects on the humpback whale auditory system, the potential direct and indirect effects of harassment due to vessels cannot be discounted. Several investigators have suggested shipping noise may have caused humpback whales to avoid or leave feeding or nursery areas (Jurasz and Jurasz 1979; Dean *et al.* 1985), while others have suggested that humpback whales may become habituated to vessel traffic and its associated noise. Still other researchers suggest that humpback whales may become more vulnerable to vessel strikes once they habituate to vessel traffic (Swingle *et al.* 1993; Wiley *et al.* 1995).

Other Threats—Similar to fin whales, humpbacks are potentially affected by a resumption of commercial whaling, loss of habitat, loss of prey (for a variety of reasons including climate variability), underwater noise, and pollutants. Generally, very little is known about the effects of organochlorine pesticides, heavy metals, and PCB's and other toxins in baleen whales, although the impacts may be less than higher trophic level odontocetes due to baleen whales' lower levels of bioaccumulation from prey.

Anthropogenic noise may also affect humpback whales, as humpback whales seem to respond to moving sound sources, such as whale-watching vessels, fishing vessels, recreational vessels, and low-flying aircraft (Beach and Weinrich 1989; Clapham *et al.* 1993; Atkins and Swartz 1989). Their responses to noise are variable and have been correlated with the size, composition, and behavior of the whales when the noises occurred (Herman *et al.* 1980; Watkins *et al.* 1981; Krieger and Wing 1986; Frankel and Clark 1998).

3.7.2.3.4 Sei whale (*Balaenoptera borealis*) Western North Pacific Stock

Listing Status—Sei whales did not have meaningful protection at the international level until 1970, when catch quotas for the North Pacific began to be set on a species basis (rather than on the basis of total production, with six sei whales considered equivalent to one "blue whale unit"). Prior to that time, the kill was limited only to the extent that whalers hunted selectively for the larger species with greater return on effort (Allen 1980). The sei whale was given complete protection from commercial whaling in the North Pacific in 1976. In the late 1970s, some "pirate" whaling for sei whales took place in the eastern North Atlantic (Best 1992). There is no direct evidence of illegal whaling for this species in the North Pacific although the acknowledged misreporting of whaling data by Soviet authorities (Yablokov 1994) means that catch data are not wholly reliable. In the U.S., sei whales were listed as endangered under the ESA in 1973 and are therefore classified as depleted and strategic stock under the MMPA. It is also classified as "endangered" by the IUCN (Baillie and Groombridge 1996) and is listed in CITES Appendix I. Critical habitat has not been designated for this species for the eastern North Pacific stock.

Population Status—Prior to the MISTCS survey, sei whales were considered to be extralimital south of 20°N latitude and in the Mariana Islands area (DoN 2005). However, they were the second most commonly sighted species during the survey, resulting in an estimated population of 166 (CV = 48.7; 95% CI = 67-416) sei whales in the MISTCS study area. Sei whale density was estimated as 0.00029 animals per km^2 (DoN 2007b; Fulling *et al.* 2007).

The IWC groups all of sei whales in the entire North Pacific Ocean into one stock (Donovan 1991). However, some mark-recapture, catch distribution, and morphological research, indicated that more than one stock exists; one between 175°W and 155°W longitude, and another east of 155°W longitude (Masaki 1976; 1977). In the U.S. Pacific EEZ, only the Eastern North Pacific Stock is recognized. Worldwide, sei whales were severely depleted by commercial whaling activities. In the North Pacific, the pre-exploitation population estimate for sei whales is 42,000 whales and the most current population estimate for sei whales in the entire North Pacific (from 1977) is 9,110 (Calambokidis *et al.* 2008).

Application of various models to whaling catch and effort data suggests that the total population of adult sei whales in the North Pacific declined from about 42,000 to 8,600 between 1963 and 1974 (Tillman 1977). Since 500-600 sei whales per year were killed off Japan from 1910 to the late 1950s, the stock size presumably was by 1963 below its carrying capacity level (Tillman 1977).

Distribution—Sei whales live in temperate regions of all oceans in the Northern and Southern Hemispheres and are not usually associated with coastal features (Calambokidis *et al.* 2008). Sei whales are highly mobile, and there is no indication that any population remains in the same area year-round (*i.e.*, are resident). Pole-ward summer feeding migrations occur, and sei whales generally winter in warm temperate or subtropical waters. Masaki (1976, 1977) reported that during the winter, sei whales are found from 20°- 23°N and during the summer from 35°-50°N, however, the MISTCS survey data appears to contradict this winter latitude restriction (DoN 2007b).

Sei whales are most often found in deep, oceanic waters of the cool temperate zone. They appear to prefer regions of steep bathymetric relief, such as the continental shelf break, canyons, or basins situated between banks and ledges (Kenney and Winn 1987; Schilling *et al.* 1992; Gregr and Trites 2001; Best and Lockyer 2002). These reports are consistent with what was observed during the MISTCS cruise, as sightings most often occurred in deep water 10,381 – 30,583 ft (3,164 to 9,322 m). Most sei whale sightings were also associated with bathymetric relief (*e.g.*, steeply sloping areas), including sightings adjacent to the Chamarro Seamounts east of CNMI (DoN 2007b). All confirmed sightings of sei whales were south of Saipan (approximately 15°N) with concentrations in the southeastern corner of the MISTCS study area (DoN 2007b). Sightings also often occurred in mixed groups with Bryde's whales.

On feeding grounds, the distribution is largely associated with oceanic frontal systems (Horwood 1987). In the North Pacific, sei whales are found feeding particularly along the cold eastern currents (Perry *et al.* 1999).

During the MISTCS cruise sightings most often occurred in deep water 10,381 – 30,583 ft (3,164 to 9,322 m). Most sightings were associated with bathymetric relief (*e.g.*, steeply sloping areas), including sightings adjacent to the Chamarro Seamounts east of CNMI (DoN 2007b). All confirmed sightings of sei whales were south of Saipan (approximately 15°N) with concentrations in the southeastern corner of the MISTCS study area (DoN 2007b). Sightings also occurred with the similar Bryde's whale.

Reproduction/Breeding—No breeding areas have been determined but calving is thought to occur from September to March (Rice 1977).

Diving Behavior—There are no reported diving depths or durations for Sei whales.

Acoustics—Sei whale vocalizations have been recorded only on a few occasions. They consist of paired sequences (0.5 to 0.8 sec, separated by 0.4 to 1.0 sec) of 7 to 20 short (4 milliseconds [msec]) frequency modulated sweeps between 1.5 and 3.5 kHz (Richardson *et al.* 1995). Sei whales in the Antarctic produced broadband "growls" and "whooshes" at frequency of 433 ±192 kHz and source level of 156 ±3.6 dB re 1 µPa at 1 m (McDonald *et al.* 2005). Calls recorded off the Hawaiian Islands consisted of down sweeps from 100 Hz to 44 Hz over 1.0 sec and low frequency calls with downs weeps from 39 Hz to 21 Hz over 1.3 sec (Rankin and Barlow 2007a).

Impact of Human Activity—Historic Whaling. Several hundred sei whales in the North Pacific were taken each year by whalers based at shore stations in Japan and Korea between 1910 and the start of World War

II (Committee for Whaling Statistics 1942). From 1910 to 1975, approximately 74,215 sei whales were caught in the entire North Pacific Ocean (Perry *et al.* 1999). The species was taken less regularly and in much smaller numbers by pelagic whalers elsewhere in the North Pacific during this period (Committee for Whaling Statistics 1942). Small numbers were taken sporadically at shore stations in British Columbia from the early 1900s until the 1950s, when their importance began to increase (Pike and MacAskie 1969). More than 2,000 were killed in British Columbia waters between 1962 and 1967, when the last whaling station in western Canada closed (Pike and MacAskie 1969). Small numbers were taken by shore whalers in Washington (Scheffer and Slipp 1948) and California (Clapham *et al.* 1997) in the early twentieth century, and California shore whalers took 386 from 1957 to 1971 (Rice 1977). Heavy exploitation by pelagic whalers began in the early 1960s, with total catches throughout the North Pacific averaging 3,643 per year from 1963 to 1974 (total 43,719; annual range 1,280-6,053; Tillman 1977). The total reported kill of sei whales in the North Pacific by commercial whalers was 61,500 between 1947 and 1987 (Barlow *et al.* 1997).

A major area of discussion in recent years has been IWC member nations issuing permits to kill whales for scientific purposes. Since the moratorium on commercial whaling came into effect Japan, Norway, and Iceland have issued scientific permits as part of their research programs. For the last five years, only Japan has issued permits to harvest sei whales although Iceland asked for a proposal to be reviewed by the IWC SC in 2003. The Government of Japan has captured minke, Bryde's, and sperm whales (*Physeter macrocephalus*) in the North Pacific (JARPN II). The Government of Japan extended the captures to include 50 sei whales from pelagic areas of the western North Pacific.

Fisheries Interactions—Sei whales, because of their offshore distribution and relative scarcity in U.S. Atlantic and Pacific waters, probably have a lower incidence of entrapment and entanglement than fin whales. Data on entanglement and entrapment in non-U.S. waters are not reported systematically. Heyning and Lewis (1990) made a crude estimate of about 73 rorquals killed/year in the southern California offshore drift gillnet fishery during the 1980's. Some of these may have been fin whales and some of them sei whales. Some balaenopterids, particularly fin whales, may also be taken in the drift gillnet fisheries for sharks and swordfish along the Pacific coast of Baja California, Mexico (Barlow *et al.* 1997). Heyning and Lewis (1990) suggested that most whales killed by offshore fishing gear do not drift far enough to strand on beaches or to be detected floating in the nearshore corridor where most whale-watching and other types of boat traffic occur. Thus, the small amount of documentation should not be interpreted to mean that entanglement in fishing gear is an insignificant cause of mortality. Observer coverage in the Pacific offshore fisheries has been too low for any confident assessment of species-specific entanglement rates (Barlow *et al.* 1997). Sei whales, similar to other large whales, may break through or carry away fishing gear. Whales carrying gear may die later, become debilitated or seriously injured, or have normal functions impaired, but with no evidence recorded.

Ship Strikes—The decomposing carcass of a sei whale was found on the bow of a container ship in Boston harbor, suggesting that sei whales, like fin whales, are killed at least occasionally by ship strikes (Waring *et al.* 1997). Sei whales are observed from whale-watching vessels in eastern North America only occasionally (Edds *et al.* 1984) or in years when exceptional foraging conditions arise (Weinrich *et al.* 1986; Schilling *et al.* 1992). There is no comparable evidence available for evaluating the possibility that sei whales experience significant disturbance from vessel traffic.

Other Threats—No major habitat concerns have been identified for sei whales in either the North Atlantic or the North Pacific. However, fishery-caused reductions in prey resources could have influenced sei whale abundance. The sei whale's strong preference for copepods and euphausiids (*i.e.*, low trophic level organisms), at least in the North Atlantic, may make it less susceptible to the bioaccumulation of organochlorine and metal contaminants than, for example, fin, humpback, and minke whales, all of which seem to feed more regularly on fish and euphausiids (O'Shea and Brownell 1995). Since sei whales off

California often feed on pelagic fish as well as invertebrates (Rice 1977), they might accumulate contaminants to a greater degree than do sei whales in the North Atlantic. There is no evidence that levels of organochlorines, organotins, or heavy metals in baleen whales generally (including fin and sei whales) are high enough to cause toxic or other damaging effects (O'Shea and Brownell 1995). It should be emphasized, however, that very little is known about the possible long-term and trans-generational effects of exposure to pollutants.

3.7.2.3.5 Sperm whale (*Physeter macrocephalus*)

Listing Status—Sperm whales have been protected from commercial harvest by the IWC since 1981, although the Japanese continued to harvest sperm whales in the North Pacific until 1988 (Reeves and Whitehead 1997). Sperm whales were listed as endangered under the ESA in 1973 and as “endangered” by the IUCN. They are also protected by the CITES and the MMPA. Critical habitat has not been designated for sperm whales.

Population Status—The sperm whale was the most frequently sighted cetacean (21 sightings) during the MISTCS cruise with acoustic detections three times higher than visual detections (DoN 2007b). There are an estimated 705 (CV = 60.4; 95% CI = 228-2,181) sperm whales in the MISTCS study area and density was estimated as 0.0012 animals per km^2 (95% CI = 0.40-3.8) (DoN 2007b).

Approximately 258,000 sperm whales in the North Pacific were harvested by commercial whalers between 1947 and 1987 (Hill and DeMaster 1999). However, this number may be negatively biased by as much as 60 percent because of under-reporting by Soviet whalers (Brownell *et al.* 1998). In particular, the Bering Sea population of sperm whales (consisting mostly of males) was severely depleted (Perry *et al.* 1999). Catches in the North Pacific continued to climb until 1968 when 16,357 sperm whales were harvested. Catches declined after 1968, in part through limits imposed by the IWC (Rice 1989). Reliable estimates of current and historical sperm whale abundance across each ocean basin are not available (Calambokidis *et al.* 2008). Five stocks of sperm whales are recognized in U.S. waters: the North Atlantic stock, the northern Gulf of Mexico stock, the Hawaiian stock, the California/Oregon/Washington stock, and the North Pacific stock (Calambokidis *et al.* 2008). Sperm whales are widely distributed across the entire North Pacific Ocean and into the southern Bering Sea in summer, but the majority of sperm whales are thought to occur south of 40°N in winter. Estimates of pre-whaling abundance in the North Pacific are considered somewhat unreliable, but may have totaled 1,260,000 sperm whales. Whaling harvests between 1800 and the 1980s took at least 436,000 sperm whales from the entire North Pacific Ocean (Calambokidis *et al.* 2008).

Several researchers have proposed population structures that recognize at least three sperm whales populations in the North Pacific for management purposes (Kasuya 1991; Bannister and Mitchell 1980). At the same time, the IWC’s Scientific Committee designated two sperm whale stocks in the North Pacific: a western and eastern stock or population (Donovan 1991). The line separating these populations has been debated since their acceptance by the IWC’s Scientific Committee. Stock structure for sperm whales in the North Pacific is not known (Dufault *et al.* 1999). For management purposes, the IWC has divided the North Pacific into two management regions defined by a zig-zag line which starts at 150°W at the equator, is at 160°W between 40 to 50°N, and ends up at 180°W north of 50°N (Donovan, 1991).

Distribution—Sperm whales occur throughout all ocean basins from equatorial to polar waters, including the entire North Atlantic, North Pacific, northern Indian Ocean, and the southern oceans. Sperm whales are found throughout the North Pacific and are distributed broadly from tropical and temperate waters to the Bering Sea as far north as Cape Navarin. Mature, female, and immature sperm whales of both sexes are found in more temperate and tropical waters from the equator to around 45˚N throughout the year. These groups of adult females and immature sperm whales are rarely found at latitudes higher than 50˚N and 50˚S (Reeves and Whitehead, 1997). Sexually mature males join these groups throughout the winter. During the summer, mature male sperm whales are thought to move north into the Aleutian Islands, Gulf of Alaska, and the Bering Sea. Sperm whales are rarely found in waters less than 990 ft (300 m) in depth. They are often concentrated around oceanic islands in areas of upwelling, and along the outer continental shelf and mid-ocean waters. Sperm whales show a strong preference for deep waters (Rice 1989), especially areas with high sea-floor relief. Sperm whale distribution is associated with waters over the continental shelf edge, over the continental slope, and into deeper waters (Hain *et al.* 1985; Kenney and Winn 1987; Waring and Finn 1995; Gannier 2000; Gregr and Trites 2001; Waring *et al.* 2001). However, in some areas, such as off New England, on the southwestern and eastern Scotian Shelf, and in the northern Gulf of California, adult males are reported to quite consistently use waters with bottom depths < 330 ft (100 m) and as shallow as 132 ft (40 m) (Whitehead *et al.* 1992; Scott and Sadove 1997; Croll *et al.* 1999; Garrigue and Greaves 2001; Waring *et al.* 2002).

Whaling records demonstrate sightings year-round around the Marianas (Townsend 1935), with group size ranging from one to 25 individuals (DoN 2007b). During the Navy-funded survey in 2007, sperm whales were observed in waters 2,670 to 32,584 ft (809 to 9,874 m) deep, however, in some locales, sperm whales also may be found in waters less than 330 ft (100 m) deep (Scott and Sadove 1997; Croll *et al.* 1999). There are two stranding records for this area (Kami and Lujan 1976; Eldredge 1991, 2003). The 2007 Navy survey had multiple sightings that included young calves and large bulls, supporting an earlier sighting of a group of sperm whales that included a newborn calf off the west coast of Guam (Eldredge 2003). Sperm whale occurrence patterns are assumed to be similar throughout the year (DoN 2005).

Sightings collected by Kasuya and Miyashita (1988) suggest that that there are two stocks of sperm whales in the western North Pacific, a northwestern stock with females that summer off the Kuril Islands and winter off Hokkaido and Sanriku, and the southwestern North Pacific stock with females that summer in the Kuroshio Current System and winter around the Bonin Islands. The males of these two stocks are found north of the range of the corresponding females, *i.e.*, in the Kuril Islands/Sanriku/Hokkaido and in the Kuroshio Current System, respectively, during the winter.

The sperm whale was the most frequently sighted cetacean (21 sightings) during the MISTCS cruise with acoustic detections three times higher than visual detections (DoN 2007b).

Life History Information—Female sperm whales become sexually mature at about 9 years of age (Kasuya 1991). Male sperm whales take between 9 and 20 years to become sexually mature, but will require another 10 years to become large enough to successfully compete for breeding rights (Kasuya 1991). Adult females give birth after about 15 months gestation and nurse their calves for 2 to 3 years. The calving interval is estimated to be about four to six years (Kasuya 1991). The age distribution of the sperm whale population is unknown, but sperm whales are believed to live at least 60 years (Rice 1978). Estimated annual mortality rates of sperm whales are thought to vary by age, but previous estimates of mortality rate for juveniles and adults are now considered unreliable (IWC 1980).

Reproduction/Breeding—Calving generally occurs in the summer at lower latitudes and the tropics (Watkins *et al.* 2002).

Diving Behavior—Sperm whales forage during deep dives that routinely exceed a depth of 1,314 ft (398 m) and 30 min duration (Watkins *et al.* 2002). Sperm whales are capable of diving to depths of over 6,564 ft (1,989 m) with durations of over 60 min (Watkins *et al.* 1993). Sperm whales spend up to 83 percent of daylight hours underwater (Jacquet *et al.* 2000; Amano and Yoshioka 2003). Males do not spend extensive periods of time at the surface (Jacquet *et al.* 2000). In contrast, females spend prolonged periods of time at the surface (1 to 5 hours daily) without foraging (Whitehead and Weilgart 1991; Amano and Yoshioka 2003). The average swimming speed is estimated to be 2.3 ft/sec (0.7 m/sec) (Watkins *et al.*

2002). Dive descents averaged 11 min at a rate of 5 ft/sec (1.52 m/sec), and ascents averaged 11.8 min at a rate of 4.6 ft/sec (1.4 m/sec) (Watkins *et al.* 2002).

Acoustics—Sperm whales produce short-duration (generally less than 3 sec) broadband clicks from about 0.1 to 30 kHz (Weilgart and Whitehead 1993, 1997; Goold and Jones 1995; Thode *et al.* 2002) in two dominant bands (2 to 4 kHz and 10 to 16 kHz), with source levels be up to 236 dB re 1 µPa-m (Møhl *et al.* 2003). Thode *et al.* (2002) suggested that the acoustic directivity (angular beam pattern) from sperm whales must range between 10 and 30 dB in the 5 to 20 kHz region. The clicks of neonate sperm whales are very different from usual clicks of adults in that they are of low directionality, long duration, and low-frequency (centroid frequency between 300 and 1,700 Hz) with estimated source levels between 140 and 162 dB re 1 µPa-m (Madsen *et al.* 2003). Centroid frequency refers to the average of frequencies within a signal, where the average is weighted by the magnitude of the frequencies. Clicks are heard most frequently when sperm whales are engaged in diving/foraging behavior (Whitehead and Weilgart 1991; Miller *et al.* 2004; Zimmer *et al.* 2005). These may be echolocation clicks used in feeding, contact calls (for communication), and orientation during dives. When sperm whales are socializing, they tend to repeat series of clicks (codas), which follow a precise rhythm and may last for hours (Watkins and Schevill 1977). Codas are shared between individuals of a social unit and are considered to be primarily for intragroup communication (Weilgart and Whitehead 1997; Rendell and Whitehead 2004). Sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins and Schevill 1975; Watkins *et al.* 1985). They also stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995).

The anatomy of the sperm whale's ear indicates that it hears high-frequency sounds (Ketten 1992). The sperm whale may also possess better low-frequency hearing than some other odontocetes, although not as extraordinarily low as many baleen whales (Ketten 1992). The only data on the hearing range of sperm whales are evoked potentials from a stranded neonate (Carder and Ridgway 1991). These data suggest that neonatal sperm whales respond to sounds from 2.5-60 kHz and the highest sensitivity to frequencies was between 5 and 20 kHz (Ridgway and Carder 2001).

Sperm whales functional hearing range is estimated to occur between approximately 150 Hz and 160 kHz, placing them in the mid-frequency cetacean group (Southall 2007). No direct tests on sperm whale hearing have been made, although the anatomy of the sperm whale's inner and middle ear indicates an ability to best hear high frequency to ultrasonic frequency sounds. The lower end of the sperm whale functional hearing range is of lower frequency than the lowest mid-frequency active sonar frequency analyzed in this EIS. However, the overall sperm whale hearing range generally intersects AFAST mid- and high-frequency sonars. The intersection of common frequencies between sperm whale functional hearing and mid and high frequency sonars suggests that more often than not there is a potential for a behavioral response. But as a result of having a functional range lower than the mid-frequency active sonars, there are still some likelihood low frequency vocalizations and sound dependent behaviors may not be disrupted or may only be partially disrupted or masked. Behavioral observations have been made whereby during playback experiments off the Canary Islands, André et al. (1997) reported that foraging whales exposed to a 10 kHz pulsed signal did not exhibit any general avoidance reactions. When resting at the surface in a compact group, sperm whales initially reacted strongly, and then ignored the signal completely (André *et al.* 1997). Additionally, even though the sperm whales may exhibit a reaction when initially exposed to active acoustic energy, the exposures are not expected to be long-term due to the likely low received level of acoustic energy and relatively short duration of potential exposures.

In the event that sperm whales are exposed to MFA/HFA sonar the available data suggests that the response to mid-frequency (1 kHz to 10 kHz) sounds is variable (Richardson *et al.* 1995). In the Caribbean, Watkins et al. (1985) observed that sperm whales exposed to 3.25 kHz to 8.4 kHz pulses interrupted their activities and left the area. The pulses were surmised to have originated from submarine sonar signals given that no vessels were observed. The authors did not report received 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. Other studies involving sperm whales indicate that, after an initial disturbance, the animals return to their previous activity. During playback experiments off the Canary Islands, André et al. (1997) reported that foraging whales exposed to a 10 kHz pulsed signal did not exhibit any general avoidance reactions. When resting at the surface in a compact group, sperm whales initially reacted strongly, then ignored the signal completely (André *et al.* 1997).

Impacts of Human Activity—In U.S. waters in the Pacific, sperm whales are known to have been incidentally taken only in drift gillnet operations, which killed or seriously injured an average of nine sperm whales per year from 1991-1995 (Barlow *et al.* 1997). Of the eight sperm whales observed taken by the California/Oregon drift gillnet fishery, three were released alive and uninjured (37.5 percent), one was released injured (12.5 percent), and four were killed (50 percent) (NMFS 2000). Therefore, approximately 63 percent of captured sperm whales could be killed accidentally or injured (based on the mortality and injury rate of sperm whales observed taken by the U.S. fleet from 1990-2000). Based on past fishery performance, sperm whales are not observed taken in every year; they were observed taken in four out of the last ten years (NMFS 2000). During the three years the Pacific Coast Take Reduction Plan has been in place, a sperm whale was observed taken only once (in a set that did not comply with the Take Reduction Plan (NMFS 2000).

Interactions between longline fisheries and sperm whales in the Gulf of Alaska have been reported over the past decade (Rice 1989; Hill and DeMaster 1999). Observers aboard Alaskan sablefish and halibut longline vessels have documented sperm whales feeding on longline-caught fish in the Gulf of Alaska (Hill and Mitchell 1998) and in the South Atlantic (Ashford *et al.* 1996). During 1997, the first entanglement of a sperm whale in Alaska’s longline fishery was recorded, although the animal was not seriously injured (Hill and DeMaster 1998). The available evidence does not indicate sperm whales are being killed or seriously injured as a result of these interactions, although the nature and extent of interactions between sperm whales and long-line gear is not yet clear. Ashford *et al.* (1996) suggested that sperm whales pluck, rather than bite, the fish from the long-line.

In 2000, the Japanese Whaling Association announced that it planned to kill 10 sperm whales and 50 Bryde’s whales in the Pacific Ocean for research purposes, which would be the first time sperm whales would be taken since the international ban on commercial whaling took effect in 1987. Despite protests from the U.S. government and members of the IWC, the Japanese government harvested 5 sperm whales and 43 Bryde’s whales in the last six months of 2000. According to the Japanese Institute of Cetacean Research (Institute of Cetacean Research undated), another five sperm whales were killed for research in 2002–2003. The consequences of these deaths on the status and trend of sperm whales remains uncertain; however, the renewal of a program that intentionally targets and kills sperm whales before it can be ascertained that the population has recovered from earlier harvests places this species at risk in the foreseeable future.

3.7.2.4 Nonendangered and Nonthreatened Marine Mammals within the MIRC Study Area

Other marine mammal species occurring within the MIRC Study Area are described below. All of these species, while protected under the MMPA, are not listed as endangered under the ESA nor considered depleted or strategic under the MMPA.

3.7.2.4.1 Bryde's Whale (*Balaenoptera edeni*)

Population Status—There were an estimated 233 (CV = 45.0; 95% CI = 99-546) Bryde's whales in the MISTCS study area and density was estimated as 0.00041 animals per km^2 (95% CI = 0.17-0.95; DoN 2007b).

The IWC recognizes three management stocks of Bryde's whales in the North Pacific: Western North Pacific, Eastern North Pacific, and East China Sea (Donovan 1991). The Bryde's whale is designated as "data deficient" on the IUCN Red List (Reeves *et al.* 2003).

Distribution—Bryde's whale is found year-round in tropical and subtropical waters, generally not moving poleward of 40° in either hemisphere (Jefferson *et al.* 1993; Kato 2002). They have been reported to occur in both deep and shallow waters globally. Long migrations are not typical of Bryde's whales, though limited shifts in distribution toward and away from the equator, in winter and summer, respectively, have been observed (Cummings 1985). Bryde's whales have a broad, overlapping winter and summer distribution in the Central Pacific from 5°S to 40°N, and are the most common baleen whales likely to occur in the Mariana Islands from May-July, and possibly August (Eldredge 1991, 2003; Kishiro 1996; Okamura and Shimada 1999; Miyashita *et al.* 1996).

Historical records show a consistent presence of Bryde's whales in the Mariana Islands. Miyashita *et al.* (1996) sighted Bryde's whales in the Mariana Islands during a 1994 survey, commenting that in the western Pacific these whales are typically only seen when surface water temperature was greater than 68°F (20°C) although Yoshida and Kato (1999) reported a preference for water temperatures between approximately 59° and 68°F (15° and 20°C). A single Bryde's whale washed ashore on Masalok Beach on Tinian in February, 2005. There was one sighting in July 1999, approximately 5 to 10 nm (9.3 to 18.5 km) west of FDM. Additionally, there was a sighting 105 nm (195 km) southeast of Guam made during December 1996, which was reported to the NMFS for their Platforms of Opportunity Program. There is also one reported stranding for this area that occurred in August 1978 (Eldredge 1991, 2003). Occurrence patterns are expected to be the same throughout the year.

Bryde's whales were observed at least 18 times during the three month Navy survey in 2007 (DoN 2007b). They were observed in groups of one to three, with several sightings including calves. Bryde's whales were sighted in deep waters, ranging from 8,363 to 24,190 ft (2,534 to 7,330 m) in bottom depth. There were several sightings in waters over and near the Mariana Trench. Most sightings though were associated with bathymetric relief (*e.g.*, steeply sloping areas and seamounts), including sightings adjacent to the Chamarro Seamounts east of CNMI and over the West Mariana Ridge. There were also concentrations in the southeast corner of the MISTCS study area. Multi-species aggregations with sei whales were also observed on several occasions (DoN 2007b)

While 25°N may represent the northernmost extent of Bryde's whale winter distribution (5°S to 25°N; Kishiro 1996), they can range from 5°N to 40°N during summer, suggesting that winter and summer ranges overlap (Okamura and Shimada 1997; Ohizumi *et al.* 2002). Miyashita *et al.* (1995) report the majority of August sightings in the Western Pacific for Bryde's whales between 20-40°N, although there was no reported sighting effort south of 20°N. Bryde's whales are sometimes seen very close to shore and even inside enclosed bays (see Best *et al.* 1984).

Reproduction/Breeding—Breeding and calving occur in warm temperate and tropical areas but regularly used sites have not been identified.

Diving Behavior—Bryde's whales are lunge-feeders, feeding on fish and krill (Nemoto and Kawamura 1977). Cummings (1985) reported that Bryde's whales might dive as long as 20 min.

Acoustics—Bryde's whales produce low frequency tonal and swept calls similar to those of other rorquals (Oleson *et al.* 2003). Calls vary regionally, yet all but one of the call types have a fundamental frequency below 60 Hz; they last from 0.25 sec to several seconds; and they are produced in extended sequences (Oleson *et al.* 2003). Heimlich *et al.* (2005) recently described five tone types. While no data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing.

3.7.2.4.2 Minke whale (*Balaenoptera acutorostrata*)

Population Status—The minke whale is designated as "near threatened" on the IUCN Red List (Reeves *et al.* 2003). There are no abundance estimates for this species in this area; Horwood (1990) noted that densities of minke whales throughout the North Pacific are low, however, frequent acoustic detections suggest that this may be due to their cryptic nature (Rankin *et al*. 2007, Rankin and Barlow 2003). The IWC recognizes three stocks of minke whales in the North Pacific, one of which is in the western Pacific west of 180ºN (Donovan 1991). The minke whale was frequently detected acoustically (29 detections) during the MISTCS cruise but was not visually detected therefore no abundance or density could be calculated for this species from the available sighting data (DoN 2007b). Therefore density was derived from the eastern tropical Pacific surveys (Ferguson and Barlow 2003).

Distribution—The minke whale generally occupies waters over the continental shelf, including inshore bays and estuaries (Mitchell and Kozicki 1975; Ivashin and Vitrogov 1981; Murphy 1995; Mignucci-Giannoni 1998; Calambokidis *et al.* 2004). However, based on whaling catches and surveys worldwide, there is also a deep-ocean component to the minke whale's distribution (Slijper *et al.* 1964; Horwood 1990; Mitchell 1991; Mellinger *et al.* 2000; Roden and Mullin 2000). During August in the North Pacific, minke whales are more common in the Bering and Chukchi seas and in the Gulf of Alaska (Miyashita *et al.* 1995).

Minke whales are distributed in polar, temperate, and tropical waters (Jefferson *et al.* 1993); they are less common in the tropics than in cooler waters. Minke whales are present in the North Pacific from near the equator to the Arctic (Horwood 1990). In the winter, minke whales are found south to within 2° of the equator (Perrin and Brownell 2002). There is no obvious migration from low-latitude, winter breeding grounds to high-latitude, summer feeding locations in the western North Pacific, as there is in the North Atlantic (Horwood 1990); however, there are some monthly changes in densities in both high and low latitudes (Okamura *et al.* 2001). Some coastal minke whales restrict their summer activities to exclusive home ranges (Dorsey *et al.* 1983) and exhibit site fidelity to these areas between years (Borggaard *et al.* 1999).

Minke whales were the most frequently acoustically detected species of baleen whale during the Navy's 2007 survey and were mostly found in the southwestern area of the MIRC near the Mariana Trench (DoN 2007b). It is not unusual to have acoustic sightings with no visual confirmation (DoN 2007b; Rankin 2007) due to the cryptic behavior of this species in tropical waters. Minke whale vocalizations in the Pacific Islands have only been reported during the winter months, however it is not known if this is indicative of a seasonal migration.

Reproduction/Breeding—Stewart and Leatherwood (1985) suggested that mating occurs in winter or early spring although it had never been observed.

Diving Behavior—Stern (1992) described a general surfacing pattern of minke whales consisting of about four surfacings, interspersed by short-duration dives averaging 38 sec. After the fourth surfacing, there was a longer duration dive ranging from approximately 2 to 6 min. Minke whales are "gulpers," like the other rorquals (Pivorunas 1979). Hoelzel *et al.* (1989) reported on different feeding strategies used by minke whales. In the North Pacific, major food items include krill, Japanese anchovy, Pacific saury, and walleye pollock (Perrin and Brownell 2002).

Acoustics—Recordings in the presence of minke whales have included both high-and low-frequency sounds (Beamish and Mitchell 1973; Winn and Perkins 1976; Mellinger *et al.* 2000). Mellinger *et al.* (2000) described two basic forms of pulse trains that were attributed to minke whales: a "speed up" pulse train with energy in the 200 to 400 Hz band, with individual pulses lasting 40 to 60 msec, and a less-common "slow-down" pulse train characterized by a decelerating series of pulses with energy in the 250 to 350 Hz band. Recorded vocalizations from minke whales have dominant frequencies of 60 Hz to greater than 12,000 Hz, depending on vocalization type (Richardson *et al.* 1995). Recorded source levels, depending on vocalization type, range from 151 to 175 dB re 1 µPa-m (Ketten 1998). Gedamke *et al.* (2001) recorded a complex and stereotyped sound sequence ("star-wars vocalization") in the Southern Hemisphere that spanned a frequency range of 50 Hz to 9.4 kHz. Broadband source levels between 150 and 165 dB re 1 µPa-m were calculated. "Boings," recently confirmed to be produced by minke whales and suggested to be a breeding call, consist of a brief pulse at 1.3 kHz, followed by an amplitude-modulated call with greatest energy at 1.4 kHz, with slight frequency modulation over a duration of 2.5 sec (Rankin and Barlow 2003). While no data on hearing ability for this species are available, Ketten (1997) hypothesized that mysticetes have acute infrasonic hearing.

3.7.2.4.3 Blainville's Beaked Whale (*Mesoplodon densirostris*)

Population Status—The Blainville's beaked whale is designated as "data deficient" on the IUCN Red List (Reeves *et al.* 2003). There are no abundance estimates for the Blainville's beaked whale in this area. There was no density estimate for Blainville's beaked whales available from the Mariana Islands (DoN 2007), therefore, a density estimate of 0.0013 animals per km^2 (CV = 0.71) that was derived from the offshore Hawaii area was used (Barlow 2006).

Distribution—Beaked whales may be expected to occur in the area including, and seaward of, the shelf break. Two *Mesopolodon* spp. were observed during the Navy's 2007 survey, over the West Mariana Ridge, but were not identified to the species level (DoN 2007b). A live Cuvier's beaked whale stranded at Piti, Guam and was coaxed back to sea (NMFS 2007o). There is a low or unknown occurrence of beaked whales on the shelf between the 165 ft (50 m) isobath and the shelf break, which takes into account that deep waters come very close to the shore in this area. In some locales, beaked whales can be found in waters over the shelf, so it is possible that beaked whales have similar habitat preferences here. Occurrence patterns are expected to be the same throughout the year.

Recent information suggests that other beaked whale species (Blainville's and Cuvier's beaked whales, and northern bottlenose whales) show site fidelity and can be sighted in the area over many years (Hooker *et al.* 2002; Wimmer and Whitehead 2005; McSweeney *et al.* 2007).

Reproduction/Breeding—Beaked whales generally breed in October and November, but little else is known of their reproductive behavior (Balcomb 1989).

Diving Behavior—Analysis of stomach contents from captured and stranded individuals suggests that beaked whales are deep-diving animals, feeding by suction (Heyning and Mead 1996). Another species of beaked whales, the Baird's beaked whale, feeds mainly on benthic fishes and cephalopods, but occasionally on pelagic fish such as mackerel, sardine, and saury (Kasuya 2002; Walker *et al.* 2002; Ohizumi *et al.* 2003). Baird *et al.* (2006) reported on the diving behavior of four Blainville's beaked whales off the west coast of Hawaii. The four beaked whales foraged in deep ocean areas (2,270 to 9,855 ft [688 to 2,986 m]) with a maximum dive to 4,619 ft (1,400 m). Dives ranged from at least 13 min (lost dive recorder during the dive) to a maximum of 68 min (Baird *et al.* 2006).

Acoustics—MacLeod (1999) suggested that beaked whales use frequencies of between 300 Hz and 129 kHz for echolocation, and between 2 and 10 kHz, and possibly up to 16 kHz, for social communication. Blainville's beaked whales echolocation clicks were recorded at frequencies from 20 to 40 kHz (Johnson *et al.* 2004) and Cuvier's beaked whales at frequencies from 20 to 70 kHz (Zimmer *et al.* 2005). Recently, an acoustic recording tag was attached to two Blainville's beaked whales in the Ligurian Sea (Johnson *et al.* 2004). The source level of these clicks ranges from 200 to 220 dB re 1 µPa-m, as measured peak to peak (Johnson *et al.* 2004). Blainville's beaked whales produce whistles and pulsed sounds between 6 and 16 kHz (Rankin and Barlow 2007).

No hearing data is available for Blainville's beaked whales but Cook *et al.* (2006) reported that the Gervais beaked whale (*Mesoplodon europeus*) could hear in the range of 5 to 80 kHz although no measurements were attempted above 80 kHz. The Gervais beaked whale was most sensitive from 40 to 80 kHz (Cook *et al.* 2006).

3.7.2.4.4 Bottlenose dolphin, Coastal (*Tursiops truncatus*)

Population Status—There were an estimated 122 (CV = 99.2; 95% CI = 5.0-2,943) bottlenose dolphins in the MISTCS study area and density was estimated as 0.00021 animals per km^2 (95% CI = 0.001-5.1; DoN 2007b). Bottlenose dolphin group size ranged from 3 to 10 individuals and calves were seen during several sightings.

Bottlenose dolphins are designated as "data deficient" on the IUCN Red List (Reeves *et al.* 2003). Nothing is known of stock structure around the Marianas. The only estimate of abundance of bottlenose dolphins for the region is an estimate of 31,700 animals for the Western North Pacific (Miyashita 1993), which may possibly coincide with the stock of offshore bottlenose dolphins that occurs around the Marianas.

Distribution—Bottlenose dolphins off the Pacific coast of the U.S. are known to feed primarily on surf perches (Family Embiotocidae) and croakers (Family Sciaendae). Bottlenose dolphins are expected to occur from the coastline to the 6,600 ft (2,000 m) isobath, which takes into consideration the known habitat preferences of *Tursiops* globally. Individuals are expected to occur in both harbors and lagoons, based on observations worldwide in similar habitats. There is a low or unknown occurrence of the bottlenose dolphin seaward of the 6,600 ft (2,000 m) isobath. This pattern takes into account possible movement by bottlenose dolphins between the Mariana Islands chain, as well as sightings globally in deep waters. Occurrence patterns are expected to be the same throughout the year. There are no stranding records available for this species in the Marianas area and vicinity, and only a mention by Trianni and Kessler (2002) that bottlenose dolphins are seen in coastal waters of Guam. It is possible that bottlenose dolphins do not occur in great numbers in this island chain. Gannier (2002) attributed the fact that large densities of bottlenose dolphins do not occur at the Marquesas Islands to the fact that the area does not have a significant shelf component. A similar situation could be occurring in the MIRC Study Area and vicinity.

Bottlenose dolphins were sighted three times during the Navy's 2007 MISTCS survey, two of the sightings were in the vicinity of Challenger Deep, while the other sighting was east of Saipan near the Mariana Trench in deep waters ranging from 13,995 to 16,536 ft (4,241 to 5,011 m) (DoN 2007b). One of the sightings near the Challenger Deep was a mixed-species aggregation that included sperm whales (with calves) logging at the surface. Another mixed-species aggregation involved bottlenose dolphins with short-finned pilot whales and rough-toothed dolphins.

Reproduction/Breeding—Newborn calves are observed through out the year and may be influenced by productivity and food abundance (Urian *et al.* 1996). Miyashita (1993) reported that all his sightings of bottlenose dolphins in the western Pacific were of a larger, unspotted type (presumably the bottlenose dolphin, as opposed to the similar Indo-Pacific bottlenose dolphin). The Indo-Pacific bottlenose dolphin is considered to be a species associated with continental margins, as it does not appear to occur around offshore islands great distances from a continent, such as the Marianas (DoN 2005). However, since the Indo-Pacific bottlenose dolphin occurs directly west and to the south of the Marianas area, there is the possibility of extralimital occurrences of this species.

There are no stranding records available for this species in the Marianas area and vicinity, and only a mention by Trianni and Kessler (2002) that bottlenose dolphins are seen in coastal waters of Guam. It is possible that bottlenose dolphins do not occur in great numbers in this island chain. Gannier (2002) attributed the fact that large densities of bottlenose dolphins do not occur at the Marquesas Islands to the fact that the area does not have a significant shelf component. A similar situation could be occurring in the MIRC Study Area and vicinity.

Diving Behavior—Pacific coast bottlenose dolphins feed primarily on surf perches (Family Embiotocidae) and croakers (Family Sciaendae) (Norris and Prescott 1961; Walker 1981; Schwartz *et al.* 1992; Hanson and Defran 1993), and also consume squid (*Loligo opalescens*) (Schwartz *et al.* 1992). Navy bottlenose dolphins have been trained to reach maximum diving depths of about 984 ft (298 m) (Ridgway *et al.* 1969). Reeves *et al.* (2002) noted that the presence of deep-sea fish in the stomachs of some offshore individual bottlenose dolphins suggests that they dive to depths of more than 1,638 ft (496 m). Dive durations up to 15 min have been recorded for trained individuals (Ridgway *et al.* 1969). Typical dives, however, are more shallow and of a much shorter duration.

Offshore bottlenose dolphins in the Bahamas dove to depths below 1,485 ft (450 m) and for over 5 min during the night but dives were shallow (< 165 ft [50 m]) during the day (Klatsky *et al.* 2007). In contrast, the dives of offshore bottlenose dolphins off the east coast of Australia were mostly within 16.5 ft (5 m) of the surface (approximately 67 percent of dives) with the deepest dives to only 495 ft (150 m) (Corkeron and Martin 2004). A comparison of hemoglobin concentration and hematocrit, important to oxygen storage for diving, between Atlantic coastal and offshore bottlenose dolphins shows higher levels of both in offshore dolphins (Hersh and Duffield 1990). The increase in hemoglobin and hematocrit suggest greater oxygen storage capacity in the offshore dolphin which may allow it to dive longer in the deep offshore areas that they inhabit.

Acoustics—Sounds emitted by bottlenose dolphins have been classified into two broad categories: pulsed sounds (including clicks and burst-pulses) and narrow-band continuous sounds (whistles), which usually are frequency modulated (FM). Clicks and whistles have a dominant frequency range of 110 to 130 kHz and a peak to peak 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 (Ketten 1998). Generally, whistles range in frequency from 0.8 to 24 kHz (Richardson *et al.* 1995).

The bottlenose dolphin has a functional high-frequency hearing limit of 160 kHz (Au 1993) and can hear sounds at frequencies as low as 40 to 125 Hz (Turl 1993). Inner ear anatomy of this species has been described (Ketten 1992). Electrophysiological experiments suggest that the bottlenose dolphin brain has a dual analysis system: one specialized for ultrasonic clicks and the other for lower-frequency sounds, such as whistles (Ridgway 2000). Scientists have reported a range of best sensitivity between 25 and 70 kHz, with peaks in sensitivity occurring at 25 and 50 kHz (Nachtigall *et al.* 2000).

TTS in hearing have been experimentally induced in captive bottlenose dolphins using a variety of noises (i.e., broad-band, pulses) (Ridgway et al., 1997; Schlundt et al., 2000, 2006; Nachtigall et al., 2003; Finneran et al., 2002, 2005). For example, TTS has been induced with exposure to a 3 kHz, one-second pulse with sound exposure level (SEL) of 195 dB re 1 µPa^2-s (Finneran et al., 2005), one-second pulses from 3 to 20 kHz at 192 to 201 dB re 1 µPa (Schlundt et al., 2000), and octave band noise (4 to 11 kHz) for 50 minutes at 179 dB re 1 µPa (Nachtigall et al., 2003). Preliminary research indicates that TTS and recovery after noise exposure are frequency dependent and that an inverse relationship exists between exposure time and sound pressure level associated with exposure (Mooney et al., 2005; Mooney, 2006). Observed changes in behavior were induced with an exposure to a 75 kHz one-second pulse at a received level of 178 dB re 1 µPa (Ridgway et al., 1997; Schlundt et al., 2000). Finneran et al. (2005) concluded that a SEL of 195 dB re 1 μPa^2 s is a reasonable threshold for the onset of TTS in bottlenose dolphins exposed to mid-frequency tones.

3.7.2.4.5 Cuvier's beaked whale (*Ziphius cavirostris*)

Population Status—There are no abundance estimates for the Cuvier's beaked whale in this area. The Cuvier's beaked whale is designated as "data deficient" on the IUCN Red List (Reeves *et al.* 2003). There was no density estimate for Cuvier's beaked whales available from the Mariana Islands (DoN 2007), therefore, a density estimate of 0.0052 animals per km^2 (CV = 0.83) that was derived from the offshore Hawaii area was used (Barlow 2006).

Distribution—Beaked whales may be expected to occur in the area mostly seaward of the shelf break. One ziphiid whale was observed during the Navy's 2007 survey in deep water, but was not identified to the species level (DoN 2007b). There is a low or unknown occurrence of beaked whales on the shelf between the 165 ft (50 m) isobath and the shelf break, which takes into account that deep waters come very close to the shore in this area. In some locales, beaked whales can be found in waters over the shelf, so it is possible that beaked whales have similar habitat preferences here. Occurrence patterns are expected to be the same throughout the year.

Little is known about the habitat preferences of any beaked whale. Based on current knowledge, beaked whales normally inhabit deep ocean waters (> 6,600 ft [2,000 m]) or continental slopes (660-6,600 ft [200–2,000 m]), and only rarely stray over the continental shelf (Pitman 2002). Cuvier's beaked whale generally is sighted in waters > 660 ft (200 m) deep, and is frequently recorded at depths > 3,300 ft (1,000 m) (Gannier 2000; MacLeod *et al.* 2004). They are commonly sighted around seamounts, escarpments, and canyons. MacLeod *et al.* (2004) reported that Cuvier's beaked whales occur in deeper waters than Blainville's beaked whales in the Bahamas. In Hawaii Cuvier's beaked whales showed a high degree of site fidelity in a study spanning 21 years and showed that there was an offshore population and an island associated population (McSweeney *et al.* 2007). The site fidelity in the island associated population was hypothesized to take advantage of the influence of islands on oceanographic conditions that may increase productivity (McSweeney *et al.* 2007). Based on those that were identified, Cuvier's beaked whale appears to be the most abundant beaked whale in the area, representing almost 80 percent of the identified beaked whale sightings (Barlow and Gerrodette 1996).

Reproductive/Breeding—Little is known of beaked whale reproductive behavior.

Diving Behavior—Cuvier's beaked whales are generally sighted in waters with a bottom depth greater than about 650 ft (197 m) and are frequently recorded at depths of 3,282 ft (995 m) or more (Gannier 2000; MacLeod *et al.* 2004). They are commonly sighted around seamounts, escarpments, and canyons. In the eastern tropical Pacific Ocean, the mean bottom depth for Cuvier's beaked whales is approximately 11,154 ft (3,380 m), with a maximum depth of over 16,732 ft (5,070 m) (Ferguson 2005). Recent studies by Baird *et al.* (2006) show that Cuvier's beaked whales dive deeply (maximum of 4,757 ft [1,442 m]) and for long periods (maximum dive duration of 68.7 min) but also spent time at shallow depths. Tyack *et al.* (2006a) has also reported deep diving for Cuvier's beaked whales with mean depth of 3,510 ft (1,064 m) and mean duration of 58 min. Gouge marks were observed on mud volcanoes on the sea floor at

5,580–6,564 ft (1,691-1,989 m), and Woodside *et al.* (2006) speculated that they were caused by Cuvier's beaked whales foraging on benthic prey.

Acoustics—MacLeod (1999) suggested that beaked whale species use frequencies of between 300 Hz and 129 kHz for echolocation, and between 2 and 10 kHz, and possibly up to 16 kHz, for social communication. Blainville's beaked whales echolocation clicks were recorded at frequencies from 20 to 40 kHz (Johnson *et al.* 2004) and Cuvier's beaked whales at frequencies from 20 to 70 kHz (Zimmer *et al.* 2005). Soto *et al.* (2006) reported changes in vocalizations during diving on close approaches of large cargo ships which may have masked their vocalizations. Cuvier's beaked whales only echolocated below 660 ft (200 m) (Tyack *et al.* 2006b). Echolocation clicks are produced in trains (interclick intervals near 0.4 sec) and individual clicks are frequency modulated pulses with durations of 200-300 µsec, the center frequency was around 40 kHz with no energy below 20 kHz (Tyack *et al.* 2006b).

Cook *et al.* (2006), in the only hearing study of a beaked whale, reported that the Gervais beaked whale (*Mesoplodon europeus*) could hear in the range of 5 to 80 kHz although no measurements were attempted above 80 kHz. The Gervais beaked whale was most sensitive from 40 to 80 kHz (Cook *et al.* 2006).

3.7.2.4.6 Dwarf Sperm Whale (*Kogia sima*)

Status—The dwarf sperm whale is not listed as endangered under the ESA and is not a depleted or strategic stock under the MMPA (Carretta *et al.* 2005). The dwarf sperm whale is designated as least concern on the IUCN Red List (Reeves *et al.* 2003).There is no information on the population trend of dwarf sperm whales or their abundance in the Marianas area. There was no density estimate for dwarf sperm whales available from the Mariana Islands (DoN 2007b), therefore, a density estimate of 0.0078 animals per km^2 (CV = 0.66) that was derived from the Hawaii offshore area was used (Barlow 2006).

The difficulty in differentiating between the two *Kogia* species (dwarf sperm whales and pygmy sperm whales) considered in this EIS is exacerbated by their avoidance reaction towards ships and change in behavior towards approaching survey aircraft (Würsig *et al.* 1998). Based on the cryptic behavior of these species and their small group sizes (much like that of beaked whales), as well as similarity in appearance, it is difficult to identify these species in sightings at sea.

Distribution—Both species of *Kogia* generally occur in waters along the continental shelf break and over the continental slope (Baumgartner *et al.* 2001; McAlpine 2002; Baird 2005b). The primary occurrence for dwarf sperm whales is seaward of the shelf break and in deep water with a mean depth of 4,674 ft (779 fathoms, 1,416 m) (Baird 2005b). This takes into account their preference for deep waters. There is a rare occurrence for *Kogia* inshore of the area of primary occurrence. Occurrence is expected to be the same throughout the year. Dwarf sperm whales showed a high degree of site fidelity, determined from photo identification over several years, in areas west of the island of Hawaii (Baird *et al.* 2006a).

There are only two stranding records for the dwarf sperm whale in the MIRC area and vicinity (Kami and Lujan 1976; Reeves *et al.* 1999; Eldredge 1991, 2003).

Reproduction/Breeding—There is no information on the breeding behavior within the MIRC. No breeding or calving areas for the Mariana Islands have been described.

Diving Behavior—Dwarf sperm whales feed on cephalopods and, less often, on deep-sea fishes and shrimps (Caldwell and Caldwell 1989; Baird *et al.* 1996; Willis and Baird 1998; Wang *et al.* 2002). Willis and Baird (1998) reported that *Kogia* make dives of up to 25 min. Median dive times of around 11 min have been documented for *Kogia* (Barlow 1999).

Acoustics—Although there is no information available on dwarf sperm whale vocalizations or hearing capabilities, there is data on the closely-related pygmy sperm whale. Pygmy sperm whale clicks range from 60 to 200 kHz, with a dominant frequency of 120 kHz (Richardson *et al.* 1995a). An auditory brainstem response study indicates that pygmy sperm whales have their best hearing between 90 and 150 kHz (Ridgway and Carder 2001), and it would be logical to assume similar acoustic characteristics in dwarf sperm whales due to similar feeding and diving behavior.

In terms of functional hearing capability pygmy and dwarf sperm whales belong to high-frequency cetaceans which have best hearing ranging from 200 Hz to 180 kHz. There are no tests or modeling estimates of specific pygmy and dwarf sperm whale hearing ranges. Exposure to mid-frequency active sonar that is below or high-frequency active sonar that is above the functional hearing capability of pygmy or dwarf sperm whales may not elicit a behavioral response since the respective frequencies are 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, pygmy or dwarf sperm whale behavioral exposures discussed in subsections 3.7.3.8 (No Action Alternative), 3.7.3.9 (Alternative 1), and 3.7.3.10 (Alternative 2) may be overestimated.

3.7.2.4.7 False killer whale (*Pseudorca crassidens*)

Population Status—There were an estimated 637 (CV = 74.3; 95% CI = 164-2,466) false killer whales in the MISTCS study area and density was estimated as 0.00111 animals per 1,000 km^2 (95% CI = 0.29-4.3 DoN 2007b). False killer whale group size ranged from 2 to 26 individuals and several sightings contained calves.

This species is designated as “lower risk” on the IUCN Red List (Reeves *et al.* 2003). Nothing is known of the stock structure of false killer whales in the North Pacific Ocean. There are estimated to be about 6,000 false killer whales in the area surrounding the Mariana Islands (Miyashita 1993).

Distribution—The false killer whale is an oceanic species, occurring in deep waters, and is known to occur close to shore near oceanic islands (Baird 2002). They are found in tropical and temperate waters, generally between 50°S and 50°N latitude with a few records north of 50°N in the Pacific and the Atlantic (Odell and McClune 1999). False killer whales were sighted in waters with a bottom depth ranging from 10,095 to 26,591 ft (3,059 to 8,058 m) during the Navy’s 2007 survey, with groups ranging from 2 to 26 individuals (DoN 2007b). Several sightings contained calves. There are two additional unpublished sightings and no reported strandings of the false killer whale in the Marianas. Seasonal movements in the western North Pacific may be related to prey distribution (Odell and McClune 1999). Baird *et al.* (2005) noted considerable inter-island movements of individuals in the Hawaiian Islands.

False killer whales are commonly sighted in offshore waters from small boats and aircraft, as well as offshore from long-line fishing vessels (*e.g.*, Mobley *et al.* 2000; Baird *et al.* 2003; Walsh and Kobayashi 2004).

Several sightings were made over the Mariana Trench and the southeast corner of the study area, in waters with a bottom depth greater than 16,404 ft (4,971 m). There was also a sighting in deep waters west of the West Mariana Ridge.

Reproduction/Breeding—There is no information on the breeding behavior in this area. No breeding or calving areas for the Mariana Islands have been described.

Diving Behavior—False killer whales primarily eat deep-sea cephalopods and fish (Odell and McClune 1999), but they have been known to attack other cetaceans, including dolphins (Perryman and Foster 1980; Stacey and Baird 1991), sperm whales (Palacios and Mate 1996), and baleen whales.

Acoustics—The dominant frequencies of false killer whale whistles are 4 to 9.5 kHz; those of their clicks are 25 to 30 kHz and 95 to 130 kHz (Thomas et al. 1990; Richardson *et al*. 1995). The source level for echolocation clicks is 220 to 228 dB re 1 µPa-m (Ketten 1998). Best hearing sensitivity measured for a false killer whale was around 16 to 64 kHz (Thomas *et al.* 1988, 1990).

Yuen et al. (2005) tested a stranded false killer whale using auditory evoke potentials to produce an audiogram in the range of 4 to 44 kHz and with best sensitivity at 16 to 24 kHz, but it may have had age related hearing loss. Nachtigall and Supin (2008) showed that false killer whales are able to adjust their hearing of echolocation signals to compensate for distance and size (*i.e.* more sensitive hearing for smaller returning echos).

3.7.2.4.8 Fraser's Dolphin (*Lagenodelphis hosei*)

Population Status—This species is designated as "data deficient" on the IUCN Red List (Reeves *et al.* 2003). There are no abundance estimates available for the Fraser's dolphin in this area. There was no density estimate for Fraser's dolphins available from the Mariana Islands (DoN 2007b), therefore, a density estimate of 0.0069 animals per km^2 (CV = 1.11) that was derived from the Hawaii offshore area was used (Barlow 2006).

Distribution—The Fraser's dolphin is an oceanic species. In the Gulf of Mexico, this species has been seen in waters over the abyssal plain (Leatherwood *et al.* 1993). In some locales, as noted earlier, Fraser's dolphins do approach closer to shore, particularly in locations where the shelf is narrow and deep waters are nearby, so there is also a low or unknown occurrence from the 330 ft (100 m) isobath to the shelf break. In the offshore eastern tropical Pacific, this species is distributed mainly in upwelling-modified waters (Au and Perryman 1985). Occurrence patterns are assumed to be the same throughout the year.

Reproduction/Breeding—There is no information on the breeding behavior in this area. No breeding or calving areas for the Mariana Islands have been identified (Jefferson and Leatherwood 1994).

Diving Behavior—Fraser's dolphins feed on mid-water fishes, squids, and shrimps (Jefferson and Leatherwood 1994; Perrin *et al.* 1994). There is no information available on depths to which Fraser's dolphins dive, but they are thought to be capable of deep dives.

Acoustics— Very little is known of the acoustic abilities of the Fraser's dolphin. Fraser's dolphin whistles have a frequency range of 7.6 to 13.4 kHz (Leatherwood *et al.* 1993) and recent data extended that range to 6.6 to 23.5 kHz with durations of 0.06 to 0.93 sec (Oswald *et al.* 2008). There are no hearing data for this species.

3.7.2.4.9 Ginkgo-toothed Whale (*Mesoplodon ginkgodens*)

Population Status—There was no density estimate for ginkgo-toothed beaked whales available from the Mariana Islands (DoN 2007b), therefore, a density estimate of 0.0005 animals per km^2 (CV = 0.45 – 1.00) that was derived from the Hawaii offshore area was used (Barlow 2006). The ginkgo-toothed beaked whale is designated as data deficient in the North Pacific on the IUCN Red List (Reeves *et al.* 2003).

Distribution—Beaked whales normally inhabit deep ocean waters (> 6,600 ft [2,000 m]) or continental slopes (660 to 6,600 ft [200 to 2,000 m]), and only rarely stray over the continental shelf (Pitman 2002).

Palacios (1996) suggested based on stranding records in the eastern Pacific Ocean, that this species may select relatively cool, upwelling-modified habitats, such as those found in the California and Perú Currents and along the equatorial front. Beaked whales may be expected to occur in the area including, and seaward of, the shelf break. There is a low or unknown occurrence of beaked whales on the shelf between the 165 ft (50 m) isobath and the shelf break, which takes into account that deep waters come very close to the shore in this area. In some locales, beaked whales can be found in waters over the shelf, so it is possible that beaked whales have similar habitat preferences here. Occurrence patterns are expected to be the same throughout the year. Very little is known about the distribution of this species. What is known of its range suggests any records in the Marianas area and vicinity would be rare (DoN 2005).

The ginkgo-toothed whale is known only from strandings (there are no confirmed live sightings) in temperate and tropical waters of the Pacific and Indian Oceans (Mead 1989; Palacios 1996). There are no occurrence records for this species in the MIRC Study Area and vicinity, but this area is within the known distribution range for this species.

Reproduction/Breeding—There is no information on the breeding behavior in this area. No breeding or calving areas for the Mariana Islands have been described.

Diving Behavior—Analysis of stomach contents from captured and stranded individuals suggests that beaked whales are deep-diving animals, feeding by suction (Heyning and Mead 1996). Another species of beaked whales, the Baird’s beaked whale, feeds mainly on benthic fishes and cephalopods, but occasionally on pelagic fish such as mackerel, sardine, and saury (Kasuya 2002; Walker *et al.* 2002; Ohizumi *et al.* 2003). Baird *et al.* (2006) reported on the diving behavior of four Blainville’s beaked whales off the west coast of Hawaii. The four beaked whales foraged in deep ocean areas (2,270-9,855ft [688-2,986 m]) with a maximum dive to 4,619 ft (1,400 m). Dives ranged from at least 13 min (lost dive recorder during the dive) to a maximum of 68 min (Baird *et al.* 2006). Tyack *et al.* (2006a) reported a mean depth of 2,740 ft (830 m) and mean duration of 46.5 min for Baird’s beaked whales.

Acoustics—Little is known of the acoustic abilities of the ginko-toothed whale.

3.7.2.4.10 Killer whale (*Orcinus orca*)

Population Status—This species is designated as “lower risk” on the IUCN Red List (Reeves *et al.* 2003). There are no abundance estimates available for the killer whale within the MIRC Study Area. Little is known of stock structure of killer whales in the North Pacific, with the exception of the northeastern Pacific where resident, transient, and offshore stocks have been described for coastal waters of Alaska, British Columbia, and Washington to California (Carretta *et al.* 2004). There was no density estimate for killer whales available from the Mariana Islands (DoN 2007b), therefore, a density estimate of 0.0002 animals per km^2 (CV = 0.72) that was derived from the offshore Hawaii area was used (Barlow 2006).

Distribution—Killer whales in general are uncommon in most tropical areas (Jefferson personal communication cited in DoN 2005). The distinctiveness of this species would lead it to be reported more than any other member of the dolphin family, if it occurs in a certain locale. Rock (1993) reported that killer whales have been reported in the tropical waters around Guam, Yap, and Palau “for years.” There is, however; a paucity of sighting documentation to substantiate this claim (Reeves *et al.* 1999; Visser and Bonoccorso 2003). There are a few sightings (most are unconfirmed) of killer whales off Guam (Eldredge 1991), including a sighting 14.6 nm (27 km) west of Tinian during January, 1997 reported to the NMFS Platforms of Opportunity Program. There was also a badly decomposed killer whale found stranded on Guam in August 1981 (Kami and Hosmer 1982).

Reproduction/Breeding—There is no information on the breeding behavior in this area. No breeding or calving areas for the Mariana Islands have been described.

Diving Behavior—The maximum depth recorded for free-ranging killer whales diving off British Columbia is about 864 ft (262 m) (Baird *et al.* 2005). On average, however, for seven tagged individuals, less than 1 percent of all dives examined were to depths greater than about 99 ft (30 m) (Baird *et al.* 2003). The longest duration of a recorded dive from a radio-tagged killer whale was 17 min (Dahlheim and Heyning 1999).

Acoustics—The killer whale produces a wide variety of clicks and whistles, but most of its sounds are pulsed and at 1 to 6 kHz (Richardson *et al.* 1995). Peak to peak source levels of echolocation signals range between 195 and 224 dB re 1 µPa-m (Au *et al.* 2004). The source level of social vocalizations ranges between 137 to 157 dB re 1 µPa-m (Veirs 2004). Acoustic studies of resident killer whales in British Columbia have found that there are dialects, in their highly stereotyped, repetitive discrete calls, which are group-specific and shared by all group members (Ford 2002). These dialects likely are used to maintain group identity and cohesion, and may serve as indicators of relatedness that help in the avoidance of inbreeding between closely related whales (Ford 2002). Dialects also have been documented in killer whales occurring in northern Norway, and likely occur in other locales as well (Ford 2002).

The killer whale has the lowest frequency of maximum sensitivity and one of the lowest high frequency hearing limits known among toothed whales (Szymanski *et al.* 1999). The upper limit of hearing is 100 kHz for this species. The most sensitive frequency, in both behavioral and in auditory brainstem response audiograms, has been determined to be 20 kHz (Szymanski *et al.* 1999).

3.7.2.4.11 Longman's Beaked Whale (*Indopacetus pacificus*)

Population Status—Longman's beaked whale is considered to be a relatively rare beaked whale species (Pitman *et al.* 1999; Dalebout *et al.* 2003). This species is listed as data deficient on the IUCN Red List. There was no density estimate for Longman's beaked whales available from the Mariana Islands (DoN 2007), therefore, a density estimate of 0.0003 animals per km^2 (CV = 1.05) that was derived from the Hawaii offshore area was used (Barlow 2006).

Distribution—Longman's beaked whale appears to have a preference for warm tropical water, with most sightings occurring in waters with a SST warmer than 79ºF (26ºC) (Pitman *et al.* 1999). Beaked whales normally inhabit deep ocean waters (> 6,600 ft [2,000 m]) or continental slopes (660 to 6,600 ft [200 to 2,000 m]), and only rarely stray over the continental shelf (Pitman 2002). Longman's beaked whale is known from tropical waters of the Pacific and Indian Oceans (Pitman *et al.* 1999; Dalebout *et al.* 2003). Ferguson and Barlow (2001) reported that all Longman's beaked whale sightings were south of 25ºN. Beaked whales may be expected to occur in the area including around seaward of the shelf break.

Longman's beaked whale is not as rare as previously thought but is not as common as the Cuvier's and *Mesoplodon* beaked whales (Ferguson and Barlow 2001). Recent information shows that Cuvier's and *Mesoplodon* beaked whales may not always inhabit deep ocean areas and may be found over the continental slope (Ferguson *et al.* 2006).

In general, there is a low or unknown occurrence of beaked whales on the shelf between the 165 ft (50 m) isobath and the shelf break, which takes into account that deep waters come very close to the shore in this area. In some locales, beaked whales can be found in waters over the shelf, so it is possible that beaked whales have similar habitat preferences in these areas.

Reproduction/Breeding—There is no information on the breeding behavior in this area. No breeding or calving areas for the Mariana Islands have been described.

Diving Behavior—Analysis of stomach contents from captured and stranded individuals suggests that beaked whales are deep-diving animals, feeding by suction (Heyning and Mead 1996). Another species of beaked whale, the Baird's beaked whale, feed mainly on benthic fishes and cephalopods, but occasionally on pelagic fish such as mackerel, sardine, and saury (Kasuya 2002; Walker *et al.* 2002; Ohizumi *et al.* 2003). Prolonged dives by the Baird's beaked whales for periods of up to 67 min have been reported (Kasuya 2002), though dives of about 84 to 114 ft (25 to 36 m) are typical, and dives of 45 min are not unusual (Balcomb 1989; Von Saunder and Barlow 1999). Tyack *et al.* (2006a) reported a mean depth of 2,740 ft (830 m) and mean duration of 46.5 min for Baird's beaked whales.

Acoustics—Little is known of the acoustics of Longman's beaked whale but information is available for other beaked whale species. MacLeod (1999) suggested that beaked whales use frequencies of between 300 Hz and 129 kHz for echolocation, and between 2 and 10 kHz, and possibly up to 16 kHz, for social communication. Blainville's beaked whales echolocation clicks were recorded at frequencies from 20 to 40 kHz (Johnson *et al.* 2004) and Cuvier's beaked whales at frequencies from 20 to 70 kHz (Zimmer *et al.* 2005).

Cook *et al.* (2006), in the only hearing study on beaked whales, reported that the Gervais beaked whale (*Mesoplodon europeus*) could hear in the range of 5 to 80 kHz although no measurements were attempted above 80 kHz). The Gervais beaked whale was most sensitive from 40 to 80 kHz (Cook *et al*. 2006).

3.7.2.4.12 Melon-headed Whale (*Peponocephala electra*)

Population Status—There were an estimated 2,455 (CV = 70.2; 95% CI = 695-8,677) melon-headed whales in the MISTCS study area and density was estimated as 0.00428 animals per km2 (95% CI = 1.2-15.1; DoN 2007b). Melon-headed whale group size ranged from 80 to109 individuals. This species is designated as "lower risk" on the IUCN Red List (Reeves *et al*. 2003).

Distribution—The melon-headed whale is an oceanic species. Occurrence patterns are assumed to be the same throughout the year. There were two sightings of melon-headed whales during the Navy's 2007 survey, with group sizes of 80 to 109 individuals (DoN 2007b). Additionally, there was a live stranding on the beach at Inarajan Bay, Guam in April 1980 (Kami and Hosmer 1982; Donaldson 1983), and have been some sightings at Rota and Guam (Jefferson *et al.* 2006; DoN 2005). Melon-headed whales are expected to occur from the shelf break (660 ft [200 m] isobath) to seaward of the Marianas area and vicinity. There is also a low or unknown occurrence from the coastline to the shelf break which would take into account any sightings that could occur closer to shore since deep water is very close to shore at these islands. For example, during 4 July 2004, there was a sighting of an estimated 500 to 700 melon-headed whales and an undetermined smaller number of rough-toothed dolphins at Sasanhayan Bay (Rota) in waters with a bottom depth of 251 ft (76 m) (Jefferson *et al.* 2006). Occurrence patterns are assumed to be the same throughout the year.

Melon-headed whales were sighted in waters with a bottom depth, ranging from 10,577 to 12,910 ft (3,205 to 3,912 m). One of the two sightings was in the vicinity of the West Mariana Ridge.

Reproduction/Breeding—Breeding behavior is unknown and it is unclear whether there is significant seasonality in calving (Jefferson and Barros 1997).

Diving Behavior—Melon-headed whales prey on squid, pelagic fishes, and occasionally crustaceans. Most of the fish and squid families eaten by this species consist of mesopelagic forms found in waters up to 4,950 ft (1,500 m) deep, suggesting that feeding takes place deep in the water column (Jefferson and Barros 1997). There is no information on specific diving depths for melon-headed whales.

Acoustics—The only published acoustic information for melon-headed whales is from the southeastern Caribbean (Watkins *et al.* 1997). Sounds recorded included whistles and click sequences. Whistles had dominant frequencies around 8 to 12 kHz; source levels for higher-level whistles were estimated at no more than 155 dB re 1 µPa-m (Watkins *et al.* 1997). Clicks had dominant frequencies of 20 to 40 kHz; higher-level click bursts were judged to be about 165 dB re 1 µPa-m (Watkins *et al.* 1997). No data on hearing ability for this species are available.

3.7.2.4.13 Pantropical spotted dolphin (*Stenella attenuata*)

Population Status—There were an estimated 12,981 (CV = 70.4; 95% CI = 3,446-48,890) pantropical spotted dolphins in the MISTCS study area and density was estimated as 0.0226 animals per km^2 (95% CI = 6.0-85.3; DoN 2007b). Pantropical spotted dolphin group size ranged from 1 to 115 individuals. There were multiple sightings that included young calves, and one mixed species aggregation with melon-headed whales and another with an unidentified *Balaenoptera* spp. These pantropical spotted dolphins were identified as the offshore morphotype.

Pantropical spotted dolphins may have several stocks in the western Pacific (Miyashita 1993), although this is not confirmed at present. There were an estimated 127,800 spotted dolphins in the waters surrounding the Mariana Islands (Miyashita 1993). This species is designated as “lower risk” on the IUCN Red List (Reeves *et al.* 2003). Three subspecies are recognized in the Pacific Ocean, two of which have not been formerly named. *S. a. subspecies A* occurs in the offshore waters of the eastern tropical Pacific, *S. a. subspecies B* inhabits nearshore waters around the Hawaiian Islands, and *S. a. graffmani* occurs in coastal waters between Baja California and the northwestern coast of South America (Reeves *et al.* 2002).

Distribution—The pantropical spotted dolphin can be found throughout tropical and some subtropical oceans of the world (Perrin and Hohn 1994). Pantropical spotted dolphins are associated with warm tropical surface water (Au and Perryman 1985; Reilly 1990; Reilly and Fiedler 1994). Pantropical spotted dolphins usually occur in deeper waters, and rarely over the continental shelf or continental shelf edge (Davis *et al.* 1998; Waring *et al.* 2002). They are extremely gregarious, forming groups of hundreds or even thousands of individuals. Range in the central Pacific is from the Hawaiian Islands in the north to at least the Marquesas in the south (Perrin and Hohn 1994). The pantropical spotted dolphin is primarily an oceanic species (Jefferson *et al.* 1993). Based on the known habitat preferences of the pantropical spotted dolphin, this species is expected to occur seaward of the shelf break (660 ft [200 m] isobath). Low or unknown occurrence of the pantropical spotted dolphin from the coastline (except in harbors and lagoons) to the shelf break is based on sightings of pantropical spotted dolphins being reported in coastal waters of Guam by Trianni and Kessler (2002).

Pantropical spotted dolphins were sighted throughout the MIRC Study Area in waters with a variable bottom depth, ranging from 374 to 18,609 ft (113 to 5,639 m) in bottom depth. The vast majority of the sightings (65 percent; 11 of 17 sightings) were in deep waters (>10,000 ft [3,030 m]); these findings match the known preference of this species for oceanic waters. There was only one shallow-water sighting 1.4 nm (2.5 km) north of Tinian during the humpback whale focal study, in waters with a bottom depth of 374 ft (113 m).

Reproduction/Breeding—In the Eastern Tropical Pacific there are two calving peaks, one in spring and one in fall (Perrin and Hohn 1994).

Diving Behavior—Results from various tracking and food habit studies suggest that pantropical spotted dolphins in the eastern tropical Pacific and off Hawaii feed primarily at night on epipelagic species and on mesopelagic species which rise towards the water's surface after dark (Robertson and Chivers 1997; Scott and Cattanach 1998; Baird *et al.* 2001). Dives during the day generally are shorter and shallower than dives at night; rates of descent and ascent are higher at night than during the day (Baird *et al.* 2001). Similar mean dive durations and depths have been obtained for tagged pantropical spotted dolphins in the eastern tropical Pacific and off Hawaii (Baird *et al.* 2001).

Acoustics—Pantropical spotted dolphin whistles have a dominant frequency range of 6.7 to 17.8 kHz (Ketten 1998). Click source levels between 197 and 220 dB re 1 µPa-m (peak to peak levels), within the range of 40-140 kHz, have been recorded for pantropical spotted dolphins (Schotten *et al.* 2004). Data from Atlantic spotted dolphins are provided to fill in the gaps of acoustic information for pantropical spotted dolphins. Echolocation clicks measured in wild Atlantic spotted dolphins showed bimodal ranges of 40 and 50 kHz and a high-frequency peak between 110 and 130 kHz, with a source level of 210 dB re 1 µPa (Au and Herzing 2003).

There are no published hearing data for pantropical spotted dolphins (Ketten 1998). Anatomy of the ear of the pantropical spotted dolphin has been studied; Ketten (1992, 1997) found that they have a Type II cochlea, like other delphinids.

3.7.2.4.14 Pygmy killer whale (*Feresa attenuata*)

Population Status—There was only one sighting of the pygmy killer whale with a group size of six animals (DoN 2007b). Based on this one sighting, the best estimate of abundance was 78 individuals (CV = 88.1; 95% CI = 17-353) and density was estimated as 0.00014 animals per km^2 (DoN 2007b). This species is designated as data deficient on the IUCN Red List (Reeves *et al*. 2003).

Distribution—The pygmy killer whale is an oceanic species. This species has a worldwide distribution in deep tropical and subtropical oceans. Pygmy killer whales generally do not range north of 40°N or south of 35°S (Jefferson *et al.* 1993). Reported sightings suggest that this species primarily occurs in equatorial waters, at least in the eastern tropical Pacific (Perryman *et al.* 1994). Most of the records outside the tropics are associated with strong, warm western boundary currents that effectively extend tropical conditions into higher latitudes (Ross and Leatherwood 1994).

The sighting was made near the Mariana Trench, south of Guam, where the bottom depth was 14,564 ft (4,413 m). This is consistent with the known habitat preferences of the species for deep, oceanic waters.

Reproduction/Breeding—There is no information on the breeding behavior in this area. No breeding or calving areas for the Mariana Islands have been described.

Diving Behavior—There is no information on the diving behavior of pygmy killer whales.

Acoustics—The pygmy killer whale produces clicks in the range of 45 to 117 kHz, with the main energy in the range of 70 to 85 kHz (Madsen *et al.* 2004). Peak to peak source levels were 197 to 223 dB re 1 µPa m. There is no information on the hearing of pygmy killer whales.

3.7.2.4.15 Pygmy sperm whale (*Kogia breviceps*)

Population Status—Pygmy sperm whales are designated as "lower risk" on the IUCN Red List (Reeves *et al.* 2003). There are no abundance estimates available for the Kogiidae family within the MIRC. There was no density estimate for pygmy sperm whales available from the Mariana Islands (DoN 2007b), therefore, a density estimate of 0.0078 animals per km^2 (CV = 0.77) that was derived from the Hawaii offshore area was used (Barlow 2006).

Distribution—Pygmy sperm whales have a worldwide distribution in tropical and temperate waters (Jefferson *et al.* 1993), and generally occur in waters along the continental shelf break and over the continental slope (*e.g.*, Baumgartner *et al.* 2001; McAlpine 2002; Baird 2005). This takes into account their preference for deep waters. There is only one stranding record available for *Kogia* in the MIRC Study Area and vicinity (Kami and Lujan 1976; Reeves *et al*. 1999; Eldredge 1991, 2003). Identification to species for this genus is difficult, particularly at sea. There is a rare occurrence for *Kogia* inshore of the area of primary occurrence. Occurrence is expected to be the same throughout the year.

Reproduction/Breeding—In the Eastern Tropical Pacific there are two calving peaks, one in spring and one in fall (Perrin and Hohn 1994).

Diving Behavior—Pygmy sperm whales feed on cephalopods and, less often, on deep-sea fishes and shrimps (Caldwell and Caldwell 1989; Baird *et al.* 1996; Willis and Baird 1998; Wang *et al.* 2002). Willis and Baird (1998) reported that *Kogia* make dives of up to 25 min. Median dive times of around 11 min have been documented for *Kogia* (Barlow 1999). A satellite-tagged pygmy sperm whale released off Florida was found to make long nighttime dives, presumably indicating foraging on squid in the deep scattering layer (Scott *et al.* 2001). Most sightings of *Kogia* are brief; these whales are often difficult to approach and they actively avoid aircraft and vessels (Würsig *et al.* 1998).

Acoustics—Pygmy sperm whale clicks range from 60 to 200 kHz, with a dominant frequency of 120 kHz (Richardson *et al.* 1995). There is no information available on pygmy sperm whale vocalizations or hearing capabilities. An auditory brainstem response study indicates that pygmy sperm whales have their best hearing between 90 and 150 kHz (Ridgway and Carder 2001).

3.7.2.4.16 Risso's dolphin (*Grampus griseus*)

Population Status—This species is designated as "data deficient" on the IUCN Red List (Reeves *et al.* 2003). Essentially nothing is known of stock structure of Risso's dolphins in the western Pacific. Assuming that several stocks may occur there, Miyashita (1993) used Japanese survey data to estimate that about 7,000 Risso's dolphins occur in the area to the north of the Mariana Islands. There was no density estimate for Risso's dolphins available from the Mariana Islands (DoN 2007b); therefore, a density estimate of 0.0010 animals per km^2 (CV = 0.65) that was derived from the Hawaii offshore area was used for acoustic effects modeling (Barlow 2006).

Distribution—Risso's dolphins are expected to occur in the Marianas area from the shelf break to seaward of the Marianas area and vicinity. While there is a predominance of Risso's dolphin sightings worldwide in areas with steep bottom topography, this species is also found in deeper waters. The largest numbers for this species will likely be in the vicinity of the shelf break and upper continental slope (Jefferson personal communication, cited in DoN 2005). There is an area of low or unknown occurrence from the 165 ft (50 m) isobath to the shelf break. This takes into consideration also the possibility that this species, with a preference for waters with steep bottom topography, might swim into areas where deep water is close to shore. Leatherwood *et al.* (1979) and Shane (1994) reported on sightings of Risso's dolphins in shallow waters in the northeastern Pacific, including near oceanic islands. These sites are in areas where the continental shelf is narrow and deep water is closer to the shore (Leatherwood *et al.* 1979, Gannier 2000, 2002). Occurrence patterns are assumed to be the same throughout the year.

A comprehensive study of the distribution of Risso's dolphin in the Gulf of Mexico found that they used the steeper sections of the upper continental slope in waters 1,150–3,200 ft (350–975 m) deep

(Baumgartner 1997). Risso’s dolphins occur individually or in small to moderate-sized groups, normally ranging in numbers from 2 to nearly 250.

Reproduction/Breeding—There is no information on the breeding behavior in this area. No breeding or calving areas for the Mariana Islands have been described.

Diving Behavior—They may remain submerged on dives for up to 30 min (Kruse *et al.* 1999). Cephalopods are the primary prey (Clarke 1996).

Acoustics—Risso’s dolphin vocalizations include broadband clicks, barks, buzzes, grunts, chirps, whistles, and simultaneous whistle and burst-pulse sounds (Corkeron and Van Parijs 2001). The combined whistle and burst pulse sound appears to be unique to Risso’s dolphin (Corkeron and Van Parijs 2001). Corkeron and Van Parijs (2001) recorded five different whistle types, ranging in frequency from 4 to 22 kHz. Broadband clicks had a frequency range of 6 to greater than 22 kHz. Low-frequency narrowband grunt vocalizations had a frequency range of 0.4 to 0.8 kHz. A recent study established empirically that Risso’s dolphins echolocate; estimated source levels were up to 216 to 225 dB re 1 µPa-m (peak to peak levels) with two prominent peaks in the range of 30-50 kHz and 80 to 100 kHz (Philips *et al*. 2003; Madsen *et al*. 2004).

The range of hearing in two Risso’s dolphins (one infant and one adult was 1.6 to 150 kHz with maximum sensitivity occurring between 8 and 64 kHz (Nachtigall *et al*. 1995, 2005).

3.7.2.4.17 Rough-toothed dolphin (*Steno bredanensis*)

Population Status—There were only two sightings of the rough-toothed dolphin made during the MISTCS cruise. There were an estimated 166 (CV = 89.2; 95% CI = 36-761) rough toothed dolphins in the MISTCS study area and density was estimated as 0.0029 animals per km^2 (DoN 2007b). Rough-toothed dolphin group size was nine individuals. A mixed-species aggregation involved common bottlenose dolphins with short finned pilot whales and rough-toothed dolphins. There was one sighting of rough-toothed dolphin that included calves.

The rough-toothed dolphin is designated as “data deficient” on the IUCN Red List (Reeves *et al.* 2003). There are no abundance estimates for this species in this area. Rough-toothed dolphins are common in tropical areas, but not nearly as abundant as some other dolphin species (Reeves *et al.* 2002). Nothing is known about stock structure for the rough-toothed dolphin in the North Pacific (Carretta *et al.* 2004).

Distribution—Rough-toothed dolphins are typically found in tropical and warm temperate waters (Perrin and Walker 1975 in Bonnell and Dailey 1993), rarely ranging north of 40°N or south of 35°S (Miyazaki and Perrin 1994). Occurrence patterns are expected to be the same throughout the year. Rough-toothed dolphins occur in low densities throughout the ETP where surface water temperatures are generally above 77°F (25°C) (Perrin and Walker 1975). Sighting and stranding records in the eastern North Pacific Ocean are rare (*e.g*., Ferrero *et al.* 1994).

There were two sightings of rough-toothed dolphins during the MISTCs survey (DoN 2007b), both in groups of nine individuals with calves present in one sighting. As an oceanic species, the rough-tooth dolphin is expected to occur from the shelf break to seaward in this area. There is also a low or unknown occurrence of rough-toothed dolphins from the coastline (including harbors and lagoons) to the shelf break, which takes into consideration the possibility of encountering this species in more shallow waters, based on distribution patterns for this species in other tropical locales. In July 2004, there was a sighting of an undetermined smaller number of rough-toothed dolphins mixed in with a school of an estimated

500-700 melon-headed whales at Sasanhayan Bay (Rota) in waters with a bottom depth of 249 ft (Jefferson *et al*. 2006).

Rough-toothed dolphins usually form groups of 10–20 (Reeves *et al.* 2002), but aggregations of hundreds can be found (Leatherwood and Reeves 1983). In the ETP, they have been found in mixed groups with spotted, spinner, and bottlenose dolphins (Perrin and Walker 1975). Reeves *et al.* (2002) suggested that they are deep divers, and can dive for up to 15 min. They usually inhabit deep waters (Davis *et al.* 1998), where they prey on fish and cephalopods (Reeves *et al.* 2002).

Rough-toothed dolphins were sighted in deep waters, ranging from 3,343 to 14,731 ft (1,013 to 4,464 m) in bottom depth. One sighting was off the island of Guguan, while the other was at the southern edge of the MIRC Study Area (DoN 2007b).

Reproduction/Breeding—There is no information on the breeding behavior in this area. No breeding or calving areas for the Mariana Islands have been described.

Diving Behavior—Rough-toothed dolphins are deep divers and can stay under for up to 15 min (Reeves *et al.* 2002). They usually inhabit deep waters (Davis *et al.* 1998), where they prey on fish and cephalopods (Reeves *et al.* 2002). Rough-toothed dolphins may stay submerged for up to 15 min and are known to dive as deep as 230 ft (70 m), but can probably dive much deeper (Miyazaki and Perrin 1994).

Acoustics—The vocal repertoire of the rough-toothed dolphin includes broad-band clicks, barks, and whistles (Yu *et al*. 2003). Echolocation clicks of rough-toothed dolphins are in the frequency range of 0.1 to 200 kHz, with a peak of about 25 kHz (Miyazaki and Perrin 1994; Yu *et al*. 2003). Whistles show a wide frequency range: 0.3 to >24 kHz (Yu *et al*. 2003).

There is little published information on hearing ability of this species. Preliminary data from Cook *et al*. (2005) showed that rough-tooth dolphins hear from 5to 80 kHz (80 kHz was the upper limit tested) and probably higher frequencies.

3.7.2.4.18 Short-beaked common dolphin (*Delphinus delphis*)

Population Status—There are no abundance estimates for the short-beaked common dolphin within the MIRC. This species is designated as “lower risk” on the IUCN Red List (Reeves *et al.* 2003). There was no density estimate for short-beaked common dolphins available from the Mariana Islands (DoN 2007), therefore, a density estimate of 0.0021 animals per km^2 (CV = 0.28) that was derived from the ETP area was used for acoustic effects modeling (Ferguson and Barlow 2001, 2003).

Distribution—*Delphinus* is a widely distributed genus of cetacean. It is found worldwide in temperate, tropical, and subtropical seas. The range of the short-beaked common dolphin may extend entirely across the tropical and temperate North Pacific (Heyning and Perrin 1994). There is a low or unknown occurrence of the short-beaked common dolphin from the shelf break to seaward of the Marianas area and vicinity. Short-beaked common dolphins are thought to be more common in cool temperate waters of the North Pacific, although there are populations in cooler, upwelling modified waters of the eastern tropical Pacific (Au and Perryman 1985). The absence of known areas of major upwelling in the western tropical Pacific suggests that common dolphins will not be found there, although there have been some reports of sightings of this species (Masaki and Kato 1979). However, the species identification of these records is not confirmed, and therefore is in doubt. Occurrence patterns are assumed to be the same throughout the year.

Reproduction/Breeding—The peak calving season occurs from spring and early summer (Forney 1994).

Diving Behavior—Limited direct measurements but dives to > 660 ft (200 m) are possible, but most are in the range of 30 to 165 ft (9 to 50 m) based on a study on one tagged individual tracked off San Diego (Evans 1971, 1994). Stomach contents of *Delphinus* from California waters revealed 19 species of fish and two species of cephalopods; *Delphinus* feeds primarily on organisms in the vertically migrating DSL (Evans 1994). Diel fluctuations in vocal activity of this species (more vocal activity during late evening and early morning) appear to be linked to feeding on the DSL as it rises during the same time (Goold 2000).

Acoustics—Recorded *Delphinus* vocalizations (which are similar among species within this genus) 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), with maximum source levels at approximately 180 dB 1 µPa-m (Fish and Turl 1976). Oswald *et al.* (2003) found that short-beaked common dolphins in the ETP 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 common dolphin. The audiogram was U-shaped with a steeper high-frequency branch. The audiogram bandwidth was up to 128 kHz at a level of 100 dB above the minimum threshold. The minimum thresholds were observed at frequencies of 60 to 70 kHz.

3.7.2.4.19 Short-finned pilot whale (*Globicephala macrorhynchus*)

Population Status—There were an estimated 909 (CV = 67.7; 95% CI = 230-3,590) short-finned pilot whales in the MISTCS study area and density was estimated as 0.00159 animals per km2 (DoN 2007b).

This species is designated as “lower risk” on the IUCN Red List (Reeves et al. 2003). There are no abundance estimates for the short-finned pilot whale in this area. Stock structure of short-finned pilot whales has not been adequately studied in the North Pacific, except in Japanese waters, where two stocks have been identified based on pigmentation patterns and head shape differences of adult males (Kasuya *et al.* 1988). The southern stock of short-finned pilot whales (Kasuya *et al.* 1988), which is probably the one associated with the Mariana Islands area, has been estimated to number about 18,700 whales in the area south of 30°N latitude (Miyashita 1993).

Distribution—Miyashita *et al.* (1996) reported sightings in the vicinity of the Northern Mariana Islands during February through March 1994, but did not provide the actual sighting coordinates. A group of more than 30 individuals was sighted in late April 1977 near Urunao Point, off the northwest coast of Guam (Birkeland 1977). A stranding occurred on Guam in July 1980 (Kami and Hosmer 1982; Donaldson 1983; Schulz 1980).

Expected occurrence of the short-finned pilot whale in the MIRC and vicinity is seaward of the 330 ft (100 m) isobath. The known preference of this species globally for steep bottom topography, which is most probably related to distribution of squid, was considered. With a narrow shelf and deep waters in close proximity to the shore, there is also a low or unknown occurrence of pilot whales in waters over the shelf from the coastline to the 330 ft (100 m) isobath, not including any lagoons. Occurrence patterns are assumed to be the same throughout the year.

Short-finned pilot whale group size ranged from 5 to 43 individuals. A mixed-species aggregation involved bottlenose dolphins with short-finned pilot whales and rough-toothed dolphins. No calves were seen. Short-finned pilot whales were sighted in waters with a bottom depth, ranging from 3,041 to 14,731 ft (922 to 4,464 m) in bottom depth (DoN 2007b). Three sightings were over the West Mariana Ridge (an area of seamounts), another sighting was 7 nm (13 km) off the northeast corner of Guam, just inshore of the 9,900 ft (3,000 m) isobath. There was also an off-effort sighting of a group of 6 to 10 pilot whales near the mouth of Apra Harbor (DoN 2007b).

Reproduction/Breeding—Calving and breeding peaks occurs in the spring and summer or spring and autumn depending on the population (Jefferson *et al.* 1993).

Diving Behavior—Pilot whales are deep divers; the maximum dive depth measured is about 3,186 ft (965 m) (Baird *et al.* 2002). Pilot whales feed primarily on squid, but also take fish (Bernard and Reilly 1999). Pilot whales are not generally known to prey on other marine mammals; however, records from the eastern tropical Pacific suggest that the short-finned pilot whale does occasionally chase, attack, and may eat dolphins during fishery operations (Perryman and Foster 1980), and they have been observed harassing sperm whales in the Gulf of Mexico (Weller *et al.* 1996).

Acoustics—Short-finned pilot whale whistles and clicks have a dominant frequency range of 2 to 14 kHz and a source level of 180 dB re 1 µPa-m for whistles (Fish and Turl 1976; Ketten 1998). There are no published hearing data available for this species.

3.7.2.4.20 Spinner dolphin (*Stenella longirostris*)

Population Status—During the MISTCS there was only one sighting of spinner dolphins with a group size of 98 animals. There were an estimated 1,803 (CV = 95.8; 95% CI = 361-9,004) spinner dolphins in the MISTCS study area and density was estimated as 0.00314 animals per km^2 (DoN 2007b).

This species is designated as “lower risk” on the IUCN Red List (Reeves *et al.* 2003).

Distribution—The spinner dolphin is found in tropical and subtropical waters worldwide. Limits are near 40°N and 40°S (Jefferson *et al.* 1993). The spinner dolphin is expected to occur throughout the entire Marianas area and vicinity, except within Apra Harbor, where there is a low or unknown occurrence for this species. Spinner dolphins are behaviorally sensitive and avoid areas with much anthropogenic usage, which is why it is unknown whether this species would occur in Apra Harbor. Lagoons are high-usage habitat for resting by spinner dolphins; spinner dolphin occurrence in at least Saipan and Cocos Lagoons would be concentrated, with animals congregating during the day to rest. In the Mariana Islands, dolphins are reported in Saipan Lagoon at Saipan nearly every year (Trianni and Kessler 2002), and they were observed off Saipan during the MISTCs survey (DoN 2007b) in 1,406 ft (426 m) of water. Typically, sightings are from the northern part of the lagoon, referred to as Tanapag Lagoon (Trianni and Kessler 2002). Spinner dolphins travel among the Mariana island chain (Trianni and Kessler 2002). Spinner dolphins are seen at FDM (DoN 2001; Trianni and Kessler 2002), Guam (Trianni and Kessler 2002), and at Rota (Jefferson *et al.* 2006).

Spinner dolphins at islands and atolls rest during daytime hours in shallow, wind-sheltered nearshore waters and forage over deep waters at night (Norris *et al.* 1994; Östman 1994; Poole 1995; Gannier 2000, 2002; Lammers 2004; Östman-Lind *et al.* 2004). Spinner dolphins are expected to occur in shallow water (about 162 ft [49 m] or less) resting areas throughout the middle of the day, moving into deep waters offshore during the night to feed. Preferred resting habitat is usually more sheltered from prevailing tradewinds than adjacent areas and the bottom substrate is generally dominated by large stretches of white sand bottom rather than the prevailing reef and rock bottom along most other parts of the coast (Norris *et al.* 1994; Lammers 2004). These clear, calm waters and light bottom substrates provide a less cryptic backdrop for predators like tiger sharks (Norris *et al.* 1994; Lammers 2004). High-use areas at Guam include Bile Bay, Tumon Bay, Double Reef, north Agat Bay, and off Merizo (Cocos Lagoon area) (Eldredge 1991; Amesbury *et al.* 2001; DoN 2005). During the MISTCS cruise spinner dolphins were sighted northeast of Saipan in waters with a bottom depth of 1,398 ft (424 m) (DoN 2007b).

Reproductive/Breeding—There is no information on the breeding behavior in this area.

Diving Behavior—Spinner dolphins feed primarily on small mesopelagic fishes, squids, and sergestid shrimp and they dive to at least 654 to 984 ft (109 to 164 fathoms, 198 to 298 m) (Perrin and Gilpatrick 1994). Foraging can begin in the late afternoon (Lammers 2004), but takes place primarily at night when the mesopelagic prey migrates vertically towards the surface and also horizontally towards the shore (Benoit-Bird *et al.* 2001; Benoit-Bird and Au 2004; Dollar and Grigg 2003).

Acoustics— Spinner dolphins produce whistles in the range of 1 to 22.5 kHz with the dominant frequency being 6.8 to 17.9 kHz, although their full range of hearing may extend down to 1 kHz or below as reported for other small odontocetes (Richardson et al. 1995a; Nedwell et al. 2004, Bazúa-Durán and Au 2002). Spinner dolphins consistently produce whistles with frequencies as high as 16.9 to 17.9 kHz, with a maximum frequency for the fundamental component at 24.9 kHz (Bazúa-Durán and Au 2002; Lammers *et al*. 2003). Clicks have a dominant frequency of 60 kHz (Ketten 1998). The burst pulses are predominantly ultrasonic, often with little or no energy below 20 kHz (Lammers *et al*. 2003). Peak to peak source levels between 195 and 222 dB have been recorded for spinner dolphin clicks (Schotten *et al.* 2004). Their echolocation clicks range up to at least 65 kHz (Richardson *et al*. 1995).

3.7.2.4.21 Striped dolphin (*Stenella coeruleoalba*)

Population Status—There were an estimated 3,531 (CV = 54.0; 95% CI = 1,250-9,977) striped dolphins in the MISTCS study area and density was estimated as 0.00616 animals per km^2 (DoN 2007b). Striped dolphin group size ranged from 7 to 44 individuals and several sightings contained calves.

This species is designated as “lower risk” on the IUCN Red List (Reeves *et al.* 2003). The stock structure of striped dolphins in the western Pacific is poorly known, although there is evidence for more than one stock (Miyashita 1993). A putative population south of 30°N in the western Pacific was estimated to number about 52,600 dolphins, and this is probably the group from which any striped dolphins around the Marianas would come from.

Distribution—Striped dolphins have a cosmopolitan distribution in tropical to warm temperate waters (Perrin *et al.* 1994a). Their preferred habitat seems to be deep water (Davis *et al.* 1998) along the edge and seaward of the continental shelf, particularly in areas influenced by warm currents (Waring *et al.* 2002). This species is well documented in both the western and eastern Pacific off the coasts of Japan and North America (Perrin *et al.* 1994); the northern limits are the Sea of Japan, Hokkaido, Washington state, and along roughly 40°N across the western and central Pacific (Reeves *et al.* 2002).

Prior to the MISTCs survey (DoN 2007b), striped dolphins were only known from one stranding that occurred in July 1985 (Wilson *et al.* 1987; Eldredge 1991, 2003). However, several striped dolphin sightings were made in waters ranging from 8,686 to 24,981 ft (2,362 to 7,570 m) of water (DoN 2007b). Group size ranged from 7 to 44 individuals. None were observed south of Guam.

Striped dolphins are gregarious (groups of 20 or more are common) and active at the surface (Whitehead *et al.* 1998). Wade and Gerrodette (1993) noted a mean group size of 61 in the ETP, and Smith and Whitehead (1999) reported a mean group size of 50 in the Galápagos.

Striped dolphins were sighted throughout the MIRC Study Area in waters with a variable bottom depth, ranging from 7,749 to 24,835 ft (2,348 to 7,526 m) in bottom depth. There was at least one sighting over the Mariana Trench, southeast of Saipan. There were no sightings south of Guam (approximately 13°N).

Reproduction/Breeding—Off Japan, where their biology has been best studied, there are two calving peaks: one in summer, another in winter (Perrin *et al.* 1994).

Diving Behavior—Striped dolphins often feed in pelagic or benthopelagic zones along the continental slope or just beyond oceanic waters. A majority of the prey possess luminescent organs, suggesting that striped dolphins may be feeding at great depths, possibly diving to about 654 to 2,298 ft (198 to 696 m) to reach potential prey (Archer and Perrin 1999). Striped dolphins may feed at night, in order to take advantage of the deep scattering layer's diurnal vertical movements. Small, mid-water fishes (in particular, myctophids or lanternfish) and squids are the dominant prey (Perrin *et al.* 1994).

Acoustics—Striped dolphin whistles range from 6 to at least 24 kHz, with dominant frequencies ranging from 8 to 12.5 kHz (Richardson *et al.* 1995).

The striped dolphin's range of most sensitive hearing (defined as the frequency range with sensitivities within 10 dB of maximum sensitivity) was determined to be 29 to 123 kHz using standard psycho-acoustic techniques; maximum sensitivity occurred at 64 kHz (Kastelein *et al.* 2003).

3.7.3 Environmental Consequences

3.7.3.1 Acoustic Effects

3.7.3.1.1 Ship Noise

Increased number of ships operating in the area will result in increased sound from vessel traffic. Marine mammals react to vessel-generated sounds 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).

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 2007a). Anthropogenic sound has increased in the marine environment over the past 50 years (Richardson *et al*. 1995; NRC 2003). This sound increase can be attributed to increases in vessel traffic as well as sound from marine dredging and construction, oil and gas drilling, geophysical surveys, sonar, and underwater explosions (Richardson *et al.* 1995).

Given the current ambient sound levels in the marine environment, the amount of sound contributed by the use of Navy vessels in the proposed exercises and training is very low. It is anticipated that any marine mammals exposed would exhibit only short-term reactions and would not suffer any long-term consequences from ship sound.

3.7.3.1.2 Pingers

MK 84 range pingers, used in association with the Portable Undersea Tracking Range, are active acoustic devices that allow ships, submarines, and target simulators to be tracked by means of deployed hydrophones. The signal from a MK 84 pinger is very brief (15 milliseconds) with a selectable frequency at 9.24 kHz, 12,93 kHz, 33.25 kHz, or 36.95 kHz and a source level of approximately 190 dB SPL.

Based on the operational characteristics (short transmission, limited directivity, output level, and limited propagation) of this acoustic source, the potential to affect marine mammals is very low. In addition, sound sources with a primary function involving safety, navigation, or required by at sea operations are not appropriate for consideration in a request for authorization since their use is not optional. Therefore, consistent with NOAA's June 3, 2002, ESA Section 7 letter to the Navy for RIMPAC 2002 and the

RIMPAC 2006 Biological Opinion, the Navy determined that use of pingers not likely to adversely affect ESA listed or MMPA protected species under the jurisdiction of NMFS.

3.7.3.1.3 Acoustic Sources Analyzed

The following mid and high frequency active sonar sources were analyzed for the MIRC:

- AN/SQS-53: Surface ship sonar—mid-frequency active sonar source,
- AN/SQS-56: Surface ship sonar—mid-frequency active sonar source,
- AN/SSQ-62: Sonobuoy sonar—mid-frequency active sonar source,
- AN/SSQ-125: Sonobuoy sonar—mid-frequency active sonar source,
- AN/AQS-22: Helicopter-dipping sonar—mid-frequency active sonar source,
- BQQ-10: Submarine sonar—mid-frequency active sonar source, and
- MK-48: Torpedo sonar—high-frequency active sonar source.

3.7.3.1.4 Analytical Framework for Assessing Marine Mammal Response to Active Sonar

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 (NRC 2005). However, it is not known how these responses relate to significant effects (*e.g*., 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.

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 time of the action to determine which marine mammal species are likely to be present.
- Determined the estimated number of marine mammals (*i.e.*, density) of each species that will likely be present in the respective areas during active sonar activities.
- Applied the applicable acoustic threshold criteria to the predicted sound exposures from the proposed activity. The results of this effort are 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, or species to assess potential population viability. Particular focus on recruitment and survival are provided to analyze whether the effects of the action can be considered to have negligible effects to species or stocks.

The following flow chart (Figure 3.7-1) is a representation of the general analytical frame work utilized in applying the specific thresholds. The framework presented in the flow chart, is organized from left to right, and is compartmentalized according to the phenomena that occur within each. These include 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 impacts 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 flow chart dotted and solid lines are used to connect related events. Solid lines are those items which "will" happen, dotted lines are those which "might" happen, but which must be considered (including those hypothesized to occur but for which there is no direct evidence).

Some boxes contained within the flow chart are colored according to how they relate to the definitions of harassment in the Marine Mammal Protection Act (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 TTS is considered as part of Level B harassment. Boxes that are shaded from red to yellow have the potential for injury (Level A harassment) and behavioral disturbance (Level B harassment).

The analytical framework outlined within the flow chart acknowledges that physiological responses must always precede behavioral responses (*i.e.*, there can be no behavioral response without first some physiological effect of the sound) and an organization where each functional block only occurs once and all relevant inputs/outputs flow to/from a single instance.

3.7.3.1.5 Physics

Starting with a sound source, the attenuation of an emitted sound due to propagation loss is determined. Uniform animal distribution is overlaid onto the calculated sound fields to assess if animals are physically present at sufficient received sound levels to be considered "exposed" to the sound. If the animal is determined to be exposed, two possible scenarios must be considered with respect to the animal's physiology– effects on the auditory system and effects on nonauditory system tissues. These are not independent pathways and both must be considered since the same sound could affect both auditory and nonauditory tissues. Note that the model does not account for any animal response; rather the animals are considered stationary, accumulating energy until the threshold is tripped.

3.7.3.1.6 Physiology

Potential impacts to the auditory system are assessed by considering the characteristics of the received sound (*e.g*., amplitude, frequency, duration) and the sensitivity of the exposed animals. Some of these assessments can be numerically based (*e.g.*, TTS, PTS, perception). Others will be necessarily qualitative, due to lack of information, or will need to be extrapolated from other species for which information exists. Potential physiological responses to sound exposure are 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).

1. 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, sometimes long 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.

2. 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.

3. 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 (*e.g.*, amplitude, duration, temporal pattern) 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 (*i.e.*, what are the known/unknown consequences of the exposure).

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).

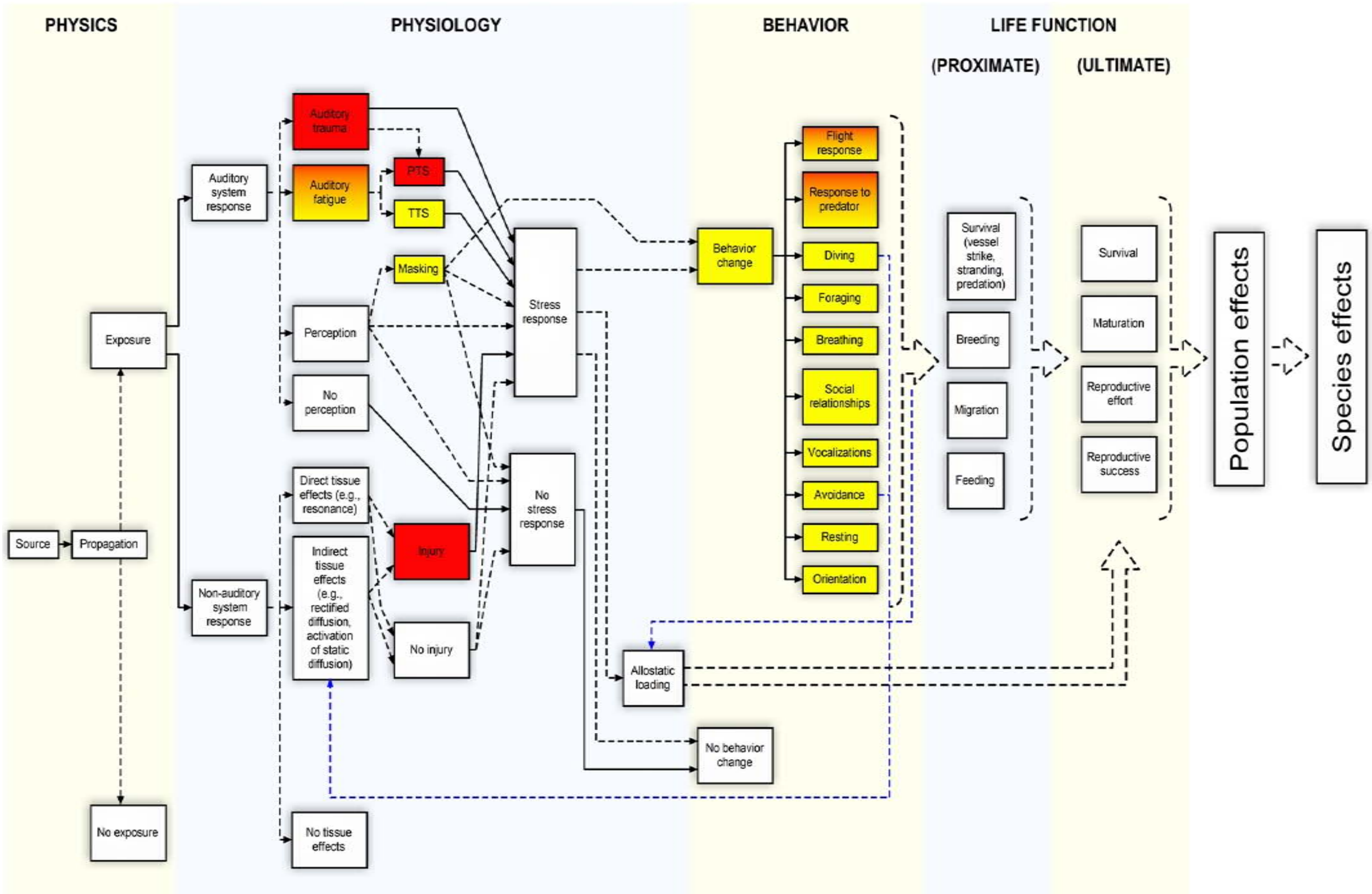


Figure 3.7-1: Conceptual Model for Assessing the Effects of Sound Exposures on Marine Mammals (Source: U.S. Navy)

Potential impacts to tissues other than those related to the auditory system are assessed by considering the characteristics of the sound (*e.g.*, amplitude, frequency, duration) 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.

1. 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.

2. 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.

3. No tissue effects – The received sound is insufficient to cause either direct (mechanical) or indirect effects to tissues. No stress response occurs.

3.7.3.1.7 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 3.7-1 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 SNS response to a stressor is immediate and acute and is characterized by the release of the catecholamine neurohormones norepinephrine and epinephrine (*i.e.*, adrenaline). These hormones produce elevations in the heart and respiration rate, increase awareness, and increase the availability of glucose and lipids for energy. The HPA response is ultimately defined by increases in the secretion of the glucocorticoid steroid hormones, predominantly cortisol in mammals. The amount of increase in circulating glucocorticoids above baseline may be an indicator of the overall severity of a stress response (Hennessy *et al.* 1979). Each component of the stress response is variable in time; *e.g.*, adrenalines are released nearly immediately and are used or cleared by the system quickly, whereas cortisol levels may take long periods of time to return to baseline.

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 (*e.g.*, neonate, juvenile, adult), the environmental conditions, reproductive or developmental state, and experience with the stressor. Not only will these factors be subject to individual variation, but they will also vary within an individual over time. In considering potential stress responses of marine mammals to acoustic stressors, each of these should be considered. For example, is the acoustic stressor in an area where animals engage in breeding activity? Are animals in the region resident and likely to have experience with the stressor (*i.e.*, repeated exposures)? Is the region a foraging ground or are the animals passing through as transients? What is the ratio of young (naïve) to old (experienced) animals in the population? It is unlikely that all such questions can be answered from empirical data; however, they should be addressed in any qualitative assessment of a potential stress response as based on the available literature.

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 is assumed that some contribution is made to the animal's allostatic load. Allostasis is the ability of an animal to maintain stability through change by adjusting its physiology in response to both predictable and unpredictable events (McEwen and Wingfield 2003). The same hormones associated with the stress response vary naturally throughout an animal's life, providing support for particular life history events (*e.g.*, pregnancy) and predictable environmental conditions (*e.g.*, seasonal changes). The allostatic load is the cumulative cost of allostasis incurred by an animal and is generally characterized with respect to an animal's energetic expenditure. Perturbations to an animal that may occur with the presence of a stressor, either biological (*e.g.*, predator) or anthropogenic (*e.g.*, construction), can contribute to the allostatic load (Wingfield 2003). Additional costs are cumulative and additions to the allostatic load over time may contribute to reductions in the probability of achieving ultimate life history functions (*e.g.*, survival, maturation, reproductive effort and success) by producing pathophysiological states. The contribution to the allostatic load from a stressor requires estimating the magnitude and duration of the stress response, as well as any secondary contributions that might result from a change in behavior.

If the acoustic source does not produce tissue effects, is not perceived by the animal, or does not produce a stress response by any other means, Figure 3.7-1 assumes that the exposure does not contribute to the allostatic load. Additionally, without a stress response or auditory masking, it is assumed that there can be no behavioral change. Conversely, any immediate effect of exposure that produces an injury (*i.e.*, red boxes on the flow chart in Figure 3.7-1) is assumed to also produce a stress response and contribute to the allostatic load.

3.7.3.1.8 Behavior

Acute stress responses may or may not cause a behavioral reaction. However, all changes in behavior are expected to result from an acute stress response. This expectation is based on the idea that some sort of physiological trigger must exist to change any behavior that is already being performed. 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 is thus considered a behavioral change.

Numerous behavioral changes can occur as a result of stress response, and Figure 3.7-1 shows only those that might be considered the most common types of response for a marine animal. For each potential behavioral change, the magnitude in the change and the severity of the response needs to be 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 allostatic load. This secondary potential is signified by the feedback from the collective behaviors to allostatic loading.

Special considerations are given to the potential for avoidance and disrupted diving patterns. Due to past incidents of beaked whale strandings associated with sonar operations, feedback paths are provided between avoidance and diving and indirect tissue effects. This feedback accounts for the hypothesis that variations in diving behavior and/or avoidance responses can possibly result in nitrogen tissue supersaturation and nitrogen off-gassing, possibly to the point of deleterious vascular bubble formation. Although hypothetical in nature, the potential process is currently popular and hotly debated.

3.7.3.1.9 Life Function

Life functions may either be considered proximate or ultimate. 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.

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.

3.7.3.1.10 Integration of Biological and Regulatory Frameworks

Regulatory Framework. The MMPA prohibits the unauthorized harassment of marine mammals, and provides the regulatory processes for authorization for any such harassment that might occur incidental to an otherwise lawful activity.

The model for estimating potential acoustic effects from MIRC ASW training activities on cetacean species makes use of the methodology that was developed in cooperation with NMFS for the Navy’s Draft *Overseas Environmental Impact Statement/Environmental Impact Statement, Undersea Warfare Training Range (OEIS/EIS)* (DoN 2005). Via response comment letter to Undersea Warfare Training Range (USWTR) received from NMFS dated January 30, 2006, NMFS concurred with the use of Energy Flux Density Level (EL) for the determination of physiological effects to marine mammals. Therefore, this methodology is used to estimate the annual exposure of marine mammals that may be considered Level A harassment as a result of permanent threshold shift in hearing or tissue injury or Level B harassment as a result of temporary, recoverable physiological effects.

In addition, the approach for estimating potential acoustic effects from MIRC training activities on marine mammal makes use of the comments received on previous NEPA documents. NMFS and other commenters recommended the use of an alternate methodology to evaluate when sound exposures might result in behavioral effects without corresponding physiological effects. As a result of these comments, this analysis uses a risk function approach to evaluate the potential for behavioral effects. The risk-function is further explained in subsection 3.7.3.1.5.

A number of Navy actions and NOAA rulings have helped to qualify possible events deemed as “harassment” under the MMPA. As stated previously, “harassment” under the MMPA includes both potential injury (Level A), and disruptions of natural behavioral patterns to a point where they are abandoned or significantly altered (Level B). NMFS also includes mortality as a possible outcome to consider in addition to Level A and Level B harassment. The acoustic effects analysis and exposure calculations are based on the following premises:

- Harassment that may result from Navy operations described in the MIRC EIS/OEIS is unintentional and incidental to those operations.
- The MIRC Letter of Authorization (LOA) request uses an unambiguous definition of injury as defined in the RIMPAC OEA (DoN 2006) and in previous rulings (NOAA 2001; 2002a): injury occurs when any biological tissue is destroyed or lost as a result of the action.
- Behavioral disruption might result in subsequent injury and injury may cause a subsequent behavioral disruption, so Level A and Level B harassment categories can overlap and are not necessarily mutually exclusive. However, consistent with prior ruling (NOAA 2001; 2006), the MIRC LOA request assumes that Level A and B do not overlap so as to preclude circular definitions of harassment.
- An individual animal predicted to experience simultaneous multiple injuries, multiple disruptions, or both, is counted as a single take (see NOAA 2001; 2006). NMFS has defined a 24-hour “refresh rate,” or amount of time in which an individual can be harassed no more than once. Behavioral harassment, under the risk function presented in the LOA request, uses maximum sound pressure level over a 24-hour period as the metric for determining the probability of harassment. The Navy has determined that, in a 24-hour period, all sonar operations in MIRC transmit for a subset of that time. Additional model assumptions account for ship movement, make adjustments for multiple ships, make adjustments for animal movement, and make adjustments for the presence of land shadows.
- The acoustic effects analysis is based on primary exposures only. Secondary, or indirect, effects, such as susceptibility to predation following injury and injury resulting from disrupted behavior or physiology, while possible, can only be reliably predicted in circumstances where the responses have been well documented. Consideration of secondary effects would result in much Level A harassment being considered Level B harassment, and vice versa, since much injury (Level A harassment) has the potential to disrupt behavior (Level B harassment), and much temporary physiological or behavioral disruption (Level B) could be conjectured to have the potential for injury (Level A). Consideration of secondary effects would lead to circular definitions of harassment.

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 under the MMPA. Effects that address behavioral disruption are considered Level B harassment under MMPA. The biological framework proposed here is structured according to potential physiological and behavioral effects resulting from sound exposure. The range of effects may then be assessed according to MMPA and ESA 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.

For example, ecology is not used as the basis of the framework because the ecology of an animal is dependent on the interaction of an animal with the environment. The animal's interaction with the environment is driven both by its physiological function and its behavior, and an ecological impact may not be observable over short periods of observation. However, ecological information is considered in the analysis of the effects of individual species.

A "physiological effect" is defined here as one in which the "normal" physiological function of the animal is altered in response to sound exposure. Physiological function is any of a collection of processes ranging from biochemical reactions to mechanical interaction and operation of organs and tissues within an animal. A physiological effect may range from the most significant of impacts (*i.e.*, mortality and serious injury) to lesser effects that would define the lower end of the physiological impact range, such as the noninjurious distortion of auditory tissues.

A "behavioral effect" is one in which the "normal" behavior or patterns of behavior of an animal are overtly disrupted in response to an acoustic exposure. Examples of behaviors of concern can be derived from the harassment definitions in the MMPA and the ESA.

In this EIS/OEIS the term "normal" is used to qualify distinctions between physiological and behavioral effects. Its use follows the convention of normal daily variation in physiological and behavioral function without the influence of anthropogenic acoustic sources. As a result, this EIS/OEIS uses the following definitions:

- A **physiological effect** is a variation in an animal's respiratory, endocrine, hormonal, circulatory, neurological, or reproductive activity and processes, beyond the animal's normal range of variability, in response to human activity or to an exposure to a stimulus such as active sonar.
- A **behavioral effect** is a variation in the pattern of an animal's breathing, feeding, resting, migratory, intraspecific behavior (such as reproduction, mating, territorial, rearing, and agonistic behavior), and interspecific behavior, beyond the animal's normal pattern of variability in response to human activity or to an exposure to a stimulus such as active sonar.

The definitions of physiological effect and behavioral effect used here are specific to this EIS/OEIS and should not be confused with more global definitions applied to the field of biology or to existing Federal law. It is reasonable to expect some physiological effects to result in subsequent behavioral effects. For example, a marine mammal that suffers a severe injury may be expected to alter diving or foraging to the degree that its variation in these behaviors is outside that which is considered normal for the species. If a physiological effect is accompanied by a behavioral effect, the overall effect is characterized as a physiological effect; physiological effects take precedence over behavioral effects with regard to their ordering. This approach provides the most conservative ordering of effects with respect to severity, provides a rational approach to dealing with the overlap of the definitions, and avoids circular arguments.

The severity of physiological effects generally decreases with decreasing sound exposure and/or increasing distance from the exposure source. The same generalization does not consistently hold for behavioral effects because they do not depend solely on the received sound level. Behavioral responses also depend on an animal's learned responses, innate response tendencies, motivational state, the pattern of the sound exposure, and the context in which the sound is presented (Southall *et al.* 2007). However, to provide a tractable approach to predicting acoustic effects that is relevant to the regulatory terms of behavioral disruption, it is assumed here that the severities of behavioral effects also decrease with decreasing sound exposure and/or increasing distance from the sound source. Figure 3.7-2 shows the relationship between severity of effects, source distance, and exposure level, as defined in this EIS/OEIS.

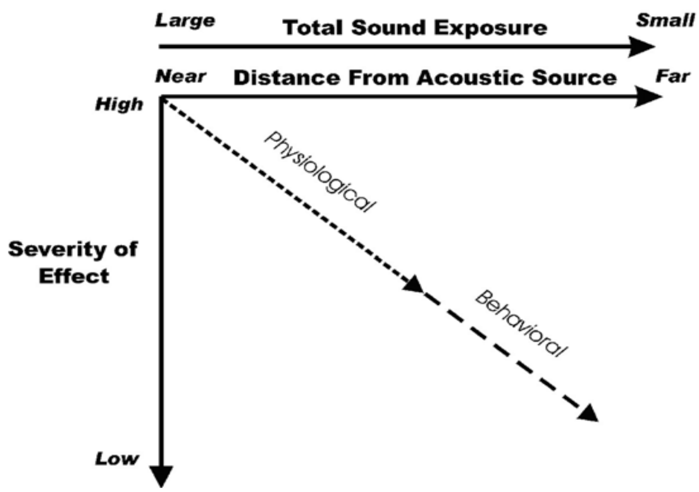


Figure 3.7-2: Relationship between Severity of Effects, Source Distance, and Exposure Level

MMPA Level A and Level B Harassment. Categorizing potential effects as either physiological or behavioral effects allows them to be related to the harassment definitions. For military readiness activities, 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, as defined in this EIS/OEIS and previous rulings (NOAA 2001; 2002a), is 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. For example, increased localized histamine production, edema, production of scar tissue, activation of clotting factors, white blood cell response, etc., may be expected following injury. Therefore, this EIS/OEIS and the corresponding LOA request assumes that all injury is qualified as a physiological effect and, to be consistent with prior actions and rulings (NOAA 2001), all injuries (slight to severe) are considered Level A harassment.

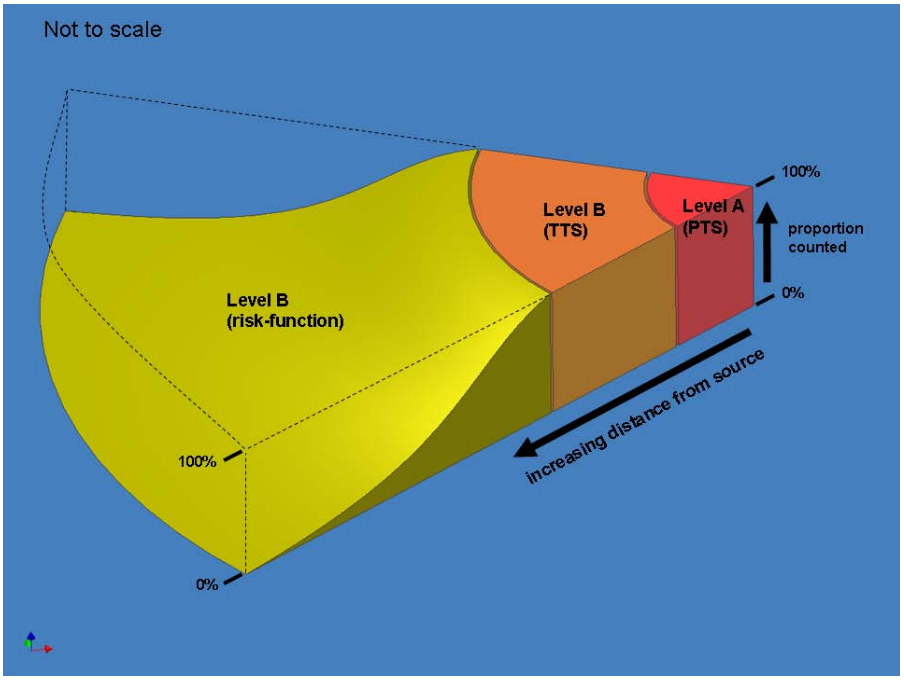
Public Law 108-136 (2004) amended the MMPA definitions of Level B harassment for military readiness activities, which applies to this action. For military readiness activities, Level B harassment is defined as "any act that disturbs or is likely to disturb a marine mammal or marine mammal stock by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behaviors are abandoned or significantly altered." Unlike Level A harassment, which is solely associated with physiological effects, both physiological and behavioral effects may cause Level B harassment.

For example, some physiological effects can occur that are noninjurious but that can potentially disrupt the behavior of a marine mammal. These include temporary distortions in sensory tissue that alter physiological function, but that are fully recoverable without the requirement for tissue replacement or regeneration. For example, an animal that experiences a temporary reduction in hearing sensitivity will not suffer injury to its auditory system, but may not perceive some sounds due to the reduction in sensitivity. As a result, the animal may not respond to sounds that would normally produce a behavioral reaction. This lack of response qualifies as a temporary disruption of normal behavioral patterns – the animal is impeded from responding in a normal manner to an acoustic stimulus.

The harassment status of slight behavior disruption has been addressed in workshops, previous actions, and rulings (NOAA 2001; DoN 2001a). The conclusion is that a momentary behavioral reaction of an animal to a brief, time-isolated acoustic event does not qualify as Level B harassment. A more general conclusion, that Level B harassment occurs only when there is "a potential for a significant behavioral change or response in a biologically important behavior or activity," is found in recent rulings (NOAA 2002a).

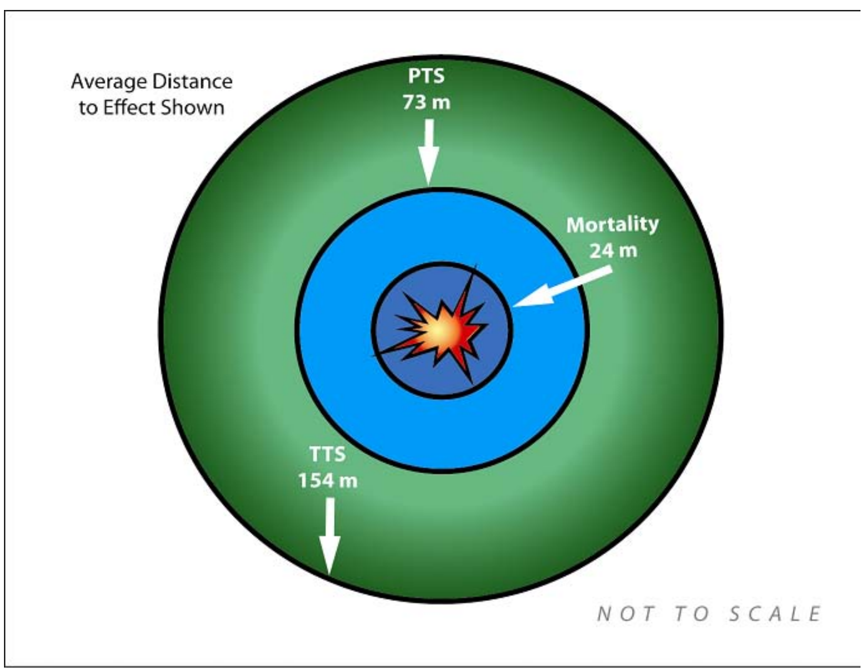
Although the temporary lack of response discussed above may not result in abandonment or significant alteration of natural behavioral patterns, the acoustic effect inputs used in the acoustic model assume that temporary hearing impairment (slight to severe) is considered Level B harassment. Although modes of action are appropriately considered, as outlined in Figure 3.7-1, the conservative assumption used here is to consider all hearing impairment as harassment. As a result, the actual incidental harassment of marine mammals associated with this action may be less than predicted via the analytical framework.

MMPA Exposure Zones. Two acoustic modeling approaches are used to account for both physiological and behavioral effects to marine mammals. This subsection of harassment zones is specific to the modeling of total energy (EL) for the onset of TTS (part of Level B harassment) and sound pressure level for behavioral responses (part of Level B harassment). When using a threshold of accumulated energy (EL) the volumes of ocean in which Level A and Level B harassment from TTS are predicted to occur are described as exposure zones. As a conservative estimate, all marine mammals predicted to be in a zone are considered exposed to accumulated sound levels that may result in harassment within the applicable Level A or Level B harassment categories. Figure 3.7-3 shows exposure zones extending from a hypothetical, directional active sonar sound source, and is not to scale. The exposure zones presented in Figure 3.7-3 that represents the estimated Level B harassment using the risk function is approximately 98 percent of all Level B harassments (2 percent associated with TTS).



This figure is for illustrative purposes only and does not represent the sizes or shapes of the actual exposure zones.

Figure 3.7-3: Exposure Zones Extending from a Hypothetical, Directional Sound Source



This figure is for illustrative purposes only and does not represent the sizes or shapes of the actual harassment zones.

Figure 3.7-4: Exposure Zones Extending from a Hypothetical, Omni-directional Sound Source

The **Level A exposure zone** extends from the 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 exposure zone. Use of the threshold associated with the onset of slight injury as the most distant point and least injurious exposure takes into account all more serious injuries by inclusion within the Level A harassment zone. The threshold used to define the outer limit of the Level A exposure zone is given as the onset PTS in Figure 3.7-3.

The **Level B exposure zone** begins just beyond the point of slightest injury and extends outward from that point to include all animals that may possibly experience Level B harassment (behavioral harassment and TTS). Approximately 98 percent of the estimated harassments are risk function. 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 (such as occurs with inner ear hair cells subjected to temporary threshold shift). The animals predicted to be in this zone are assumed to experience Level B harassment from TTS by virtue of temporary impairment of sensory function (altered physiological function) that can disrupt behavior. The criterion and threshold used to define the outer limit of the Level B exposure zone for the on-set of certain physiological effects are given in Figure 3.7-3.

Auditory Tissues as Indicators of Physiological Effects. Exposure to continuous-type sound may cause a variety of physiological effects in mammals. For example, exposure to very high sound levels may affect the function of the visual system, vestibular system, and internal organs (Ward 1997). Exposure to high-intensity, continuous- type sounds of sufficient duration may cause injury to the lungs and intestines (*e.g.*, Dalecki *et al.* 2002). Sudden, intense sounds may elicit a “startle” response and may be followed by an orienting reflex (Ward 1997; Jansen 1998). The primary physiological effects of sound however, are on the auditory system (Ward 1997).

The mammalian auditory system consists of the outer ear, middle ear, inner ear, and central nervous system. Sound waves are transmitted through the middle ears to fluids within the inner ear. The inner ear contains delicate electromechanical hair cells that convert the fluid motions into neural impulses that are sent to the brain. The hair cells within the inner ear are the most vulnerable to over-stimulation by sound exposure (Yost 1994).

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 permanent, in which case it is called a PTS, or temporary, in which case it is called a TTS. Still lower levels of sound may result in auditory masking, which may interfere with an animal’s ability to hear other concurrent sounds.

The tissues of the ear appear to be the most susceptible to the physiological effects of sound and TSs occur at lower exposures than other more serious auditory effects, therefore, PTS and TTS are used here as the biological indicators of physiological effects. TTS is the first indication of physiological noninjurious change and is not physical injury. Therefore, this section focused on TSs, including PTSs and TTSs. Masking (without a resulting TS) is not associated with abnormal physiological function, therefore, it is not considered a physiological effect in the LOA request, but rather a potential behavioral effect.

Noise-Induced Threshold Shifts. The amount of TS depends on the amplitude, duration, frequency, and temporal pattern of the sound exposure. Threshold shifts will generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy will lead to approximately equal effects (Ward 1997). For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (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 eventually 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 post-exposure, it is common to use a subscript to indicate the time in minutes after exposure (Quaranta *et al.* 1998). For example, TTS_2 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 3.7-5 shows two hypothetical TSs, one that completely recovers, a TTS, and one that does not completely recover, leaving some PTS.

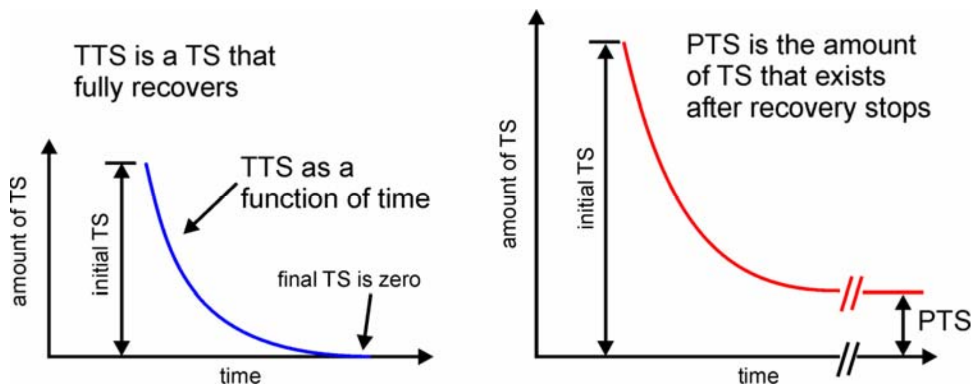


Figure 3.7-5: Hypothetical Temporary and Permanent Threshold Shifts

PTS, TTS, and Harassment Zones. PTS is nonrecoverable 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 MMPA. 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.

TTS is recoverable and, as in recent rulings (NOAA 2001, 2002a), is considered to result from the temporary, noninjurious distortion of hearing-related tissues. Because it is considered noninjurious (there is no tissue damage), 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, in the MIRC, TTS is considered as a Level B harassment resulting from physiological effects on the auditory system.

3.7.3.1.11 Criteria and Thresholds for Explosive Source Effects

The criterion for mortality for marine mammals from explosive sources used in the CHURCHILL FEIS (DoN 2001) is “onset of severe lung injury.” This is conservative in that it corresponds to a one 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 in a complex way, the actual impulse value corresponding to the 31-psi-ms index is a complicated calculation. Again, to be conservative, the CHURCHILL FEIS used the mass of a calf dolphin (at 27 lb [12.2 kg]), so that the threshold index is 30.5 psi-ms (Table 3.7-4).

The dual 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 3.7-5 and Table 3.7-6).

- 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 2001a). 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 for cetaceans, as sound energy is transferred via the cetacean mandible to the middle ear, bypassing the TM (Pickles 1998). The TM rupture threshold, however, 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 PTS at the same threshold).

Table 3.7-5: Effects Analysis Criteria for Underwater Detonations for Explosives < 2000 lb (909 kg) Net Explosive Weight

	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
Mortality & Injury	**Slight Injury** **Onset of slight lung hemorrhage**	**Shock Wave** Goertner modified positive impulse	**13.0 psi-msec**	All marine mammals (dolphin calf)	Goertner 1982
Mortality & Injury	**Slight Injury** **50% TM Rupture**	**Shock Wave** Energy Flux Density (EFD)	**205 dB re:1μPa^2-sec**	All marine mammals	DoN 2001
Harassment	**Temporary Auditory Effects** **TTS**	**Noise Exposure** greatest EFD in any 1/3-octave band *over all exposures*	**182 dB re:1μPa^2-sec**	For odontocetes greatest EFD for frequencies >100 Hz and for mysticetes ≥10 Hz	NMFS 2005, NMFS 2006
Harassment	**Temporary Auditory Effects** **TTS**	**Noise Exposure** Peak Pressure for *any single exposure*	**23 psi**	All marine mammals	DoN 2001
	Behavioral Modification	**Noise Exposure** greatest EFD in any 1/3-octave band *over multiple exposures*	**177 dB re:1μPa^2-sec**	For odontocetes greatest EFD for frequencies >100 Hz and for mysticetes ≥10 Hz	NMFS

Based on CHURCHILL FEIS (DoN 2001) and Eglin Air Force Base IHA (NMFS 2005h) and LOA (NMFS 2006b)

Notes:

Goertner, J.F. 1982. Prediction 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. 2001. USS Churchill Shock Trail FEIS- February 2001. Department of the Navy.

NMFS. 2005. Notice of Issuance of an Incidental Harassment Authorization, Incidental to Conducting the Precisions Strike Weapon (PSW) Testing and Training by Eglin Air Force Base in the Gulf of Mexico. Federal Register,70(160):48675-48691.

NMFS. 2006. Incidental Takes of Marine Mammals Incidental to Specified Activities; Naval Explosive Ordnance Disposal School Training Operations at Eglin Air Force Base, Florida, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Federal Register 71(199):60693-60697

NMFS. Briefed to NMFS for VAST-IMPASS; U.S. Air Force uses 176 dB for permit applications at Eglin Gulf Test and Training Range (EGTTR)

Three criteria are considered for noninjurious harassment temporary threshold shift (TTS), which is a temporary, recoverable, loss of hearing sensitivity (NMFS 2001; DoN 2001a).

- The first criterion for TTS is 182 dB re 1 μPa^2-s maximum EL level in any 1/3-octave band at frequencies >100 hertz (Hz) for odontocetes and >10 Hz for mysticetes.
- A second criterion for estimating TTS threshold has also been developed. A threshold of 12 pounds per square inch (psi) peak pressure was developed for 10,000-lb (4,545 kg) charges as part of the CHURCHILL FEIS (DoN 2001a, [FR 70/160, 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 psi criterion for explosive charges less than 2,000 lb (909 kg) and the 12 psi criterion for explosive charges larger than 2,000 lb (909 kg). This is below the level of onset of TTS for an odontocete (Finneran *et al.* 2002). All explosives modeled for the MIRC EIS/OEIS are less than 1,500 lb (682 kg).
- The third criterion is used for estimation of behavioral disturbance before TTS (behavioral harassment) for cases with multiple successive explosions. The result of exposure at 177 dB re 1 μPa2-s (EL) is behavioral harassment: behavioral effects significant enough to be judged as harassment, but occurring at lower sound energy levels than those that may cause TTS.

Harassment Threshold for Multiple Successive Explosions (MSE). There may be rare occasions when MSE are part of a static location event such as during MINEX, MISSILEX, BOMBEX, SINKEX, GUNEX, and NSFS (when using other than inert weapons). For these events, the CHURCHILL FEIS approach was extended to cover MSE 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 the CHURCHILL FEIS. For positive impulse, it is consistent with the CHURCHILL FEIS to use the maximum value over all impulses received.

For MSE, the acoustic criterion for 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. Behavioral harassment is derived following the approach of the CHURCHILL 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 μPa^2-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. Determination of behavioral harassment is therefore derived by subtracting five 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) behavioral disturbance threshold for MSE.

Preliminary modeling undertaken for other Navy compliance documents considers behavioral harassment to result from exposure to 177 dB; this approach has demonstrated that for events involving MSE using small (NEW) explosives (MINEX, GUNEX, NSFS, and underwater detonations [UNDET]), the footprint of the threshold for explosives onset TTS criteria based on the 23 psi pressure component dominates and supersedes any exposures at a received level involving the 177 dB EL threshold. Restated in another manner, modeling for behavioral harassment should not result in any estimated impacts that are not already quantified under the larger footprint of the 23 psi criteria for small MSE. Given that modeling for behavioral harassment should not, therefore, result in any additional harassment takes for MINEX, GUNEX, NSFS, and underwater detonations (UNDET), analysis of potential for behavioral disturbance using the behavioral harassment criteria was not undertaken for these events (MINEX, GUNEX, NSFS, and UNDET).

For the remainder of the MSE events (BOMBEX, SINKEX, and MISSILEX) where the behavioral harassment exposures may need to be considered, these potential behavioral disturbances were estimated by extrapolation from the acoustic modeling results for the explosives TTS threshold (182 dB re 1 mPa^2-s in any 1/3 octave band). In the absence of modeling, to account for the 5 dB lower behavioral harassment threshold, a factor of 3.17 was applied to the TTS modeled numbers in order to extrapolate the number of behavioral harassment exposures estimated for MSE events. This multiplication factor is used to calculate the increased area represented by the difference between the 177 dB behavioral harassment threshold and the modeled 182 dB threshold. The factor is based on the increased range 5 dB would propagate (assuming spherical spreading), where the range increases by approximately 1.78 times, resulting in a circular area increase of approximately 3.17 times that of the modeled results at 182 dB.

Potential overlap of exposures from multiple explosive events within a 24-hour period was not taken into consideration in the modeling resulting in the potential for some double counting of exposures. However, because an animal would generally move away from the area following the first explosion, the overlap is likely to be minimal.

It should be emphasized that there is a lead time for set up and clearance of any area before an event using explosives takes place (this may be 30 minutes to several hours). There will, therefore, be a long period of area monitoring before any detonation or live-fire event begins. Ordnance cannot be released until the target area is determined clear. Many events, such as GUNEX, may involve only inert rounds. In addition, live rounds are generally expended and immediately halted if sea turtles are observed within the target area. Training is delayed until the animal clears the target area. These mitigation factors to determine if the area is clear, serve to minimize the risk of harming sea turtles and marine mammals.

3.7.3.1.12 Criteria and Thresholds for Physiological Effects (Sensory Impairment)

This section presents the effects criteria and thresholds for physiological effects of sound leading to injury and behavioral disturbance as a result of sensory impairment. The tissues of the ear are the most susceptible to physiological effects of underwater sound. PTS and TTS were determined to be the most appropriate biological indicators of physiological effects that equate to the onset of injury (Level A harassment) and behavioral disturbance (Level B harassment as a result of physiological effects), respectively. Therefore, this section is focused on criteria and thresholds to predict PTS and TTS in marine mammals as described above.

Marine mammal ears are functionally and structurally similar to terrestrial mammal ears; however, there are important differences (Ketten 1998). The most appropriate information from which to develop PTS/TTS criteria for marine mammals would be experimental measurements 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. Because of the ethical issues presented, PTS data do not exist for marine mammals and are unlikely to be obtained. Therefore, PTS criteria must be extrapolated using TTS criteria and estimates of the relationship between TTS and PTS.

This section begins with a review of the existing marine mammal TTS data. The review is followed by a discussion of the relationship between TTS and PTS. The specific criteria and thresholds for TTS and PTS used in this EIS/OEIS are then presented. This is followed by discussions of sound energy flux density level (EL), the relationship between EL and sound pressure level (SPL), and the use of SPL and EL in previous environmental compliance documents.

> **Energy Flux Density Level and Sound Pressure Level**
>
> Energy Flux Density Level (EL) is a measure of the sound energy flow per unit area expressed in dB. EL is stated in dB re 1 µPa^2-s for underwater sound and dB re 20 µPa^2-s for airborne sound.
>
> Sound Pressure Level (SPL) is 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 20 µPa for airborne sound.

TTS in Marine Mammals. A number of investigators have 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 (for example, Schlundt *et al.* 2000). The existing cetacean TTS data are summarized in the following bullets.

- Schlundt *et al.* (2000) reported the results of TTS experiments conducted with bottlenose dolphins and white whales exposed to 1-second tones. This paper also includes a reanalysis of preliminary TTS data released in a technical report by Ridgway *et al.* (1997). At frequencies of 3, 10, and 20 kHz, SPLs necessary to induce measurable amounts (6 dB or more) of TTS were between 192 and 201 dB re 1 µPa (EL = 192 to 201 dB re 1 µPa^2-s). The mean exposure SPL and EL for onset-TTS were 195 dB re 1 µPa and 195 dB re 1 µPa^2-s, respectively. The sound exposure stimuli (tones) and relatively large number of test subjects (five dolphins and two white whales) make the Schlundt *et al.* (2000) data the most directly relevant TTS information for the scenarios described in the MIRC EIS/OEIS.

- Finneran *et al.* (2001, 2003, 2005, 2007) described TTS experiments conducted with bottlenose dolphins exposed to 3-kHz tones with durations of 1, 2, 4, and 8 seconds. Small amounts of TTS (3 to 6 dB) were observed in one dolphin after exposure to ELs between 190 and 204 dB re 1 µPa^2-s. These results were consistent with the data of Schlundt *et al.* (2000) and showed that the Schlundt *et al.* (2000) data were not significantly affected by the masking sound used. These results also confirmed that, for tones with different durations, the amount of TTS is best correlated with the exposure EL rather than the exposure SPL.

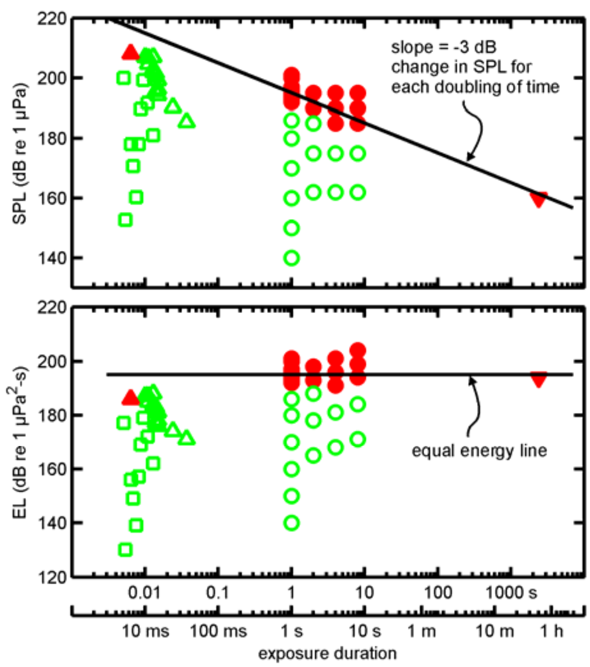
- Nachtigall *et al.* (2003) measured TTS in a bottlenose dolphin exposed to octave-band sound centered at 7.5 kHz. Nachtigall *et al.* (2003a) reported TTSs of about 11 dB measured 10 to 15 minutes after exposure to 30 to 50 minutes of sound with SPL 179 dB re 1 µPa (EL about 213 dB re µPa^2-s). No TTS was observed after exposure to the same sound at 165 and 171 dB re 1 µPa. Nachtigall *et al.* (2003b) reported TTSs of around 4 to 8 dB 5 minutes after exposure to 30 to 50 minutes of sound with SPL 160 dB re 1 µPa (EL about 193 to 195 dB re 1 µPa^2-s). The difference in results was attributed to faster post-exposure threshold measurement—TTS may have recovered before being detected by Nachtigall *et al.* (2003a). These studies showed that, for long-duration exposures, lower sound pressures are required to induce TTS than are required for short-duration tones. These data also confirmed that, for the cetaceans studied, EL is the most appropriate predictor for onset-TTS.

- Finneran *et al.* (2000, 2002) conducted TTS experiments with dolphins and white whales exposed to impulsive sounds similar to those produced by distant underwater explosions and seismic water guns. These studies showed that, for very short-duration impulsive sounds, higher sound pressures were required to induce TTS than for longer-duration tones.

Figure 3.7-6 shows the existing TTS data for cetaceans (dolphins and white whales). Individual exposures are shown in terms of SPL versus exposure duration (upper panel) and EL versus exposure duration (lower panel). Exposures that produced TTS are shown as filled symbols. Exposures that did not produce TTS are represented by open symbols. The squares and triangles represent impulsive test results from Finneran *et al.* 2000 and 2002, respectively. The circles show the 3-, 10-, and 20-kHz data from Schlundt *et al.* (2000) and the results of Finneran *et al.* (2003). The inverted triangle represents data from Nachtigall *et al.* (2003b).

Figure 3.7-6 illustrates that the effects of the different sound exposures depend on the SPL and duration. As the duration decreases, higher SPLs are required to cause TTS. In contrast, the ELs required for TTS do not show the same type of variation with exposure duration.

The solid line in the upper panel of Figure 3.7-6 has a slope of -3 dB per doubling of time. This line passes through the point where the SPL is 195 dB re 1 µPa and the exposure duration is 1 second. Since EL = SPL + 10 log10 (duration), doubling the duration *increases* the EL by 3 dB. Subtracting 3 dB from the SPL *decreases* the EL by 3 dB. The line with a slope of -3 dB per doubling of time, therefore, represents an *equal energy line* – all points on the line have the same EL, which is, in this case, 195 dB re 1 µPa^2-s. This line appears in the lower panel as a horizontal line at 195 dB re 1 µPa^2-s. The equal energy line at 195 dB re 1 µPa^2-s fits the tonal and sound data (the nonimpulsive data) very well, despite differences in exposure duration, SPL, experimental methods, and subjects.



Legend: Filled symbol: Exposure that produced TTS, Open symbol: Exposure that did not produce TTS

Squares: Impulsive test results from Finneran *et al.* 2000, Triangles: Impulsive test results from Finneran *et al.* 2002, Circles: 3, 10, and 20-kHz data from Schlundt *et al.* (2000) and results of Finneran *et al.* (2003), and Inverted triangle: Data from Nachtigall *et al.* 2003b.

Figure 3.7-6: Existing TTS Data for Cetaceans

In summary, the existing cetacean TTS data show that, for the species studied and sounds (non impulsive) of interest, the following is true:

- **The growth and recovery of TTS are likely analogous to those in land mammals (Southall, et al. 2007).** This means that, as in land mammals, cetacean TSs depend on the amplitude, duration, frequency content, and temporal pattern of the sound exposure. Threshold shifts will generally increase with the amplitude and duration of sound exposure. For continuous sounds, exposures of equal energy will lead to approximately equal effects (Ward 1997). For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur between exposures) (Kryter *et al.* 1965; Ward 1997).
- **SPL by itself is not a good predictor of onset-TTS**, since the amount of TTS depends on both SPL and duration.
- **Exposure EL is correlated with the amount of TTS** and is a good predictor for onset-TTS for single, continuous exposures with different durations. This agrees with human TTS data presented by Ward *et al.* (1958, 1959).
- An energy flux density level of 195 dB re 1 μPa^2-s is the most appropriate predictor for onset-TTS from a single, continuous exposure.

Relationship between TTS and PTS. Since marine mammal PTS data do not exist, onset-PTS levels for these animals must be estimated using TTS data and relationships between TTS and PTS. Much of the early human TTS work was directed towards relating TTS_2 after 8 hours of sound exposure to the amount of PTS that would exist after years of similar daily exposures (*e.g.*, Kryter *et al.* 1966). Although it is now acknowledged that susceptibility to PTS cannot be reliably predicted from TTS measurements, TTS data do provide insight into the amount of TS that may be induced without a PTS. Experimental studies of the growth of TTS may also be used to relate changes in exposure level to changes in the amount of TTS induced. Onset-PTS exposure levels may therefore be predicted by:

- Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.
- Estimating the additional exposure, above the onset-TTS exposure, necessary to reach the maximum allowable amount of TTS that, again, may be induced without PTS. This is equivalent to estimating the growth rate of TTS – how much additional TTS is produced by an increase in exposure level.

Experimentally induced TTSs in marine mammals have generally been limited to around 2 to 10 dB, well below TSs that result in some PTS. Experiments with terrestrial mammals have used much larger TSs and provide more guidance on how high a TS may rise before some PTS results. Early human TTS studies reported complete recovery of TTSs as high as 50 dB after exposure to broadband sound (Ward 1960; Ward *et al.* 1958, 1959). Ward *et al.* (1959) also reported slower recovery times when TTS_2 approached and exceeded 50 dB, suggesting that 50 dB of TTS_2 may represent a "critical" TTS. Miller *et al.* (1963) found PTS in cats after exposures that were only slightly longer in duration than those causing 40 dB of TTS. Kryter *et al.* (1966) stated: "A TTS_2 that approaches or exceeds 40 dB can be taken as a signal that danger to hearing is imminent." These data indicate that TSs up to 40 to 50 dB may be induced without PTS, and that 40 dB is a reasonable upper limit for TS to prevent PTS.

The small amounts of TTS produced in marine mammal studies also limit the applicability of these data to estimates of the growth rate of TTS. Fortunately, data do exist for the growth of TTS in terrestrial mammals. For moderate exposure durations (a few minutes to hours), TTS_2 varies with the logarithm of exposure time (Ward *et al.* 1958, 1959; Quaranta *et al.* 1998). For shorter exposure durations the growth of TTS with exposure time appears to be less rapid (Miller 1974; Keeler 1976). For very long-duration exposures, increasing the exposure time may fail to produce any additional TTS, a condition known as asymptotic threshold shift (Saunders *et al.* 1977; Mills *et al.* 1979).

Ward *et al.* (1958, 1959) provided detailed information on the growth of TTS in humans. Ward *et al.* presented the amount of TTS measured after exposure to specific SPLs and durations of broadband sound. Since the relationship between EL, SPL, and duration is known, these same data could be presented in terms of the amount of TTS produced by exposures with different ELs.

Figure 3.7-7 shows results from Ward *et al.* (1958, 1959) plotted as the amount of TTS_2 versus the exposure EL. The data in Figure 3.7-7(a) are from broadband (75 Hz to 10 kHz) sound exposures with durations of 12 to 102 minutes (Ward *et al.* 1958). The symbols represent mean TTS_2 for 13 individuals exposed to continuous sound. The solid line is a linear regression fit to all but the two data points at the lowest exposure EL. The experimental data are fit well by the regression line (R^2 = 0.95). These data are important for two reasons: (1) they confirm that the amount of TTS is correlated with the exposure EL; and (2) the slope of the line allows one to estimate the additional amount of TTS produced by an increase in exposure. For example, the slope of the line in Figure 3.7-7(a) is approximately 1.5 dB TTS_2 per dB of EL. This means that each additional dB of EL produces 1.5 dB of additional TTS_2.

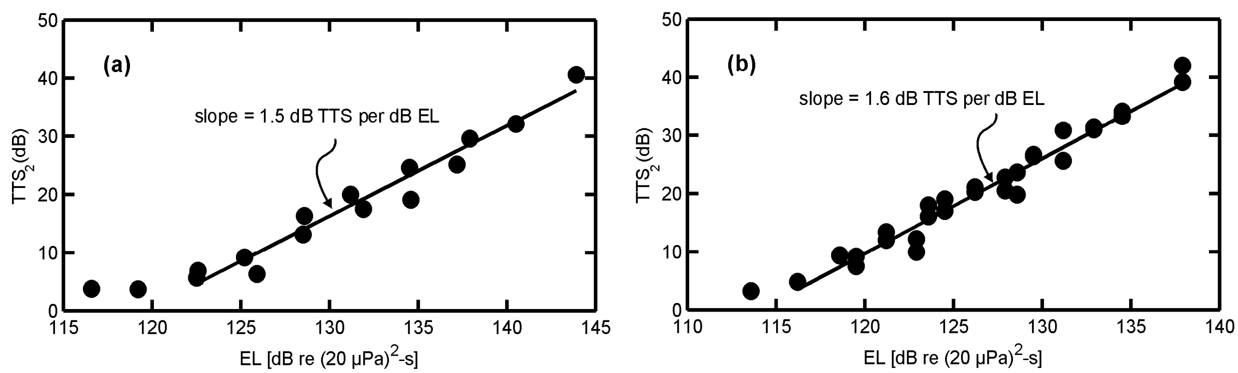


Figure 3.7-7: Growth of TTS versus the Exposure EL (from Ward *et al.* [1958, 1959])

The data in Figure 3.7-7(b) are from octave-band sound exposures (2.4 to 4.8 kHz) with durations of 12 to 102 minutes (Ward *et al.* 1959). The symbols represent mean TTS for 13 individuals exposed to continuous sound. The linear regression was fit to all but the two data points at the lowest exposure EL. The results are similar to those shown in Figure 3.7-6(a). The slope of the regression line fit to the mean TTS data was 1.6 dB TTS_2/dB EL. A similar procedure was carried out for the remaining data from Ward *et al.* (1959), with comparable results. Regression lines fit to the TTS versus EL data had slopes ranging from 0.76 to 1.6 dB TTS_2/dB EL, depending on the frequencies of the sound exposure and hearing test.

An estimate of 1.6 dB TTS_2 per dB increase in exposure EL is the upper range of values from Ward *et al.* (1958, 1959) and gives the most conservative estimate – it predicts a larger amount of TTS from the same exposure compared to the lines with smaller slopes. The difference between onset-TTS (6 dB) and the upper limit of TTS before PTS (40 dB) is 34 dB. To move from onset-TTS to onset-PTS, therefore, requires an increase in EL of 34 dB divided by 1.6 dB/dB, or approximately 21 dB. An estimate of 20 dB between exposures sufficient to cause onset-TTS and those capable of causing onset-PTS is a reasonable approximation. To summarize:

- In the absence of marine mammal PTS data, onset-PTS exposure levels may be estimated from marine mammal TTS data and PTS/TTS relationships observed in terrestrial mammals. This involves:
  - Estimating the largest amount of TTS that may be induced without PTS. Exposures causing a TS greater than this value are assumed to cause PTS.
  - Estimating the growth rate of TTS – how much additional TTS is produced by an increase in exposure level.
- A variety of terrestrial mammal data sources point toward 40 dB as a reasonable estimate of the largest amount of TS that may be induced without PTS. A conservative is that continuous-type exposures producing TSs of 40 dB or more always result in some amount of PTS.
- Data from Ward *et al.* (1958, 1959) reveal a linear relationship between TTS_2 and exposure EL. A value of 1.6 dB TTS_2 per dB increase in EL is a conservative estimate of how much additional TTS is produced by an increase in exposure level for continuous- type sounds.
- There is a 34 dB TS difference between onset-TTS (6 dB) and onset-PTS (40 dB). The additional exposure above onset-TTS that is required to reach PTS is therefore 34 dB divided by 1.6 dB/dB, or approximately 21 dB.
- Exposures with ELs 20 dB above those producing TTS may be assumed to produce a PTS. This number is used as a conservative simplification of the 21 dB number derived above.

Threshold Levels for Harassment from Physiological Effects. For this specified action, sound exposure thresholds for TTS and PTS are as presented as follows:

195 dB re 1 µPa^2-s received EL for TTS

215 dB re 1 µPa^2-s received EL for PTS

Marine mammals predicted to receive a sound exposure with EL of 215 dB re 1 µPa^2-s or greater are assumed to experience PTS and are counted as Level A harassment. Marine mammals predicted to receive a sound exposure with EL greater than or equal to 195 dB re 1 µPa^2-s but less than 215 dB re 1 µPa^2-s are assumed to experience TTS and are counted as Level B harassment from TTS.

Derivation of Effect Threshold. 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 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 cetaceans 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.

The PTS threshold is 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).

Use of EL for Physiological Effects Thresholds. Effect thresholds are expressed in terms of total received EL. Energy flux density is a measure of the flow of sound energy through an area. Marine and terrestrial mammal data show that, for continuous-type sounds of interest, TTS and PTS are more closely related to the energy in the sound exposure than to the exposure SPL.

The EL for each individual ping is calculated from the following equation:

$$\mathbf{EL = SPL + 10\ \textit{log}\ 10(duration)}$$

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 energy flux density in each individual ping is summed to calculate the total EL. Since mammalian 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 – intermittent exposures are considered comparable to 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.

Comparison to Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active Risk Functions. The physiological effect thresholds described in this EIS/OEIS should not be confused with criteria and thresholds used for the Navy's SURTASS LFA sonar. SURTASS LFA features pings lasting many tens of seconds. SURTASS LFA risk functions were expressed in terms of the received "single ping equivalent" SPL. Physiological effect thresholds described in this EIS/OEIS are expressed in terms of the total received EL. The SURTASS LFA risk function parameters cannot be directly compared to the effect thresholds used in the MIRC EIS/OEIS. Comparisons must take into account the differences in ping duration, number of pings received, and method of accumulating effects over multiple pings.

Previous Use of EL for Physiological Effects. Energy measures have been used as a part of dual criteria for cetacean auditory effects in shock trials, which only involve impulsive-type sounds (DoN 1997, 2001a). These actions used 192 dB re 1 μPa^2-s as a reference point to derive a TTS threshold in terms of EL. A second TTS threshold, based on peak pressure, was also used. If either threshold was exceeded, effect was assumed.

The 192 dB re 1 µPa^2-s reference point differs from the threshold of 195 dB re 1 µPa^2-s used in this EIS/OEIS. The 192 dB re 1 µPa^2-s value was based on the minimum observed by Ridgway *et al.* (1997) and Schlundt *et al.* (2000) during TTS measurements with bottlenose dolphins exposed to 1-second tones. At the time, no impulsive test data for marine mammals were available and the 1-second tonal data were considered to be the best available. The minimum value of the observed range of 192 to 201 dB re 1 µPa^2-s was used to protect against misinterpretation of the sparse data set available. The 192 dB re 1 µPa^2-s value was reduced to 182 dB re 1 µPa^2-s to accommodate the potential effects of pressure peaks in impulsive waveforms.

The additional data now available for onset of TTS in small cetaceans confirm the original range of values and increase confidence in it (Finneran *et al.* 2001, 2003; Nachtigall *et al.* 2003a, 2003b). The MIRC EIS/OEIS, therefore, uses the more complete data available and the mean value of the entire Schlundt *et al.* (2000) data set (195 dB re 1 µPa^2-s), instead of the minimum of 192 dB re 1 µPa^2-s. From the standpoint of statistical sampling and prediction theory, the mean is the most appropriate predictor—the "best unbiased estimator"—of the EL at which onset of TTS should occur; predicting the number of exposures in future actions relies (in part) on using the EL at which onset of TTS will most likely occur. When that EL is applied over many pings in each of many sonar exercises, that value will provide the most accurate prediction of the actual number of exposures by onset of TTS over all of those exercises. Use of the minimum value would overestimate the number of exposures because many animals counted would not have experienced onset of TTS. Further, there is no logical limiting minimum value of the distribution that would be obtained from continued successive testing. Continued testing and use of the minimum would produce more erroneous estimates.

3.7.3.1.13 Criteria and Thresholds for Behavioral Effects

This section presents the effect criterion and threshold for behavioral effects of sound leading to behavioral disturbance without accompanying physiological effects. Since TTS is used as the biological indicator for a physiological effect leading to behavioral disturbance, the behavioral effects discussed in this section may be thought of as behavioral disturbance occurring at exposure levels below those causing TTS.

A large body of research on human response to airborne sound exists, but results from those studies are not readily extendable to the development of effect criteria and thresholds for marine mammals. For example, "annoyance" is one of several criteria used to define impact to humans from exposure to industrial sound sources. Comparable criteria cannot be developed for marine mammals because there is no acceptable method for determining whether a nonverbal animal is annoyed. Further, differences in hearing thresholds, dynamic range of the ear, and the typical exposure patterns of interest (*e.g.*, human data tend to focus on 8-hour-long exposures) make extrapolation of human sound exposure standards inappropriate.

Behavioral observations of marine mammals exposed to anthropogenic sound sources exist, however, there are few observations and no controlled measurements of behavioral disruption of cetaceans caused by sound sources with frequencies, waveforms, durations, and repetition rates comparable to those employed by the tactical sonars to be used in the MIRC. At the present time there is no consensus on how to account for behavioral effects on marine mammals exposed to continuous-type sounds (NRC 2003). Response can range from avoidance of the sound source, changes in vocalizations rates, duration or intensity, changes in foraging behavior, swim speed or even investigation of the sound source (see review by Richardson *et al.* 1995; Croll *et al.* 2001; Nowacek *et al.* 2007)

This analysis uses behavioral observations from three studies of trained or wild cetaceans exposed to underwater sound. The first study was conducted under controlled circumstances with odontocetes in the laboratory (Schlundt et al. 2000; Finneran and Schlundt 2004). The second study exposed mysticetes in the wild to known sound sources (Nowacek *et al*. 2004, 2007). The third study consisted of observations of the behavior of odonticetes in the wild near ships using mid frequency active sonar (NMFS 2005a; Navy 2004b; Fromm 2004a, 2004b).

3.7.3.1.14 Assessing MMPA Level B Behavioral Harassment Using Risk Function

Background. 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.* 1995a; 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 operations, 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 (Marine Mammal Commission 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/HFA 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 2001c), and relied on in the Supplemental SURTASS LFA Sonar EIS (DoN 2007d) for the probability of MFA/HFA 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 (2001c), 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 percent risk;

A = risk transition sharpness parameter (A=10 odontocetes (except harbor porpoises)/pinnipeds; A=8 mysticetes) (explained in subsection 3.7.3.1.5).

In order to use this function, the values of the three parameters (B, K, and A) need to be established. 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 (2005a); DoN (2004b); 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.* 2002a). Bottlenose dolphins exposed to 1-sec intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1 μPa 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.* 2002a). 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 μPa^2/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 experiment in which baleen whales (mysticetes) were exposed to sounds ranging in frequency from 50 Hz (ship noise playback) to 4500 Hz (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 500 Hz to 4500 Hz, 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 500 Hz and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 Hz to 500 Hz; and (3) a pair of low (1,500 Hz)-high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz 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 operations 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, noncaptive animal upon exposure to the AN/SQS-53 MFA sonar.

3. U.S. Department of Commerce (NMFS 2005a); DoN (2004b); from (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 1,650 ft (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 the 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 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 µPa2-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-sec 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 stimulus that contained mid-frequency components but was 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 500 Hz and 850 Hz; (2) a 2-sec logarithmic down-sweep from 4,500 Hz to 500 Hz; and (3) a pair of low (1,500 Hz)-high (2,000 Hz) sine wave tones amplitude modulated at 120 Hz and each 1-sec long. This 18-minute alert stimulus 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 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 previously above. The risk continuum function approximates the dose-response function in a manner analogous to pharmacological risk assessment (DoN 2001c, Appendix A). 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 estimate 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 A 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, and A=8 for mysticetes, (Figures 3.7-8 and 3.7-9) (NMFS 2008).

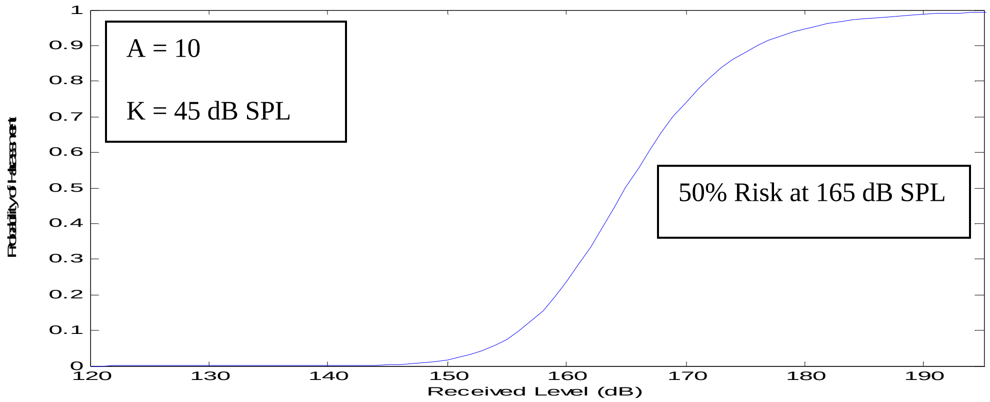


Figure 3.7-8: Risk Function Curve for Odontocetes (toothed whales)

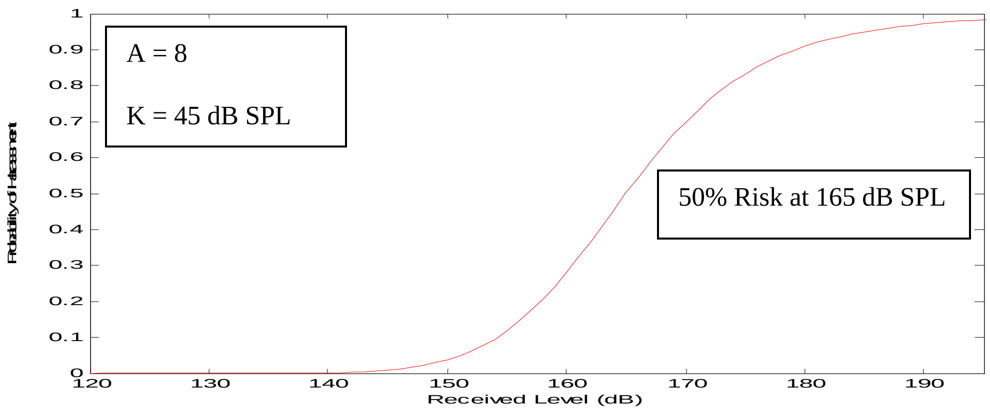


Figure 3.7-9: Risk Function Curve for Mysticetes (Baleen Whales)

Justification for the Steepness Parameter of A = 10 for the Odontocete Curve. The NMFS independent review process described in Section 4.1.2.4.9 of 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 DoN (2008).

As background, a sensitivity analysis of the A=10 parameter was undertaken and presented in Appendix D of the SURTASS/LFA FEIS (DoN 2001c). 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 (1.1nm [2 km] 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 (2.2 nm [4 km] 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 2001c). As concluded in the SURTASS LFA Sonar Final OEIS/EIS (DoN 2001c), 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 OEIS/EIS, Subchapters 1.4.3, 4.2.4.3 and Appendix D, and NMFS 2008).

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 stimulus) 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 of the six North Atlantic right whales exposed to an alert stimulus "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 root- mean-square sound (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 that 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 in 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/HFA 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 the Navy and NMFS apply 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, it is known 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 Hawaii Range Complex, for example, animals exposed to received levels between 120 and 130 dB may be more than 65 nm (120 km) 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 its 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.

Table 3.7-6: Percent of Harassments at Each Received Level Band

Received Level	Distance at which Levels Occur in MIRC	Percent of Harassments Occurring at Given Levels
Below 140 dB SPL	36 km–125 km	<1%
140>Level>150 dB SPL	15 km–36 km	2%
150>Level>160 dB SPL	5 km–15 km	20%
160>Level>170 dB SPL	2 km–5 km	40%
170>Level>180 dB SPL	0.6–2 km	24%
180>Level>190 dB SPL	180–560 meters	9%
Above 190 dB SPL	0–180 meters	2%
TTS (195 dB EFDL)	0–110 meters	2%
PTS (215 dB EFDL)	0–10 meters	<1%

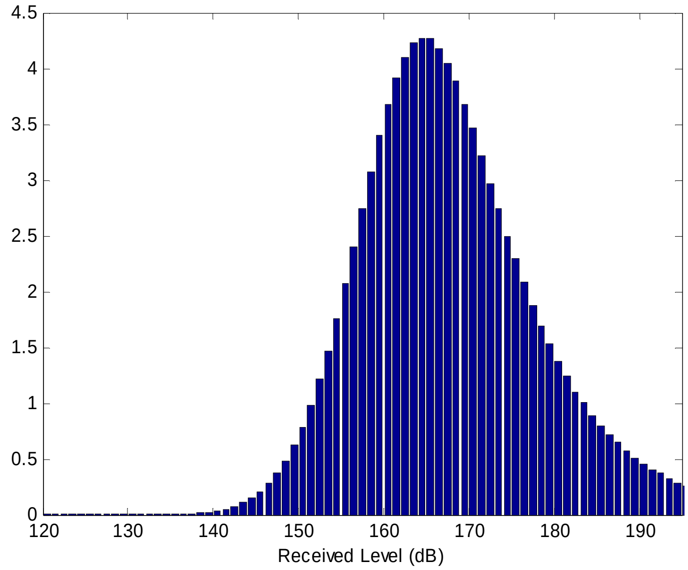


Figure 3.7-10: The Percentage of Behavioral Harassments Resulting from the Risk Function for Every 5dB of Received Level

Navy Post Acoustic Modeling Analysis. The quantification of the acoustic modeling results includes additional analysis to increase the accuracy of the number of marine mammals affected. Table 3.7-7 provides a summary of the modeling protocols used in this analysis. Post modeling analysis includes reducing acoustic footprints where they encounter land masses, accounting for acoustic footprints for sonar sources that overlap to accurately sum the total area when multiple ships are operating together, and to better account for the maximum number of individuals of a species that could potentially be exposed to sonar within the course of one day or a discreet continuous sonar event.

Table 3.7-7: Navy Protocols for Accurate Modeling Quantification of Marine Mammal Exposures

Acoustic Parameters	AN/SQS-53 and AN/SQS-56	The AN/SQS-53 and the AN/SQS-56 active sonar sources were modeled separately to account for the differences in source level, frequency, and exposure effects.
	Submarine Sonar	Submarine active sonar use is included in effects analysis calculations.
Post Modeling Analysis	Land Shadow	For sound sources within the acoustic footprint of land, (approximately 65 nm for the MIRC), subtract the land area from the marine mammal exposure calculation.
	Multiple Ships	Correction factors are used to address the maximum potential of exposures to marine mammals resulting from multiple counting based on the acoustic footprint when there are occasions for more than one ship operating within approximately 130 nm of one another.
	Multiple Exposures	Accurate accounting for MIRC training events within the course of one day or a discreet continuous sonar event: • Other MIRC ASW training – 12 hours • Joint Multi-strike Group – 12 hours

As described above and as required by NMFS, the analysis included in this EIS/OEIS assumes that short-term, noninjurious sound exposure levels (SELs) predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment from TTS. Application of this criterion assumes an effect even though not every behavioral disruption or instances of TTS will result in the abandonment or significant alteration of behavioral patterns (refer to military readiness definition of “harassment”). Given the context of exposures at the lowest received levels (~120 dB) it is expected that there will be adjustments to the modeled exposures, or at least consideration of these factors in the preparation of an incidental take authorization. To date, there is no information indicating a correlation between MFA/HFA sonar use and marine mammals abandoning their habitat in other range complexes such as Hawaii and Southern California.

3.7.3.1.15 Other Acoustic Effects Considered

Stress. A possible effect for marine mammals exposed to sound, is health and physiological stress (review by Fair and Becker 2000). A stimulus may cause a number of behavioral and physiological responses such as an increase in vigilance, elevated heart rate, increases in endocrine and neurological function, and decreased immune function, particularly if the animal perceives the stimulus as life threatening (Seyle 1950; Moberg 2000; Sapolsky *et al*. 2005). The primary response to the stressor is to move away to avoid continued exposure although other factors such as foraging or tending to an offspring may influence the animal to stay in the area of exposure. Next, the animal’s physiological response to a stressor is to engage the autonomic nervous system with the classic “fight or flight” response. This includes changes in the cardiovascular system (increased heart rate), the gastrointestinal system (decrease digestion), the exocrine glands (increased hormone output), and the adrenal glands (increased norepinephrine). These physiological and hormonal responses are short-lived and may not have significant long-term effects on an animal’s health or fitness. Generally these short term responses are not detrimental to the animal except when the health of the animal is already compromised by disease, starvation or parasites; or the animal is chronically exposed to a stressor.

Exposure to chronic or high intensity sound sources can cause physiological stress. Acoustic exposures and physiological responses have been shown to cause stress responses (elevated respiration and increased heart rates) in humans (Jansen 1998). Jones (1998) reported on reductions in human performance when faced with acute, repetitive exposures to acoustic disturbance. Trimper *et al.* (1998) reported on the physiological stress responses of osprey to low-level aircraft noise. Krausman *et al.* (2004) reported on the auditory (TTS) and physiology stress responses of endangered Sonoran pronghorn to military overflights. Smith *et al.* (2004a, 2004b) recorded sound-induced physiological stress responses in a hearing-specialist fish that was associated with TTS and PTS. Welch and Welch (1970) reported physiological and behavioral stress responses that accompanied damage to the inner ears of fish and several mammals.

Most of these responses to sound sources or other stimuli have been studied extensively in terrestrial animals but are much more difficult to determine in marine mammals. Increases in heart rate are common reaction to acoustic disturbance in marine mammals (Miksis *et al.* 2001) as are small increases in the hormones norepinephrine, epinephrine, and dopamine (Romano *et al.* 2002; 2004). Increases in cortical steroids are more difficult to determine because blood collection procedures will also cause stress (Romano *et al.* 2002; 2004). A recent study, Chase Encirclement Stress Studies (CHESS), was conducted by NMFS on chronic stress effects in small odontocetes affected by the ETP tuna fishery (Forney *et al.* 2002). Analysis was conducted on blood constituents, immune function, reproductive parameters, heart rate and body temperature of small odontocetes that had been pursued and encircled by tuna fishing boats. Some effects were noted, including lower pregnancy rates, increases in norepinephrine, dopamine, adrenocorticotropic hormone, and cortisol levels, heart lesions and an increase in fin and surface temperature when chased for over 75 minutes but with no change in core body temperature (Forney *et al.* 2002). These stress effects in small cetaceans that were actively pursued (sometimes for over 75 minutes) were relatively small and difficult to discern. It is unlikely that marine mammals exposed to mid-frequency active sonar would be exposed as long as the cetaceans in the CHESS study and would not be pursued by the Navy ships, therefore stress effects would be minimal from the short term exposure to sonar. Ridgway *et al.* (2006) reported that increased vigilance in bottlenose dolphins exposed to sound over a five day period did not cause sleep deprivation or stress effects such as changes in cortisol or epinephrine levels.

The primary potential deleterious effect from SURTASS LFA sonar is change in a biologically significant behavior. An activity is biologically significant when it affects an animal’s ability to grow, survive, and reproduce (NRC 2005). The Low Frequency Sound Scientific Research Program (LFS SRP) field research in 1997-98 provided important results on and insights into the types of responses of whales to SURTASS LFA sonar signals and how those responses scaled relative to RL and context. The results of the LFS SRP confirmed that some portion of the whales exposed to the SURTASS LFA sonar responded behaviorally by changing their vocal activity, moving away from the source vessel, or both, but the responses were short-lived (Clark *et al.* 2001)

In a 1998 SURTASS LFA sonar playback experiment, migrating gray whales avoided exposure to LFA signals (source levels of 170 and 178 dB) when the source was placed within their migration corridor. Responses were similar for the 170-dB SL LFA stimuli and for the 170-dB SL one-third octave band-limited noise with timing and frequency band similar to the LFA stimulus. However, during the SURTASS LFA sonar playback experiments, in all cases, whales resumed their normal activities within tens of minutes after the initial exposure to the LFA signal (Clark *et al.* 2001). Essentially, the whales made minor course changes to go around the source. When the source was relocated outside of the migration corridor, but with SL increased so as to reproduce the same sound field inside the corridor, the whales continued their migration unabated. This result stresses the importance of context in interpreting animals’ responses to underwater sounds.

Prey fish within the 180-dB sound field of the SURTASS LFA sonar source could potentially be affected, which would suggest that this could presumably affect the foraging potential for some localized marine mammals to some extent. However, recent results from low frequency sonar exposure studies conducted on trout and channel catfish indicated that the impact from low frequency sonar is likely to be minimal, if not negligible; and certainly there is no potential for any measurable fish stock mortalities from SURTASS LFA sonar operations (subchapter 4.1.1 of the SURTASS LFA SEIS). Therefore, marine mammal foraging will not be affected. Because major exercises that may use SURTASS LFA are included in Alternative 1 and Alternative 2, this discussion is included in subsection 3.7.3.9 (Alternative 1) of this EIS/OEIS.

Eight weekly aerial surveys of humpback whales were flown north of the Hawaiian Island of Kauai each year when the North Pacific Acoustic Laboratory (NPAL) source was not transmitting in 2001 and when it was transmitting in 2002 and 2003 during the peak residency period of humpback whales (February through March) (Mobley 2005). The goal of the NPAL program was to extend the earlier thermometry findings of the Acoustic Thermometry of Ocean Climate (ATOC) experiment over a longer time to determine ocean-basin scale trends in temperature. The results of these surveys suggest that exposure to the NPAL source during the two years sampled with the source on, did not change the numbers of whales north of Kauai. It did not produce any noticeable distributional changes as measured by distance from the source and from shore, nor did it produce any noticeable changes in the depths of sighting locations.

These results contrast somewhat with the results from the ATOC and MMRP studies, which found a slight change in distribution and behavior, although no change in abundance (Frankel and Clark 2000; 2002). After four years of exposure to the ATOC/NPAL transmissions, the humpback whales continue to return to their wintering grounds near Kauai and show little changes in their normal pattern of distribution (Mobley 2005).

Acoustically Mediated Bubble Growth. One suggested cause of injury to marine mammals is by 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 a gas, such as nitrogen which makes up approximately 78 percent of air (remainder of air is about 21 percent oxygen with some carbon dioxide). 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 (for example, beaked whales) are theoretically predicted to induce greater supersaturation (Houser *et al.* 2001). Conversely, studies have shown that marine mammal lung structure (both pinnipeds and cetaceans) facilitates collapse of the lungs at depths deeper than approximately 162 ft (49 m) for phocids (Kooyman *et al.* 1970). Collapse of the lungs would force air in to the non-air exchanging areas of the lungs (in to the bronchioles away from the alveoli) or nasal passages thus significantly decreasing nitrogen diffusion in to the body. Deep diving pinnipeds such as the northern elephant (*Mirounga angustirostris*) and Weddell seals (*Leptonychotes weddellii*) typically exhale before long deep dives, further reducing air volume in the lungs (Kooyman *et al.* 1970). If rectified diffusion were possible in marine mammals exposed to high-level sound, conditions of tissue super saturation 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 short 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 for a long enough period of time and exposed to a continuous sound source for bubbles to become of a problematic size.

Another hypothesis suggests 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). In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation. Cox *et al.* (2006), with experts in the field of marine mammal behavior, diving, physiology, respiration physiology, pathology, anatomy, and bio-acoustics considered this to be a plausible hypothesis but requires further investigation. Conversely, Fahlman *et al.* (2006) suggested that diving bradycardia (reduction in heart rate and circulation to the tissues), lung collapse and slow ascent rates would reduce nitrogen uptake and thus reduce the risk of decompression sickness by 50 percent in models of marine mammals. Recent information on the diving profiles of Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales in Hawaii (Baird *et al.* 2006) and in the Ligurian Sea in Italy (Tyack *et al.* 2006a) showed that while these species do dive deeply (regularly exceed depths of 2,624 ft [795 m]) and for long periods (48-68 minutes), they have significantly slower ascent rates than descent rates. This fits well with Fahlman *et al.* (2006) model of deep and long duration divers that would have slower ascent rates to reduce nitrogen saturation and reduce the risk of decompression sickness. Therefore, if nitrogen saturation remains low, then a rapid ascent in response to sonar should not cause decompression sickness. Currently it is not known if beaked whales do rapidly ascend in response to sonar or other disturbances. It may be that deep diving animals would be better protected diving to depth to avoid predators, such as killer whales, rather than ascending to the surface where they may be more susceptible to predators.

A recent publication by Zimmer *et al.* (2007) modeled a scenario that suggested that beaked whales may incur decompression sickness during shallow repetitive dives while trying to flee a predator or some sound source. There is no evidence to support this type of diving behavior as it has not been observed in beaked whales but the model was an attempt to explain the presence of tissue damage that may be caused by bubble formation from decompression. Conversely, as explained above, these instances of tissue damage may only reflect injuries that occur during the stranding as they roll on the beach or rocks or could be post mortem changes.

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; Evans and Miller 2003). To date, ELs predicted to cause *in vivo* bubble formation within diving cetaceans have not been evaluated (NOAA 2002b). 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 of this and complicating factors associated with introduction of gas in to the venous system during necropsy. Because evidence supporting it is debatable, no marine mammals addressed in this EIS/OEIS are given special treatment due to the possibility for acoustically mediated bubble growth. Beaked whales are, however, assessed differently from other species to account for factors that may have contributed to prior beaked whale strandings as set out in the subsection 3.7.3.4.

The issue of bubble growth via rectified diffusion was evaluated in the SURTASS LFA Final OEIS/EIS, Record of Decision and Final Rule. Crum and Mao (1996) stated that RL would have to exceed 190 dB in order for there to be the possibility of significant bubble growth via rectified diffusion (one form of the growth of gas bubbles in liquids) due to supersaturation of gases in the blood.

Resonance. Another suggested cause of injury in marine mammals is air cavity resonance due to sonar exposure. Resonance is 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.

Displacement of the cavity boundaries during resonance has been suggested as a cause of injury. Large displacements have the potential to tear tissues that surround the air space (for example, lung tissue).

Understanding resonant frequencies and the susceptibility of marine mammal air cavities to resonance is important in determining whether certain sonars have the potential to affect different cavities in different species. In 2002, NMFS convened a panel of government and private scientists to address this issue (NOAA 2002b). They modeled and evaluated the likelihood that Navy mid-frequency active sonar caused resonance effects in beaked whales that eventually led to their stranding (DoC and DoN 2001). The conclusions of that group were that resonance in air-filled structures the frequencies at which resonance were predicted to occur were below the frequencies utilized by the sonar systems employed. Furthermore, air cavity vibrations due to the resonance effect were not considered to be of sufficient amplitude to cause tissue damage.

In response to the resonance issue raised by letters and comments to NMFS's Proposed Rule, Cudahy and Ellison (2002) analyzed the potential for injury related to resonance from SURTASS LFA sonar signals. Their analysis did not support the claim that resonance from SURTASS LFA sonar will cause injury. Physical injury due to resonance will not occur unless it will increase stress on tissue to the point of damage. Therefore, the issue is not whether resonance occurs in air/gas cavities, but whether tissue damage occurs. Cudahy and Ellison (2002) indicate that the potential for in vivo tissue damage to marine mammals from exposure to underwater low frequency sound will occur at a damage threshold on the order of 180 to 190 dB RL or higher. These include: 1) transluminal (hydraulic) damage to tissues at intensities on the order of 190 dB RL or greater; 2) vascular damage thresholds from cavitation at intensities in the 240-dB RL regime; 3) tissue shear damage at intensities on the order of 190 dB RL or greater; and 4) tissue damage in air-filled spaces at intensities above 180 dB RL.

In a workshop held April 24 and 25, 2002, an international group of 32 scientists with backgrounds in acoustics met at NMFS Headquarters in Silver Spring, Maryland, to consider the question of acoustic resonance and its possible role in tissue damage in marine mammals. The group concluded that it is not likely that acoustic resonance in air spaces plays a primary role in tissue damage in marine mammals exposed to intense acoustic sources. Tissue displacements are too small to cause damage, and the resonant frequencies of marine mammal air spaces are too low to be excited by most sounds produced by humans. Resonance of non-air containing tissues was not ruled out. While tissue trauma from resonance in air spaces seems highly unlikely, the group agreed that resonance in non-air-containing tissues cannot be considered negated until certain experiments are performed (NOAA/NMFS 2002).

In summary, the best available scientific information shows that, while resonance can occur in marine animals, this resonance does not necessarily cause injury, and any such injury is not expected to occur below a sound pressure level of 180 dB RL. Because the SURTASS LFA FOEIS/EISs used 180 dB RL as the criterion for the determination for the potential for injury to marine life and for the implementation of geographic and monitoring mitigation measures, any non-auditory physiological impacts associated with resonance were accounted for. The 145-dB RL restriction for known recreational and commercial dive sites will provide an additional level of protection to marine animals in these areas.

Additionally, it has been claimed that air space resonance impacts can cause damage to the lungs and large sinus cavities of cetaceans, that low frequency sound could induce panic and subsequent problems with equalization, and that low frequency sound could cause bubble growth in blood vessels. With regard to the specific impacts to lungs and sinus cavities, there is abundant anatomical evidence that marine mammals have evolved and adapted to dramatic fluctuations in pressure during long, deep dives that seem to exceed their aerobic capacities (Williams *et al.* in *Science*, 2000; ENN 2000). For example, marine mammal lungs are reinforced with more extensive connective tissues than their terrestrial relatives. These extensive connective tissues, combined with the probable collapse of the alveoli at the depths at which significant SURTASS LFA sonar signals can be heard, make it very unlikely that significant lung resonance effects could be realized.

Permanent Hearing Loss. Hearing thresholds for the marine mammals considered for analysis within this EIS/OEIS are discussed previously within this subsection (above). The issue of permanent hearing loss was evaluated in the SURTASS LFA Final OEIS/EIS, Record of Decision and Final Rule. The updated literature reviews and research results included in the SURTASS LFA SEIS indicate that there are no new data that contradict any of the assumptions or conclusions in the FOEIS/EIS; thus, its findings regarding the potential for permanent loss of hearing from SURTASS LFA sonar operations remains valid. That is, that the potential impact on any stock of marine mammals from injury (such as permanent loss of hearing) is considered negligible.

Temporary Hearing Loss. In addition to the possibility of causing permanent injury to hearing, sound may cause TTS, a temporary and reversible loss of hearing that may last for minutes to hours. The precise physiological mechanism for TTS is not understood. It may result from fatigue of the sensory hair cells as a result of their being over-stimulated or from some small damage to the cells, which is repaired over time. The duration of TTS depends on a variety of factors including intensity and duration of the stimulus, and recovery can take minutes, hours, or even days. Therefore, animals suffering from TTS over longer time periods, such as hours or days, may be considered to have a change in a biologically significant behavior, as they could be prevented from detecting sounds that are biologically relevant, including communication sounds, sounds of prey, or sounds of predators. As concluded in the SURTASS LFA Final OEIS/EIS and substantiated in the SURTASS LFA SEIS, there is no evidence for the potential effects of LF sound to cause temporary loss of hearing in marine mammals.

Likelihood of Prolonged Exposure. The proposed ASW activities within the MIRC would not result in prolonged exposure because the vessels are constantly moving, and the flow of the activity in the MIRC when ASW training occurs reduces the potential for prolonged exposure.

Likelihood of Masking. Natural and artificial sounds can disrupt behavior by masking, or interfering with an animal's ability to hear other sounds. Masking occurs when the receipt of a sound is interfered with by a second sound at similar frequencies and at similar or higher levels. If the second sound were artificial, it could be potentially harassing if it disrupted hearing-related behavior such as communications or echolocation. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which occurs during the sound exposure.

Historically, principal masking concerns have been with prevailing background sound levels from natural and manmade sources (for example, Richardson et al. 1995). Dominant examples of the latter are the accumulated sound from merchant ships and sound of seismic surveys. Both cover a wide frequency band and are long in duration. A recent study by Nachtigall and Supin (2008) showed that false killer whales adjust their hearing to compensate for ambient sounds and the intensity of returning echolocation signals.

The proposed MIRC ASW areas are away from harbors but may include heavily traveled shipping lanes, although shipping lanes are a small portion of the overall range complex. The loudest mid-frequency underwater sounds in the MIRC are those produced by hull-mounted MFA or HFA tactical sonar. The sonar signals are likely within the audible range of most cetaceans, but are very limited in the temporal and frequency domains. In particular, the pulse lengths are short, the duty cycle low, the total number of hours of training activities per year is small, and these hull-mounted MFA and HFA tactical sonars transmit within a narrow band of frequencies (typically less than one-third octave).

For the reasons outlined above, the chance of sonar training activities causing masking effects is considered negligible.

Weapons Firing Noise

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 (DoN 2006).

The largest proposed shell size for these operations 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: one 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: one µPa at 330 ft (100 m) (DoN 2000) and as the distance increases, the pressure would decrease.

In reference to the EFD harassment criteria, the EFD levels (greatest in any 1/3 octave band above 10 Hz) of a 5-inch gun muzzle blast were calculated to be 190 dB re: one µPa2-s directly below the gun muzzle decreasing to 170 dB re: one µPa2-s at 330 ft (100 m) into the water (DoN 2006). 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 training, would result in a blast from a gun muzzle with neglible effects on marine mammals.

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 (DoN 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 (DoN 2006).

The structural component for a standard round was calculated to be 6.19 percent of the air blast (DoN 2006). 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 marine mammals.

Long-term Effects. Navy activities are conducted in the same general areas throughout the MIRC, so marine mammal populations could be exposed to repeated activities over time. However, as described earlier, short-term noninjurious sound exposure levels predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment. Application of this criterion assumes an effect even though it is highly unlikely that all behavioral disruptions or instances of TTS will result in long term significant impacts. Because some marine mammals may be more or less year-round residents within the MIRC (*e.g.*, Risso's dolphin, melon-headed whale), individuals may be exposed to more behavioral disruptions due to MIRC activities; however, the accumulated behavioral disruptions or instances of TTS is unlikely to result in long term significant impacts. In addition, sonar exercises have been conducted in the MIRC for 40 years without a sonar-related stranding being observed. Most populations of marine mammals have been stable or increasing in the MIRC.

Monitoring programs for the MIRC are being developed by the Navy to assess population trends and responses of marine mammals to Navy activities. Short-term monitoring programs for major exercises (*e.g*., RIMPAC, Joint Task Force Exercises [JTFEX]) are being developed to assess mitigation measures and responses of marine mammals to Navy activities.

3.7.3.1.16 Application of Exposure Thresholds to Other Species

Mysticetes. Information on auditory function in mysticetes is extremely lacking. Sensitivity to low-frequency sound by baleen whales has been inferred from observed vocalization frequencies, observed reactions to playback of sounds, and anatomical analyses of the auditory system. Baleen whales are estimated to hear from 7 Hz to 22 kHz (higher frequenies are attributed to the inclusion of humpback whales in the baleen auditory range), with best sensitivity below 1,000 Hz (Southall *et al.* 2007). Filter-bank models of the humpback whale's ear have been developed from anatomical features of the humpback's ear and optimization techniques (Houser *et al.* 2001). The results suggest that humpbacks are sensitive to frequencies between 40 Hz and 16 kHz, but best sensitivity is likely to occur between 100 Hz and 8 kHz. However, absolute sensitivity has not been modeled for any baleen whale species. Furthermore, there is no indication of what sorts of sound exposure produce threshold shifts in these animals.

The criteria and thresholds for PTS and TTS developed for odontocetes for this activity are also used for mysticetes. This generalization is based on the assumption that the empirical data at hand are representative of both groups until data collection on mysticete species shows otherwise. For the frequencies of interest for this action, there is no evidence that the total amount of energy required to induce onset-TTS and onset-PTS in mysticetes is different than that required for odontocetes.

Beaked Whales. Previous beaked whale strandings involving multiple animals have prompted inquiry into the relationship between high-amplitude nonimpulsive sound and the cause of those strandings. For example, in the stranding in the Bahamas in 2000, the Navy mid-frequency sonar was identified as the only contributory cause that could have lead to the stranding. The Bahamas exercise entailed multiple ships using mid-frequency sonar during transit of a long constricted channel. The Navy participated in an extensive investigation of the stranding with the NMFS. The "Joint Interim Report, Bahamas Marine Mammal Stranding Event of 15-16 March 2000" concluded that the variables to be considered in managing future risk from tactical mid-range sonar were "sound propagation characteristics (in this case a surface duct), unusual underwater bathymetry, intensive use of multiple sonar units, a constricted channel with limited egress avenues, and the presence of beaked whales that appear to be sensitive to the frequencies produced by these sonars" (DoC and DoN 2001).

The Navy analyzed the known range of operational, biological, and environmental factors involved in the Bahamas stranding and focused on the interplay of these factors to reduce risks to beaked whales from ASW training. The confluence of these factors do not occur in the Mariana Islands although surface ducts may be present, there are rapid changes in bathymetry over relatively short distances, and beaked whales are present where MFA sonar is used. Although beaked whales are visually and acoustically detected in areas where sonar use routinely takes place, there has not been a stranding of beaked whales in the Mariana Islands associated with the approximately 30 year use history of the present sonar systems.

This history would suggest that the simple exposure of beaked whales to sonar is not enough to cause beaked whales to strand. Brownell *et al.* (2004) suggested that the high number of beaked whale strandings in Japan between 1980 and 2004 may be related to U.S. Navy sonar use in those waters given the presence of U.S. Naval Bases and exercises off Japan. The Center for Naval Analysis compiled the history of naval exercises taking place off Japan and found there to be no correlation in time for any of the stranding events presented in Brownell *et al.* (2004). Like the situation in California, there are clearly beaked whales present in the waters off Japan (as evidenced by the strandings), however, there is no correlation in time to strandings and sonar use. Sonar did not cause the strandings described by Brownell *et al.* (2004) and more importantly, this suggests sonar use in the presence of beaked whales over two decades has not resulted in strandings.

As suggested by the known presence of beaked whales in waters sonar use has historically taken place, it is likely that beaked whales have been occasionally exposed to sonar during the last 40 years of sonar use in Hawaii, Southern California and the Mariana Islands; and yet there is no indication of any adverse impact on beaked whales from exposure to sonar.

The Navy and NMFS are coordinating on the need for development of a stranding response plan specific to the Mariana Islands.

3.7.3.2 Cetacean Stranding Events

The Navy is very concerned and thoroughly investigates each stranding potentially associated with Navy activities to better understand these interactions. Strandings can involve 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 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 unfamiliarity 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 [65 km]), environmental conditions (*e.g.*, surface ducting), and multiple sonar ships (refer to section on Stranding Events Associated with Navy Sonar) were compared among the different stranding events.

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 affected and raised concerns about anthropogenic sources of stranding. While there has 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. 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. However, 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).

Additional details regarding cetacean stranding is provided in Appendix H.

3.7.3.3 Estimated Effects Modeling

3.7.3.3.1 Acoustic Source Modeling

The approach for estimating potential acoustic effects from MIRC ASW training activities on cetacean species makes use of the methodology that was developed in cooperation with NOAA for the Navy's USWEX EA/OEA (DoN 2007c), RIMPAC EA/OEA (2006) and Composite Training Unit Exercise/Joint Task Force Exercise (COMPTUEX/JTFEX) EA/OEA (2007), as well as additional cooperative work with NMFS for analyzing behavioral effects to marine mammals using the risk-function methodology (DoN 2008). The methodology is provided here to determine the number and species of marine mammals for which incidental take authorization is being requested in consultation between the Navy and NMFS.

In order to estimate acoustic effects from the MIRC ASW training activities, acoustic sources to be used were examined with regard to their operational characteristics. Sources were examined using simple spreadsheet calculations to ensure that they did not need to be considered further. For example, if a sonobuoy's typical use yielded an exposure area that produced no marine mammal exposures based on the maximum marine mammal density that sonobuoy as a source was designated nonproblematic and was not modeled in the sense of running its parameters through the environmental model (CASS), generating an acoustic footprint, etc.

In addition, systems with an operating frequency greater than 100 kHz were not analyzed in the detailed modeling as these signals attenuate rapidly (due to the frequency) resulting in very short propagation distances for a received level exceeding the acoustic thresholds of concern. There are no ASW sonars transmitting sound underwater in excess of 50 kHz in use by the Navy in the MIRC Study Area.

Based on the information above, only hull-mounted MFA tactical sonar (on combatant ships and submarines), DICASS sonobuoy, MK 48 torpedo (HFA), and AN/AQS 22 (dipping sonar) were determined to have the potential to affect marine mammals protected under the MMPA and ESA during MIRC ASW training events.

For modeling purposes, sonar parameters (*i.e.*, source levels, ping length, the interval between pings, output frequencies, etc.) were based on records from training events, previous exercises, and preferred ASW tactical doctrine to reflect the sonar use expected to occur during events in the MIRC. The actual sonar use across a given exercise area is classified, however, marine mammal exposure estimates employed actual and preferred parameters to which the participants have trained to use during ASW events in the MIRC.

For discussion purposes surface ship sonars can be considered as having the nominal source level of 235 decibels (dB) re 1 µPa^2-s @ 1 m, transmitting a 1 second omnidirectional ping at center frequencies of 2.6 kHz and 3.3 kHz, with 30 seconds between pings.

Every active sonar operation includes the potential to harass marine animals in the vicinity of the source. The number of animals exposed to potential harassment in any such action is dictated by the propagation field and the manner in which the sonar is operated (*i.e.*, source level, depth, frequency, pulse length, directivity, platform speed, repetition rate).

3.7.3.3.2 Modeling Physiological Effects

For the MIRC, the relevant measure of potential physiological effects to marine mammals due to sonar training is the accumulated (summed over all source emissions) energy flux density level received by the animal over the duration of the activity.

The modeling for estimating received energy flux density level from surface ship active tactical sonar consisted of five broad steps, listed below. Results were calculated based on the typical ASW activities planned for the MIRC.

- **Step 1**. Environmental Seasons. The MIRC Study Area is divided into two seasons, dry season and wet season and each has a unique combination of environmental conditions. Seasonal variation provides the most significant variation in the sound speed field, as evidenced during warm and cool seasons in tropical waters. A study area in relatively higher latitudes would typically be divided into four seasons.
- **Step 2**. Transmission Loss. The MIRC Study Area is divided into nine environmental provinces, which are characterized by water depth, sediment thickness, and acoustic variables related to sound velocity and bottom loss of high and low frequency sound. Since sound propagates differently in these nine environmental provinces, separate transmission loss calculations must be made for each, in both seasons. The transmission loss is predicted using Comprehensive Acoustic System Simulation Gaussian Ray Bundle (CASS-GRAB) sound modeling software.
- **Step 3**. Exposure Volumes. The transmission loss, combined with the source characteristics, gives the energy field of a single ping. The energy of over 12 hours (the typical length of a TORPEX training event) of pinging is summed, carefully accounting for overlap of several pings, so an accurate average exposure of an hour of pinging is calculated for each depth increment. Repeating this calculation for each environment in each season gives the hourly ensonified volume, by depth, for each environment and season.
- **Step 4**. Marine Mammal Densities. The marine mammal densities were given in two dimensions, but using sources such as the North Pacific Acoustic Laboratory EIS, the depth regimes of these marine mammals are used to project the two dimensional densities into three dimensions. Estimations of marine mammal densities are discussed in section 3.7.2.1 (Overview of Marine Mammals within the MIRC Study Area).
- **Step 5**. Exposure Calculations. Each marine mammal’s three dimensional density is multiplied by the calculated impact volume—to that marine mammal’s depth regime. This is the number of exposures per hour for that particular marine mammal. In this way, each marine mammal's exposure count per hour is based on its density, depth habitat, and the ensonified volume by depth. Calculated exposures above 0.5 were counted as one exposure.

The movement of various units during an ASW event is largely unconstrained and dependent on the developing tactical situation presented to the commander of the forces. Only when all exposures for all training are summed for the year does the model indicate the potential for exposure in excess of 215 dB re 1 μPa^2-s.

3.7.3.3.3 Modeling Behavioral Effects

For the MIRC, the relevant measure of potential behavioral disturbance effects to marine mammals due to sonar training is the maximum sound pressure level (SPL) received by the animal over the duration of the activity (or over each day).

The modeling for estimating received energy flux density from surface ship active tactical sonar is analogous to the modeling for energy flux density level, discussed above. However, the SPL metric yields the maximum SPL (and not the sum of energies).

Results were calculated based on the typical ASW activities planned for the MIRC. Acoustic propagation and mammal population data are analyzed for both the dry season (December to June) and wet season (July to November).

3.7.3.4 Model Results Explanation

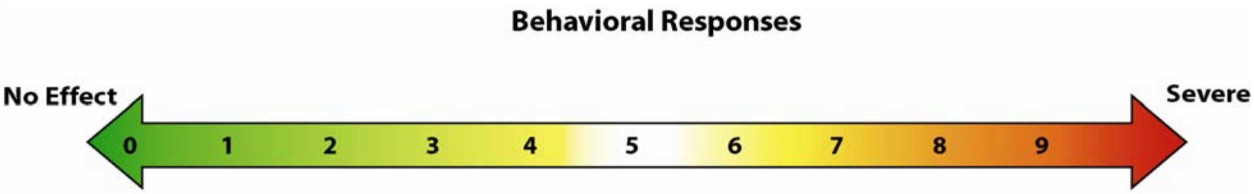
Acoustic exposures are evaluated based on their potential direct effects on marine mammals, and these effects are then assessed in the context of the species biology and ecology to determine if there is a mode of action that may result in the acoustic exposure warranting consideration as a harassment level effect.

A large body of research on terrestrial animal and human response to airborne sound exists, but results from those studies are not readily applicable to the development of behavioral criteria and thresholds for marine mammals. Differences in hearing thresholds, dynamic range of the ear, and the typical exposure patterns of interest (*e.g.*, human data tend to focus on 8-hour-long exposures), and the difference between acoustics in air and in water make extrapolation of human sound exposure standards inappropriate.

Behavioral observations of marine mammals exposed to anthropogenic sound sources exists, however, there are few observations and no controlled measurements of behavioral disruption of cetaceans caused by sound sources with frequencies, waveforms, durations, and repetition rates comparable to those employed by the tactical sonars described in this EIS/OEIS (Deecke 2006) or for multiple explosives. Controlled studies in the laboratory have been conducted to determine physical changes (TTS) in hearing of marine mammals associated with sound exposure (Finneran *et al.* 2001, 2003, 2005). Research on behavioral effects has been difficult because of the difficulty and complexity of implementing controlled conditions.

At the present time there is no general scientifically accepted consensus on how to account for behavioral effects on marine mammals exposed to anthropogenic sounds including military sonar and explosions (NRC 2003; 2005). While the first elements in Figure 3.7-11 can be easily defined (source, propagation, receiver) the remaining elements (perception, behavior, and life functions) are not well understood given the difficulties in studying marine mammals at sea (NRC 2005). The National Research Council (2005) acknowledges “there is not one case in which data can be integrated into models to demonstrate that noise is causing adverse affects on a marine mammal population.”

For purposes of predicting the number of marine mammals that will be behaviorally harassed or sustain either temporary or permanent threshold shift, the Navy uses an acoustic impact model process with numeric criteria agreed upon with the NMFS.



0 - No observable response
1- Brief orientation response (investigation / visual orientation)
2 - Moderate or multiple orientation behaviors
- Brief or minor cessation / modification of vocal behavior
- Brief or minor change in respiration rates
3 - Prolonged orientation behavior
- Individual alert behavior
- Minor changes in locomotion speed, direction, and/or dive profile but no avoidance of sound source
- Moderate change in respiration rate
- Minor cessation or modification of vocal behavior (duration < duration of source activity), including the Lombard Effect
4 - Moderate changes in locomotion speed, direction, and/or dive profile, but not avoidance of sound source
- Brief, minor shift in group distribution
- Moderate cessation or modification of vocal behavior (approximate duration of source activity)
5 - Extensive or prolonged changes in locomotion speed, direction, and / or dive profile, but not avoidance in sound source
- Moderate shift in group distribution
- Change in inter-animal distance and / or group size (aggregation or separation)
- Prolonged cessation or modification of vocal behavior (duration > duration of source activity)
6 - Minor or moderate individual and / or group avoidance of sound source
- Brief or minor separation of females and dependent offspring
- Aggressive behavior related to noise exposure (e.g., tail / flipper slapping, fluke display, jaw clapping / gnashing teeth, abrupt directed movement, bubble clouds)
- Extended cessation or modification of vocal behavior
- Visible startle response
- Brief cessation of reproductive behavior
7 - Excessive or prolonged aggressive behavior
- Moderate separation of females and dependent offspring
- Clear antipredator response
- Severe and / or sustained avoidance of sound source
- Moderate cessation of reproductive behavior
8 - Obvious aversion and / or progressive sensitization
- Prolonged or significant separation of females and dependent offspring with disruption of acoustic reunion mechanism
- Long-term avoidance of area (> source activity)
- Prolonged cessation of reproductive behavior
9 - Outright panic, fight, stampede, attack of conspecifics, or stranding event
- Avoidance behavior related to predator detection

Source: Southall et al., 2007

Figure 3.7-11: Proposed Marine Mammal Response Severity Scale Spectrum to Anthropogenic Sounds in Free Ranging Marine Mammals

In order to fully understand the exposure estimates, there are some associated caveats that help to put them into context. For instance:

1. Significant scientific uncertainties are implied and carried forward in any analysis using marine mammal density data as a predictor for animal occurrence within a given geographic area;

2. There are limitations to the actual model process based on information available, such as animal densities, animal depth distributions, animal motion data, impact thresholds, type of sound source and intensity, behavior (involved in reproduction or foraging), and/or previous experience and supporting statistical model; and,

3. Determination of what constitutes a significant behavioral effect in a marine mammal is still unresolved (NRC 2005).

The sources of marine mammal densities used in this EIS/OEIS (discussed in section 3.7.2.1) are derived from the Navy MISTCS cruise (DoN 2007b) and surveys from other areas (in Barlow 2003; Ferguson and Barlow 2001, 2003; 2006; and Miyashita *et al.* 1993). These ship board surveys cover significant distance around the Hawaiian Islands, Eastern Tropical Pacific and the Mariana Islands. Although survey design includes statistical placement of survey tracks, the survey itself can only cover so much ocean area. Post-survey statistics are used to calculate animal abundance and densities (Barlow and Forney 2007). There is often significant statistical variation inherent within the calculation of the final density values depending on how many sightings were available during a survey. Occurrence of marine mammals within any geographic area including the Mariana Islands is highly variable and strongly correlated to oceanographic conditions, bathymetry, and ecosystem level patterns (prey abundance and distribution) (Benson *et al.* 2002; Moore *et al.* 2002; Tynan 2005; Redfern 2006).

For some species, distribution may be even more highly influenced by relative small scale biological or oceanographic features over both short and long-term time scales (Ballance *et al.* 2006; Etnoyer *et al.* 2006; Ferguson *et al.* 2006; Skov *et al.* 2007). Unfortunately, the scientific understanding of some large scale and most small scale processes thought to influence marine mammal distribution is incomplete.

Given the uncertainties in marine mammal density estimation and localized distributions, the Navy's acoustic impact models can not currently take into account location data for any marine mammals within specific areas of the MIRC. To resolve this issue and allow modeling to proceed, animals are "artificially and uniformly distributed" within the modeling provinces, and modeled as stationary points.

3.7.3.4.1 Behavioral Responses

The intensity of the behavioral responses exhibited by marine mammals depends on a number of conditions including the age, reproductive condition, experience, behavior (foraging or reproductive), species, received sound level, type of sound (impulse or continuous) and duration (including whether exposure occurs once or multiple times) of sound (Reviews by Richardson *et al.* 1995a; Wartzok *et al.* 2003; Cox *et al.* 2006, Nowacek *et al.* 2007; Southall *et al.* 2007) (Figure 3.7-11). Many behavioral responses may be short term (seconds to minutes orienting to the sound source or over several hours if they move away from the sound source) and of little immediate consequence for the animal. However, certain responses may lead to a stranding or mother-offspring separation (Baraff and Weinrich 1994; Gabriele *et al.* 2001). Active sonar exposure is brief as the ship is constantly moving and the animal will likely be moving as well (although marine mammals are modeled as stationary points). Generally the louder the sound source the more intense the response although duration is also very important (Southall *et al.* 2007).

According to the severity scale response spectrum (Figure 3.7-11) proposed by Southall *et al.* (2007), responses classified as from 0-3 are brief and minor, those from 4-6 have a higher potential to affect foraging, reproduction, or survival and those from 7-9 are likely to affect foraging, reproduction and survival. Sonar and explosive mitigation measures (sonar power-down or shut-down zones and explosive exclusion zones) would likely prevent animals from being exposed to the loudest sonar sounds or explosive effects that could potentially result in TTS or PTS and more intense behavioral reactions (*i.e.*, 7-9) on the response spectrum.

There are little data on the consequences of sound exposure on vital rates of marine mammals. Several studies have shown the effects of chronic noise (either continuous or multiple pulses) on marine mammal presence in an area exposed to seismic survey airguns or ship noise (*e.g.*, Malme et al. 1984; McCauley et al. 1998; Nowacek et al. 2004). MFA sonar is not continuous and only occurs over a short time period within an area, therefore, there is no chronic exposure to marine mammals. There are no data to suggest that the MFA/HFA sonar affects the presence of marine mammals. MFA/HFA sonar use in the MIRC is not new given the current hull-mounted sonar employs the same basic sonar equipment and having the same output for over approximately 30 years. Given this history, the Navy believes that risk to marine mammals from sonar training is low.

Even for more cryptic species such as beaked whales, the main determinant of causing a stranding appears to be exposure in limited egress areas (a long narrow channel) with multiple ships. The result is that animals may be exposed for a prolonged period rather than several sonar pings over several minutes and the animals having no means to avoid the exposure. Under these specific circumstances and conditions, MFA sonar is believed to have contributed to the stranding event, resulting in indirect mortality of a small number of beaked whales in locations other than the MIRC. As discussed previously in this subsection, the "Joint Interim Report, Bahamas Marine Mammal Stranding Event of 15-16 March 2000" (DoC and DoN 2001) noted that in addition to the presence of beaked whales and the constricted channels with limited egress, the occurrence of a surface duct, unusual underwater bathymetry, and intensive use of multiple sonar units, were aggregate factors that contributed to the stranding event. There are no limited egress areas (long narrow channels) in the MIRC, therefore, it is unlikely that the proposed sonar use would result in any strandings. Although the Navy has substantially changed operating procedures to avoid the aggregate of circumstances that may have contributed to previous strandings, it is important that future unusual stranding events be reviewed and investigated so that any human cause of the stranding can be understood and avoided.

There have been no beaked whales strandings in the MIRC associated with the use of MFA/HFA sonar. This is a critically important contextual difference between the MIRC and areas of the world where strandings have occurred (Southall *et al.* 2007). While the absence of evidence does not prove there have been no impacts on beaked whales, decades of history with no evidence cannot be lightly dismissed.

3.7.3.4.2 Temporary Threshold Shift

A temporary threshold shift is a temporary recoverable, loss of hearing sensitivity over a small range of frequencies related to the sound source to which it was exposed. The animal may not even be aware of the TTS and does not become deaf, but requires a louder sound stimulus (relative to the amount of TTS) to detect that sound within the affected frequencies. TTS may last several minutes to several days and the duration is related to the intensity of the sound source and the duration of the sound (including multiple exposures). Sonar exposures are generally short in duration and intermittent (approximately one ping per 30 seconds from a moving ship), and with mitigation measures in place, TTS in marine mammals exposed to mid- or high-frequency active sonar and underwater detonations are unlikely to occur. There is currently no information to suggest that if an animal has TTS, that it will decrease the survival rate or reproductive fitness of that animal. TTS range from a MFA or HFA sonar's 235 dB source level one second ping is approximately 361 ft (110 m) from the bow of the ship under nominal oceanographic conditions.

3.7.3.4.3 Permanent Threshold Shift

A permanent threshold shift is nonrecoverable and results from the destruction of tissues within the auditory system and occurs over a small range of frequencies related to the sound exposure. PTS could indicate that an animal is deaf in part of its range, or that the animal does not become deaf but requires a louder sound stimulus (relative to the amount of PTS) to detect that sound within the affected frequencies. Sonar exposures are generally short in duration and intermittent (approximately one ping per 30 seconds from a moving ship), and with mitigation measures in place, PTS in marine mammals exposed to MFA or HFA sonar is unlikely to occur. There is currently no information to suggest that if an animal has PTS that it decreases the survival rate or reproductive fitness of that animal. The distance to PTS from a MFA sonar's 235 dB source level one second ping is approximately 33 ft (10 m) from the bow of the ship under nominal oceanographic conditions.

3.7.3.4.4 Population Level Effects

Some MIRC training activities will be conducted in the same general areas, so marine mammal populations could be exposed to repeated activities over time. This does not mean, however, that there will be a repetition of any effects given the vast number of variables involved. The acoustic analyses assume that short-term noninjurious sound levels predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment. However, it is unlikely that most behavioral disruptions or instances of TTS will result in long-term significant effects. Mitigation measures reduce the likelihood of exposures to sound levels that would cause significant behavioral disruption (the higher levels of 7-9 in Figure 3.7-11), TTS or PTS. The Navy does not anticipate any indirectly caused mortality to result from the proposed or existing training. It is unlikely that the short term behavioral disruption would adversely affect the species or stock through effects on annual rates of recruitment or survival.

3.7.3.4.5 Assessment of Marine Mammal Response to Acoustic Exposures

Acoustic exposures are evaluated based on their potential direct effects on marine mammals, and these effects are then assessed in the context of the species biology and ecology to determine if there is a mode of action that may result in the acoustic exposure warranting consideration as a harassment level effect. A large body of research on terrestrial animal and human response to airborne sound exists, but results from those studies are not readily extendable to the development of effect criteria and thresholds for marine mammals. For example, “annoyance” is one of several criteria used to define impact to humans from exposure to industrial sound sources. Comparable criteria cannot be developed for marine mammals because there is no acceptable method for determining whether a nonverbal animal is annoyed. Further, differences in hearing thresholds, dynamic range of the ear, and the typical exposure patterns of interest (*e.g.*, human data tend to focus on 8-hour-long exposures) make extrapolation of human sound exposure standards inappropriate. Behavioral observations of marine mammals exposed to anthropogenic sound sources exist, however, there are few observations and no controlled measurements of behavioral disruption of cetaceans caused by sound sources with frequencies, waveforms, durations, and repetition rates comparable to those employed by the tactical sonars to be used in the MIRC. At the present time there is no consensus on how to account for behavioral effects on marine mammals exposed to continuous-type sounds (NRC 2003).

When analyzing the results of the acoustic effect modeling to provide an estimate of harassment, it is important to understand that there are limitations to the ecological data used in the model, and to interpret the model results within the context of a given species’ ecology.

Limitations in the model include:

- Density estimates (may be limited in duration and time of year and are modeled to derive density estimates).
- When reviewing the acoustic effect modeling results, it is also important to understand that the estimates of marine mammal sound exposures are presented without consideration of mitigation which may reduce the potential for estimated sound exposures to occur.
- Overlap of TTS and risk function.

3.7.3.4.6 Potential Injury

As described previously, with respect to the acoustic model, the model inputs included the lowest sound level at which a response might occur. For example, the model considered the potential of onset of PTS in estimating exposures that might result in permanent tissue damage. Other effects postulated as permanent damage to marine mammal tissues also are considered in evaluating the potential for the estimated acoustic exposures to actually result in tissue damage. Resonance, rectified diffusion and decompression sickness were discussed previously with the conclusion that these effects are unlikely to occur.

3.7.3.4.7 Behavioral Disturbance

TTS was used as an onset of physiological response but not at the level of injury. This response is easily measured in a laboratory situation but is difficult to predict in free ranging animals exposed to sound. Because it is an involuntary response, it is easier to predict than behavioral responses. The risk function methodology considers other exposures which may include a variety of modes of action that could result in behavioral responses.

Limited information from literature on the proximal responses specific to mid-frequency active sonar and marine mammals require the use of information from other species and from other types of acoustic sources to build a conceptual model for considering issues such as allostatic loading, spatial disorientation, impaired navigation and disrupted life history events, disrupted communication, or increased energy costs. The risk function methodology assumes a range of responses from very low levels of exposure for certain individuals (with some individuals being more reactive than others depending on the situation – *i.e.*, foraging, breeding, migrating), with increasing probability of response as the received sound level increases. The result is an estimate of probability that the range of physiological and behavioral responses that might occur are accounted for in determining the number of harassment incidents. The predicted responses using the risk function and TTS methodology are conservatively estimated to result in the disruption of natural behavioral patterns although it is assumed that such behavioral patterns are not abandoned or significantly altered.

3.7.3.4.8 No Harassment

Although a marine mammal may be exposed to mid-frequency active sonar, it may not respond or may only show a mild response, which may not rise to the level of harassment. In using the risk function it is assumed that the response of animals is variable, depending on their activity, gender or age, and that higher sound levels would elicit a greater response. Each exposure, using the Risk Function methodology, represents the probability of a response that NMFS would classify as harassment under the MMPA. The ESA listed species that may be exposed to mid-frequency active sonar in the MIRC include the blue whale, fin whale, humpback whale, sei whale, and sperm whale. The exposure modeling was completed using the same methodology as that for non-ESA listed species.

3.7.3.5 Nonacoustic Effects

3.7.3.5.1 Aircraft Overflights

Overview. Various types of fixed-wing aircraft and helicopters are used in training exercises throughout the MIRC Study Area (see Chapter 2 and Appendix D). 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 operations while at the surface or while submerged (see section 3.5 – Airborne Noise for a description of the existing noise environment for an overview of airborne and underwater acoustics). 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.*, (1985), 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: (1) a direct path, refracted upon passing through the air-water interface; (2) direct-refracted paths reflected from the bottom in shallow water; (3) lateral (evanescent) transmission through the interface from the airborne sound field directly above; and (4) 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 3.7-12). 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.

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 (psf) at the sea surface becomes an impulsive wave in water with a maximum peak pressure of 20 psf. 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 2, 10, and 50 m) for F-18 aircraft subsonic overflights (250 knots) at various altitudes (990, 3,300, and 9,900 ft [300, 1000, and 3,000 m]). As modeled for all deep water scenarios, the sound pressure levels ranged from approximately 120 to 150 dB re 1 µPa. 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 F/A-18 aircraft supersonic overflights range from 5.2 psf at 10,000 ft (3,030 m) to 28.8 psf at 1,000 ft (303 m) (Ogden 1997). Considering an extreme case of a sonic boom that generates maximum overpressure of 50 psf in air, it would become an impulsive wave in water with a maximum peak pressure of 100 psf or about 0.7 psi. Therefore, even a worst case situation for sonic booms would produce a peak pressure in water well below the level that would cause harm to marine mammals or sea turtles (Laney and Cavanagh 2000).

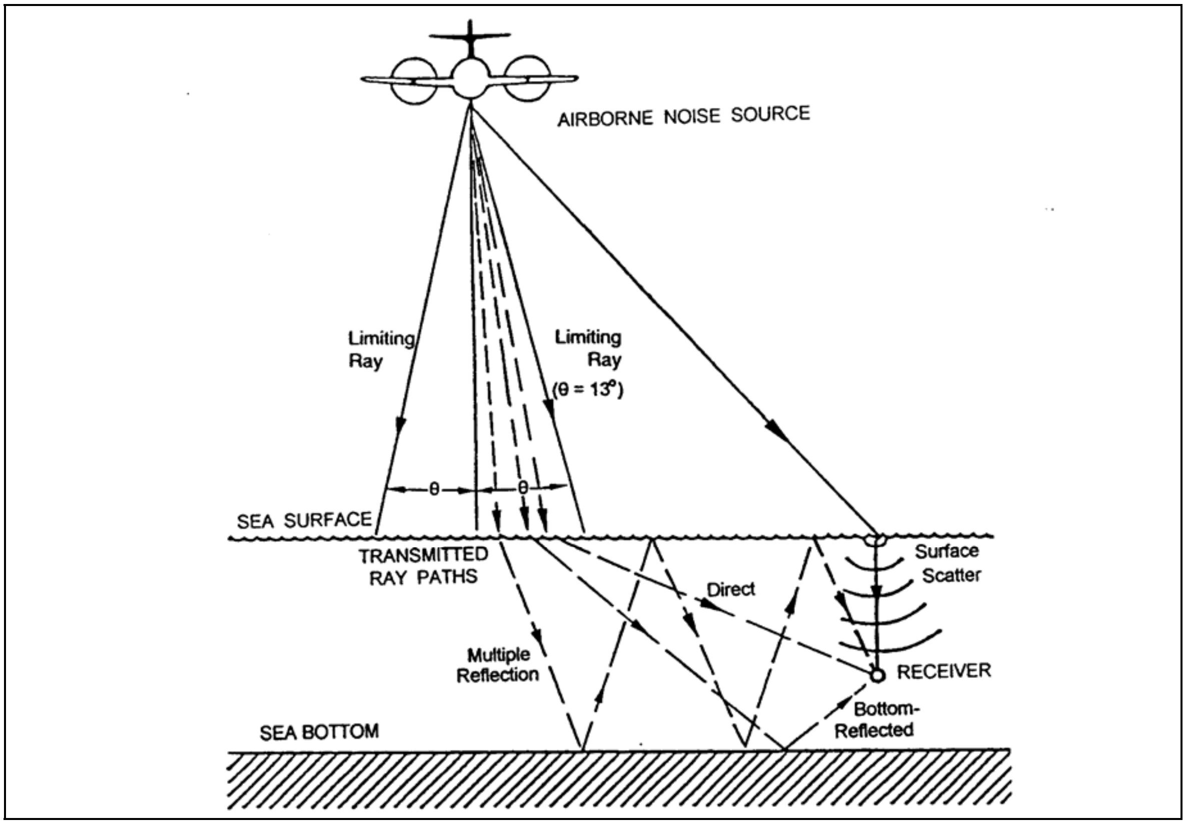


Figure 3.7-12: Characteristics of Sound Transmission through Air-Water Interface

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. Exposure to fixed-wing aircraft noise would be brief (seconds) as an aircraft quickly passes overhead. As stated in Appendix D, insertion / extraction training events would involve fixed wing aircraft at altitudes greater than 25,000 ft (7,576 m) or less than 1,000 ft (303 m). 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 [227 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 to 1,100 ft [242 to 333 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. Smultea *et al.* (2008) reported population study results where a significant subset of groups approached within 1,180 ft (360 m) responded with sudden dives or group formations that the researchers interpreted as agitation, distress, and/or defense. 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).

Marine mammals exposed to a low-altitude fixed-wing aircraft overflight 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, but are 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. Helicopter overflights can occur throughout the MIRC Study Area. Unlike fixed-wing aircraft, helicopters would fly above the surface at 200 to 400 ft (61 to 122 m) altitude, and hover for an insertion or extraction exercise as low as 20 ft (6 m) above the surface.

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 propellers (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 approximately 500 ft (150 m) or higher.

Marine mammals exposed to a low-altitude helicopter overflight could exhibit a short-term behavioral response, but not to the extent where natural behavioral patterns would be abandoned or significantly 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 may affect ESA-listed marine mammals, but 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 significant impact on marine mammals. Furthermore, helicopter 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.

Vessel Movements. Many of the ongoing and proposed training events within the MIRC 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 MIRC Study Area is dependent upon several factors including numbers, types, and speeds of vessels; the regularity, duration, and spatial extent of training events; the presence/absence and density of marine mammals; and mitigation measures implemented by the Navy. Currently, the number of Navy vessels operating in the MIRC Study Area varies based on training schedules and can range from zero to about ten vessels at any given time. Ship sizes range from 362 ft (110 m) for a nuclear submarine (SSN) to 1,092 ft (331 m) for a nuclear aircraft carrier (CVN). Speeds are typically within 10 to 14 knots; however, slower or faster speeds are possible depending upon the specific training scenario. Training involving vessel movements occurs intermittently and is variable in duration, ranging from a few hours up to two weeks. These training events are widely dispersed. Consequently, the density of ships within the MIRC Study Area at any given time is extremely low (*i.e.*, less than 0.0002 ships/nm^2). The Navy logs about 1,000 total vessel days within the MIRC Study Area during a typical year.

Globally, marine mammals are frequently exposed to vessels due to research, ecotourism, commercial and private vessel traffic, and government activities; many of these activities occur in the Mariana Islands. Vessel strikes to marine mammals are a significant cause of mortality and stranding (Laist *et al.* 2001; Geraci and Lounsbury 2005; de Stephanis and Urquiola 2006). After reviewing historical records and computerized stranding databases for evidence of ship strikes involving baleen and sperm whales, Laist *et al.* (2001) found that accounts of large whale ship strikes involving motorized boats date back to at least the late 1800s. Ship collisions remained infrequent until the 1950s, after which point they increased. 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. Berzin (1972) noted that there were "many" reports of sperm whales of different age classes being struck by vessels, including passenger ships and tug boats. There were also instances in which sperm whales approached vessels too closely and were cut by the propellers (NMFS 2006b). In the Canary Islands, Spain, de Stephanis and Urquiola 2006) reported that 37 marine mammals had been struck by vessels since 1985, with significant increases in strikes with the advent of inter-island fast ferry service since 1999 (seven prior to 1997 and 30 after 1998).

Although the most vulnerable marine mammals may be assumed to be slow-moving cetaceans or those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (*e.g.*, sperm whale), fin whales are actually struck most frequently (Laist *et al.* 2001, Jensen and Silber 2003, Panigada *et al.* 2006, Nelson *et al.* 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 over 85,000 vessels in 1998 (NRC 2003; Southall 2005). Between 1950 and 1998, the U.S. flagged fleet declined from approximately 25,000 to less 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 (Best *et al.* 2001; Knowlton and Kraus 2001; Laist *et al.* 2001; IWC 2007; Glass *et al.* 2008). In addition, there is limited information on vessel strike interactions between ships and marine mammals outside of U.S. waters (Laist *et al.* 2001; de Stephanis and Urquiola 2006; Glass *et al.* 2008). Laist *et al.* (2001) and Glass *et al.* (2008) 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 population segments.

Of 11 species known to be hit by ships in a world-wide context, fin whales are struck most frequently; right whales, humpback whales, sperm whales, and gray whales are hit commonly (Laist *et al.* 2001). De Stephanis and Urquiola (2006) also report multiple ship strikes on sperm whales, beaked whales, and other medium sized toothed whales such as pilot whale, and pygmy sperm whales in the Canary Islands. Smaller marine mammals such as dolphins move more quickly throughout the water column and are often seen riding the bow wave of large ships. The severity of injuries to any marine mammal subject to ship strike typically depends on the size and speed of the vessel (Knowlton and Kraus 2001; Laist *et al.* 2001; Vanderlaan and Taggart 2007). Richardson *et al.* (1995) and Southall (2005) summarizes some of the previous research and data gaps on vessel noise impacts on marine mammals. Reactions to vessels and potential for ship strikes are best summarized by grouping of species with similar behaviors and diving characteristics, as follows:

- ***Fin and Humpback Whales:*** Fin whales have been observed altering their swimming patterns by increasing speed and heading away from the vessel, as well as their breathing patterns in response to a vessel approach (Jahoda *et al.* 2003). Observations have shown that when vessels remain 330 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. In this study, 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 6,600 ft (0 and 2,000 m) away (Baker *et al.* 1983): 1) horizontal avoidance (changing direction and/or speed) when vessels were between 6,600 and 13,200 ft

(2,000 and 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.

- ***Blue and Sei Whales:*** There is little information on blue whale or sei whale response to vessel presence (NMFS 1998b; NMFS 1998a). 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.
- ***Sperm Whales:*** Sperm whales spend long periods (typically up to ten minutes; Jacquet *et al.* 1998) “rafting” at the surface between deep dives. This could make them exceptionally vulnerable to ship strikes. Berzin (1972) noted that there were “many” reports of sperm whales of different age classes being struck by vessels, including passenger ships and tug boats. There were also instances in which sperm whales approached vessels too closely and were cut by the propellers (NMFS 2006b).
- ***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.
- ***Dwarf and Pygmy Sperm Whales and Beaked Whales:*** The two species of *Kogia* and beaked whales generally avoid vessels; however, when in close proximity to vessels, Wursig *et al.* (1998) observed quick diving behavior and avoidance measures.

In summary, 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 (*e.g.*, sperm whale). In addition, some baleen whales, such as the northern right whale and fin whale swim slowly and seem generally unresponsive to ship sound, making them more susceptible to ship strikes (Nowacek *et al.* 2004).

The Navy has adopted standard protective measures that reduce the potential for collisions with surfaced marine mammals and sea turtles. At all times when ships are underway, there are many people on watch scanning the area around the ship. If a marine mammal or sea turtle is sighted, appropriate action will be taken to avoid the animal. Collisions with marine mammals are not expected to occur. Navy lookouts are trained in marine mammal identification with curriculum approved by NMFS, which includes species-specific characteristics to aid in species identification and tell-tail signs of marine mammal presence in the vicinity of a ship. These signs and identification keys include tall blows, whale silhouettes, physical size of animals, and group size.

3.7.3.5.2 Expended Materials—Ingestion, Entanglement, and Direct Strike

Marine mammals become entangled in abandoned fishing gear and cannot submerge to feed or surface to breathe; they may lose a limb, attract predators with their struggling, or interrupt normal life functions. Debris, such as sonobuoy floats and parachutes, torpedo parachutes, and missile and target components that float may be encountered by marine mammals in the waters of the MIRC. Entanglement in military-related debris was not cited as a source of injury or mortality for any marine mammals recorded in a large marine mammal and sea turtle stranding database for Californian waters. That is most likely attributable to the relatively low density of military debris that remains on or near the sea surface where it might be encountered by a marine mammal. Parachute and cable assemblies used to facilitate target recovery are collected in conjunction with the target during normal operations. Sonobuoys and flares sink along with the attached parachutes. Range scrap/debris and munition constituents will not likely interfere with marine mammal species in the MIRC Study Area.

Torpedo Guidance Wire. The potential entanglement impact of MK 48 torpedo control wires on marine mammals is very low because of the following:

The control wire is very thin (approximately 0.02 in. [0.5 mm]) and has a relatively low breaking strength. Even with the exception of a chance encounter with the control wire while it was sinking to the sea floor (at an estimated rate of 0.5 ft/sec [0.15 m/sec]), a marine animal would not be vulnerable to entanglement given the low breaking strength.

The torpedo control wire is held stationary in the water column by drag forces as it is pulled from the torpedo in a relatively straight line until its length becomes sufficient for it to form a catenary droop (DoN 1996). When the wire is released or broken, it is relatively straight and the physical characteristics of the wire prevent it from tangling, unlike the monofilament fishing lines and polypropylene ropes identified in the entanglement literature (DoN 1996). The Navy therefore believes the potential for any harm or harassment to these species from torpedo guidance wires is extremely low.

ASW is a primary warfare area for Navy patrol ships (surface and submarines), aircraft, and ASW helicopters. ASW aircrews must practice using sensors, including electro-optical devices, radar, magnetic anomaly detectors, and sonar (including helicopter dipping sonar and both active and passive sonobuoys) in both the deep and shallow water environment. The training events being analyzed are not new and have taken place in the MIRC over the past 40 years, and with no significant changes in the equipment being used in the last 30 years. Although there may be many hours of active ASW sonar events, the actual “pings” of the sonar signal may only occur several times a minute, as it is necessary for the ASW operators to listen for the return echo of the sonar ping. As a result of scientific advances in acoustic exposure effects analysis modeling on marine mammals, the extent of acoustic exposure on marine mammals can be estimated.

Torpedo Flex Hoses. Improved flex hoses or strong flex hoses will be expended during torpedo exercises. DoN (1996) analyzed the potential for the flex hoses to affect sea turtles. This analysis concluded that the potential entanglement effects to marine animals will be insignificant for reasons similar to those stated for the potential entanglement effects of control wires:

- Due to its weight, the flex hoses will rapidly sink to the bottom upon release. With the exception of a chance encounter with the flex hose while it was sinking to the sea floor, a marine animal would be vulnerable to entanglement only if its diving and feeding patterns placed it in contact with the bottom.

- Due to its stiffness, the 250-ft (76 m)-long flex hose will not form loops that could entangle marine animals.

Parachutes. Aircraft-launched sonobuoys, torpedoes, and EMATTs deploy nylon parachutes of varying sizes. At water impact, the parachute assembly is expended, and it sinks away from the exercise sonobuoy or torpedo. The parachute assembly will potentially be at the surface for a short time before sinking to the sea floor. Entanglement and the eventual drowning of a sea turtle in a parachute assembly will be unlikely, since the parachute will have to land directly on an animal, or an animal will have to swim into it before it sinks. The potential for a sea turtle to encounter an expended parachute is extremely low, given the generally low probability of a sea turtle being in the immediate location of deployment.

All of the material is negatively buoyant and will sink to the ocean floor. Many of the components are metallic and will sink rapidly. The expended material will accumulate on the ocean floor and will be covered by sediments over time, thereby remaining on the ocean floor, reducing the potential for entanglement. This accrual of material is not expected to cause an increased potential for sea turtle 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 parachute assembly and the potential for accidental entanglement in the canopy or suspension lines is considered to be unlikely.

The overall possibility of marine mammals ingesting parachute fabric or becoming entangled in cable assemblies is very remote.

Falling Debris. Marine mammals are widely dispersed in the MIRC, therefore, there is an extremely low probability of injury to a marine mammal from falling debris and shock waves from inert munitions and target impacts on the water surface. As discussed in Chapter 2, "nonvirtual" surface targets include MK-42 FAST, MK-58 markers, SEPTARs, ISTTs, or decommissioned hulks.

ASW Training Targets. ASW training targets are used to simulate target submarines. They are equipped with one or a combination of the following devices: (1) acoustic projectors emanating sounds to simulate submarine acoustic signatures; (2) echo repeaters to simulate the characteristics of the echo of a particular sonar signal reflected from a specific type of submarine; and (3) magnetic sources to trigger magnetic detectors.

Two anti-submarine warfare targets are used in the MAA. The first is the MK 30 Mobile ASW Training Target. The MK 30 target is a torpedo-like, self-propelled, battery powered underwater vehicle capable of simulating the dynamic, acoustic, and magnetic characteristics of a submarine. The MK-30 is 21 inches in diameter and 20.5 feet in length. These targets are launched by aircraft and surface vessels and can run approximately four hours dependent on the programmed training scenario. The MK 30 is recovered after the exercise for reconditioning and subsequent reuse. The MK 30 has no discharges into the environment and fulfills the need for a convenient, cost-effective means for training Navy units in ASW.

3.7.3.5.3 Effects of Shock Waves from Mines, Inert Bombs, Missiles and Targets Striking the Water's Surface

Mines, inert bombs, or intact missiles or targets fall into the waters of the MIRC during the following exercises:

- MCMEX
- MISSILEX
- SINKEX

- BOMBEX
- GUNEX

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 sound 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 affect marine mammals in proximity. The rise times of these shock waves are very short and the effects of shock waves from mines, inert bombs, and intact missiles and targets hitting the water surface on marine mammals are expected to be localized and minimal.

Torpedo Strike Impact. There is negligible risk that a marine mammal could be struck by a torpedo during ASW training events. This conclusion is based on a review of ASW torpedo design features. The torpedoes are specifically designed to ignore false targets. As a result, their homing logic does not detect or recognize the relatively small air volume associated with the lungs of marine mammals. They do not detect or home to marine mammals. In addition, there has never been a recoverable reconditioned practice torpedo (numbered in the thousands) which showed evidence of having inadvertently struck a marine mammal, which would have been apparent given the fragile nature of the components at the head of the torpedo.

3.7.3.6 No Action Alternative

3.7.3.6.1 Nonacoustic Exposures Summary

All Stressors. In an ESA context nonacoustic associated potential impacts under the No Action Alternative may affect ESA-listed whales. Based on the descriptions of vessel movements, expended materials, and other nonacoustic stressors included in subsection 3.7.3.5, the nonacoustic stressors are not expected to result in Level A or Level B harassment as defined by the MMPA. Although the nonacoustic stressors may affect ESA-listed marine mammals, these effects are not expected to result in take by harming or harassing ESA-listed marine mammals. Therefore, in accordance with NEPA, nonacoustic stressors would have no significant impact on marine mammals in territorial waters. Furthermore, in accordance with EO 12114, nonacoustic stressors would not cause significant harm to marine mammals in non-territorial waters.

3.7.3.6.2 Acoustic Exposures Summary

Sonar Exposures. 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 used in the model, and that the model results must be interpreted within the context of a given species' ecology. When reviewing the acoustic effects modeling results, it is also important to understand that the estimates of marine mammal sound exposures are presented without consideration of standard mitigation operating procedures or the fact that there have been no confirmed acoustic effects on any marine species in previous MIRC exercises or from any other mid-frequency active sonar training events within the MIRC.

All Level B harassment would be short term and temporary in nature. In addition, the short-term non injurious exposures predicted to cause TTS or temporary behavioral disruptions are considered Level B harassment even though it is highly unlikely that the disturbance would be to a point where behavioral patterns are abandoned or significantly altered. The modeling for MIRC analyzed the potential interaction of mid-frequency active tactical sonar and underwater detonations with marine mammals that occur in the MIRC.

The annual estimated number of exposures for mid-frequency active sonar and underwater detonations (mine neutralization, MISSILEX, BOMBEX, and GUNEX) are given for each species. The modeled exposure is the probability of a response that NMFS would classify as harassment under the MMPA. These exposures are calculated for all activities modeled and represent the total exposures per year and are not based on a per day basis.

The resulting exposure numbers are generated by the model without consideration of mitigation measures that would reduce the potential for marine mammal exposures to sonar and other activities.Table 3.7-8 summarizes the predicted annual usage for different sonar sources under the No Action Alternative. Table 3.7-9 provides the number of exposures modeled based on risk function, the TTS threshold, and the PTS threshold. Table 3.7-10 provides a summary of the total sonar exposures from ASW training (for MFA) that will be conducted under the No Action Alternative over the course of a year.

Table 3.7-8: No Action Alternative—Summary of Predicted Annual Usage of Sonar Sources in the MIRC

Exercise	SQS 53C Sonar Hours	SQS 56 Sonar Hours	Sub BQQ Hours	Total Sonar Hours	Number of Dips for AQS-22	Number of DICASS Sonobuoy Deployment	MK-48 Torpedo Events
Major Exercise	1,705	77	0	1,782	288	1,282	0
Other ASW	120	20	6	146	144	100	20
Total Hours or Number of Events	**1,825**	**97**	**6**	**1,928**	**432**	**1,368**	**20**

Table 3.7-9: Sonar Exposures by Sonar Source Type

Source	Risk Function	TTS	PTS
SQS-53C	67,344	1,097	1
SQS-56	169	0	0
BQQ-10 Submarine sonar	21	0	0
AQS-22 Dipping Sonar	167	0	0
SSQ-62 DICASS Sonobuoy	118	0	0
MK-48 Torpedo Sonar	39	10	0
Total	**67,872**	**1,097**	**1**

Table 3.7-10: No Action Alternative—Summary of Estimated Level A and Level B Annual Exposures from All MFA ASW Sonar

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Function	TTS	PTS
ESA Species			
Blue whale	113	2	0
Fin whale	157	2	0
Humpback whale	0	0	0
Sei whale	277	5	0
Sei and Bryde's whale	54	1	0
Sperm whale	708	9	0
Unidentified Balaenopterid	62	1	0
Mysticetes			
Bryde's whale	392	7	0
Minke whale	382	6	0
Odontocetes			
Blainville's beaked whale	664	11	0
Common bottlenose dolphin	148	3	0
Cuvier's beaked whale	3,131	40	0
Pygmy and Dwarf sperm whale	5,755	92	0
False killer whale	1,109	20	0
Fraser's dolphin	3,955	66	0
Ginkgo-toothed beaked whale	368	6	0
Killer whale	200	5	0
Longman's beaked whale	180	2	0
Melon-headed whale	2,452	42	0
Pantropical spotted dolphin	28,004	452	1
Pygmy killer whale	140	2	0
Bottlenose rough-toothed dolphin	64	1	0
Risso's dolphin	5,792	97	0
Rough-toothed dolphin	207	4	0
Short-beaked common dolphin	802	15	0
Short-finned pilot whale	1,960	32	0
Spinner dolphin	1,837	32	0
Striped dolphin	7,633	123	0
Unidentified delphinid	1,326	21	0
Total	67,872	1,097	1

MFA and HFA Sonar Risk Function Curve 120-195 dB SPL
195 dB – TTS 195-215 dB re 1 µPa^2-s
215 dB- PTS >215 dB re 1 µPa^2-s
TTS = temporary threshold shift
PTS = permanent threshold shift

3.7.3.6.3 Explosive Exposure Summary

The modeled exposure harassment numbers for all training events involving explosives are presented by species in Table 3.7-11. The modeling indicates that under the No Action Alternative, 42 exposures to marine mammals would be considered behavioral harassment. Fifteen annual exposures would result in TTS (Level B harassment). Under the No Action Alternative, there would be no exposures that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Table 3.7-11: No Action Alternative—Summary of Estimated Level A and Level B Annual Exposures from Underwater Detonations

Species	Level B Exposures Behavioral Harassment 177 dB	Level B Exposures TTS 182 dB/23 psi	Level A Exposures 50% TM Rupture 205 dB or Slight Lung Injury 13 psi-ms	Onset Massive Lung Injury or Mortality 31 psi-ms
ESA Species				
Blue whale	0	0	0	0
Fin whale	0	0	0	0
Humpback whale	0	0	0	0
Sei whale	0	0	0	0
Sei and Bryde's whale	0	0	0	0
Sperm whale	0	0	0	0
Unidentified balaenopterid	0	0	0	0
Mysticetes				
Bryde's whale	0	0	0	0
Minke whale	0	0	0	0
Odontocetes				
Blainville's beaked whale	0	0	0	0
Common bottlenose dolphin	0	0	0	0
Cuvier's beaked whale	6	2	0	0
Pygmy and dwarf sperm whale	6	2	0	0
False killer whale	0	0	0	0
Fraser's dolphin	6	2	0	0
Ginkgo-toothed beaked whale	0	0	0	0
Killer whale	0	0	0	0
Longman's beaked whale	0	0	0	0
Melon-headed whale	6	2	0	0
Pantropical spotted dolphin	6	3	0	0
Pygmy killer whale	0	0	0	0
Bottlenose rough-toothed dolphin	0	0	0	0
Risso's dolphin	12	4	0	0
Rough-toothed dolphin	0	0	0	0
Short-beaked common dolphin	0	0	0	0
Short-finned pilot whale	0	0	0	0
Spinner dolphin	0	0	0	0
Striped dolphin	0	0	0	0
Unidentified delphinid	0	0	0	0
Total	42	15	0	0

dB – decibel; psi = pounds per square inch; ms = milli second; TM = Tympanic Membrane

3.7.3.6.4 Effects to ESA-Listed Species

The endangered species that may be affected as a result of the No Action Alternative include the blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), and sperm whale (*Physeter macrocephalus*). No risk function exposures, TTS, or PTS will occur for humpback whales (*Megoptera novaeangliae*) for sonar use or underwater detonations under the No Action Alternative.

Blue Whales. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 113 blue whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be two exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No blue whales would be exposed to sound levels that could cause PTS. The modeling analysis for underwater detontations estimates blue whales would not be exposed to behavioral disturbance events, Level B or Level A harassment and injury events, or exposures resulting in mortality.

Without consideration of clearance procedures, there would be no exposures from impulsive sound, and no exposures from underwater detonations that would exceed the TTS threshold; no exposure that would exceed the onset of slight injury threshold, and no exposure that would exceed the onset of massive lung injury or mortality threshold.

Given the large size (up to 98 ft [30 m]) of individual blue whales (Leatherwood *et al.* 1982), pronounced vertical blow, and aggregation of approximately two to three animals in a group (probability of track line detection = 0.90 in Beaufort Sea States of 6 or less), it is likely that lookouts would detect a group of blue whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, blue whale behavior and acoustics, past training events, and the implementation of mitigation measures (continued from past SINKEX events), the Navy finds that the No Action Alternative would not likely result in any death or injury to blue whales. Modeling does indicate the potential for Level B harassment, indicating the proposed ASW exercises may affect (as defined by ESA) blue whales.

Fin Whales. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 157 fin whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be two exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No fin whales would be exposed to sound levels that could cause PTS. The modeling analysis for underwater detonations estimates fin whales would not be exposed to behavioral disturbance events, Level B or Level A harassment and injury events, or exposures resulting in mortality.

Given the large size (up to 78 ft [24m]) of individual fin whales (Leatherwood *et al.* 1982), pronounced vertical blow, mean aggregation of three animals in a group (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of fin whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

In the St. Lawrence estuary area, fin whales avoided vessels with small changes in travel direction, speed and dive duration, and slow approaches by boats usually caused little response (MacFarlane 1981). Fin whales continued to vocalize in the presence of boat sound (Edds and MacFarlane 1987), indicating that the presence of vessels would not disturb fin whales significantly enough where takes of this species would occur. Even though any undetected fin whales transiting the MIRC Study Area may exhibit a reaction when initially exposed to active acoustic energy, field observations indicate the effects would not cause disruption of natural behavioral patterns to a point where such behavioral patterns would be abandoned or significantly altered.

Based on the model results, behavioral patterns, acoustic abilities of fin whales, results of past training, and the implementation of mitigation measures for sonar and for underwater detonations, the Navy finds that the MIRC training events would not likely result in any death or injury to fin whales. Modeling does indicate the potential for Level B harassment, indicating the proposed ASW exercises may affect fin whales.

Humpback Whales. Although humpback whales are known to occur in the MIRC, their seasonal migration does not coincide with major exercises; therefore the risk function and Navy post-modeling analysis estimates that under the No Action Alternative, no humpback whales will be exposed to sound levels that exhibit behavioral responses that NMFS will classify as harassment under the MMPA. Modeling also indicates there would be no exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No humpback whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, none that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Based on the model results, the nature of Navy's training, and behavioral patterns of humpback whales, the Navy finds that the MIRC sonar and underwater detonation training events under the No Action Alternative would not affect humpback whales.

Sei Whales. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 277 sei whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be five exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No sei whales would be exposed to sound levels that could cause PTS.

The modeling estimates no behavioral disturbance exposures from underwater detonations. There would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposure that would exceed the onset of massive lung injury or mortality threshold

In addition, Bryde's and sei whales are often difficult to distinguish at sea and the Navy's 2007 survey in the Mariana Islands had three sightings which were classified as Bryde's/sei whales (DoN 2007b). Estimates were also made using the density for this group. The risk function and Navy post-modeling analysis estimates 54 Bryde's/sei whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be one exposure to accumulated acoustic energy above 195 dB re 1 μPa^2-s. As for underwater detonations, behavioral disturbance events, injury or mortality are not expected to occur.

Given the large size (up to 53 ft [16m]) of individual sei whales (Leatherwood *et al.* 1982), pronounced vertical blow, aggregation of approximately three animals (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of sei whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

There is little information on the acoustic abilities of sei whales or their response to human activities. The only recorded sounds of sei whales are frequency modulated sweeps in the range of 1.5 to 3.5 kHz (Thompson *et al.* 1979) but it is likely that they also vocalized at frequencies below 1 kHz as do fin whales. Sei whales were more difficult to approach than were fin whales and moved away from boats but were less responsive when feeding (Gunther1949).

Based on the model results, behavioral patterns, acoustic abilities of sei whales, results of past training, and the implementation of mitigation measures presented for sonar and underwater detonations, the Navy finds that the MIRC training events would not likely result in any death or injury to sei whales. Modeling does indicate the potential for Level B harassment, indicating the proposed ASW exercises may affect sei whales.

Sperm Whales. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 708 sperm whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be nine exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No sperm whales would be exposed to sound levels that could cause PTS.

As for impulsive sound or pressures from underwater detonations, there would be no exposures that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold or mortality.

Given the large size (up to 56 ft [17m]) of individual sperm whales (Leatherwood *et al.* 1982), pronounced blow (large and angled), mean group size of approximately seven animals (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow 2003; 2006), it is likely that lookouts would detect a group of sperm whales at the surface. Sperm whales can make prolonged dives of up to two hours making detection more difficult but passive acoustic monitoring can detect and localize sperm whales from their calls (Watwood *et al.* 2006). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

In the unlikely event that sperm whales are exposed to mid-frequency sonar, the information available on sperm whales exposed to received levels of active mid-frequency sonar suggests that the response to mid-frequency (1 kHz to 10 kHz) sounds is variable (Richardson *et al.* 1995). While Watkins *et al.* (1985) observed that sperm whales exposed to 3.25 kHz to 8.4 kHz pulses interrupted their activities and left the area, other studies indicate that, after an initial disturbance, the animals return to their previous activity. 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. When resting at the surface in a compact group, sperm whales initially reacted strongly but then ignored the signal completely (André *et al.* 1997).

Based on the model results, behavioral patterns, acoustic abilities of sperm whales, results of past training, and the implementation of mitigation measures for sonar and underwater detonations, the Navy finds that the MIRC training events would not likely result in any death or injury to sperm whales. Modeling does indicate the potential for Level B harassment, indicating the proposed ASW exercises may affect sperm whales.

3.7.3.6.5 Estimated Exposures for Non-ESA Species

Bryde's Whale. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 392 Bryde's whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be seven exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Bryde's whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would induce behavioral changes or exceed TTS or PTS thresholds.

Given the large size (up to 46 ft. [14 m]) of individual Bryde's whales, pronounced blow, and mean group size of approximately 1.5 animals and (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow 2003; 2006), it is likely that lookouts would detect a group of Bryde's whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of Bryde's whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to Bryde's whales.

Minke Whale. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 382 minke whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be six exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No minke whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposure that would exceed the onset of massive lung injury or mortality threshold.

Minke whales are difficult to spot visually but can be detected using passive acoustic monitoring (when available). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of minke whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to minke whales.

Blainville's Beaked Whale. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 664 Blainville's beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 11 exposures to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No Blainville's beaked whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposure that would exceed the onset of massive lung injury or mortality threshold.

Given the size (up to 15.5 ft. [4.7 m]) of individual Blainville's beaked whales, aggregation of 2.3 animals, it is likely that lookouts would detect a group of Blainville's beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird *et al*. 2004). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to Blainville's beaked whales.

Bottlenose Dolphin. The risk function and Navy post-modeling analysis estimates 148 bottlenose dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be three exposure to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No bottlenose dolphins would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS or PTS limits.

Given the frequent surfacing, aggregation of approximately nine animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of bottlenose dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of bottlenose dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to bottlenose dolphins.

Cuvier's Beaked Whale. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 3,131 Cuvier's beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 40 exposures to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No Cuvier's beaked whale would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be six exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, two exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, none that would exceed the onset of slight injury threshold, and no exposure that would exceed the onset of massive lung injury or mortality threshold.

Given the medium size (up to 23 ft. [7.0 m]) of individual Cuvier's beaked whales, aggregation of approximately two animals (Barlow 2006), it is likely that lookouts would detect a group of Cuvier's beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird *et al.* 2004). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of Cuvier's beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to Cuvier's beaked whales.

Dwarf and Pygmy Sperm Whales. Dwarf and pygmy sperm whales are difficult to distinguish from each other at sea, therefore, the two species were combined for acoustic exposure modeling. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 5,755 dwarf/pygmy sperm whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 92 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No dwarf/pygmy sperm whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be six exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, two exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, none that would exceed the onset of slight injury threshold, and no exposure that would exceed the onset of massive lung injury or mortality threshold.

The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of dwarf/pygmy sperm whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to dwarf/pygmy sperm whales.

False Killer Whale. The risk function and Navy post-modeling analysis estimates 1,109 false killer whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 20 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No dwarf sperm whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposure that would exceed the onset of massive lung injury or mortality threshold.

Given their size (up to 19.7 ft [6 m]) and large mean group size of 10.3 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of false killer whales at the surface. Additionally, mitigation measures call for continuous visual observation during training with active sonar; therefore, false killer whales that are present in the vicinity of ASW training events would be detected by visual observers. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of false killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to false killer whales.

Fraser's Dolphin. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 3,955 Fraser's dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 66 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Fraser's dolphins would be exposed to sound levels that could cause PTS.

Modeling indicates there would be six exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, two exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury or onset of massive lung injury.

Given their large aggregations, mean group size of 286.3 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow 2006), it is likely that lookouts would detect a group of Fraser's dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of Fraser's dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to Fraser's dolphins.

Ginkgo-Toothed Beaked Whale. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 368 ginkgo-toothed beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be six exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No ginkgo-toothed beaked whale would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposure that would exceed the onset of massive lung injury or mortality threshold.

Given the size (up to 15.5 ft. [4.7 m]) of individual ginkgo-toothed beaked whales, aggregation of 2.3 animals, lookouts may detect a group of ginkgo-toothed beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird *et al.* 2004). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of ginkgo-toothed beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to ginkgo-toothed beaked whales.

Killer Whale. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 200 killer whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be five exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No killer whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposure that would exceed the onset of massive lung injury or mortality threshold.

Given their size (up to 23 ft [7.0 m]), conspicuous coloring, pronounced dorsal fin and large mean group size of 6.5 animals (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003). It is likely that lookouts would detect a group of killer whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to killer whales.

Longman's Beaked Whale. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 180 Longman's beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be two exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Longman's beaked whale would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposure that would exceed the onset of massive lung injury or mortality threshold.

Given the size (up to 15.5 ft. [4.7 m]) of individual Longman's beaked whales, aggregation of 2.3 animals, lookouts may detect a group of Longman's beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird *et al.* 2004). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of Longman's beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to Longman's beaked whales.

Melon-Headed Whale. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 2,452 melon-headed whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 42 exposures to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No melon-headed whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be six exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, two exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, no exposures that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Mitigation measures call for continuous visual observation during training with active sonar; Given their size (up to 8.2 ft [2.5 m]) and large group size (mean of 89.2 whales or more animals) (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of melon-headed whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of melon-headed whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to melon-headed whales.

Pantropical Spotted Dolphin. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 28,004 pantropical spotted dolphin will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 452 exposures to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. One pantropical spotted dolphin would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be six exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, three exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, no exposures that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations. Given their frequent surfacing, large group size in the hundreds of animals (Leatherwood *et al.* 1982), and probability of trackline detection of 1.00 in Beaufort Sea States of 6 or less (Barlow 2006), it is likely that lookouts would detect a group of pantropical spotted dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of pantropical spotted dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to pantropical spotted dolphins. The exposures estimated by the model are the accumulation of all exposures for the entire year and therefore rises to the threshold of one PTS exposure for a pantropical spotted dolphin.

Pygmy Killer Whale. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 140 pygmy killer whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be two exposures to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No pygmy killer whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposures that would exceed the onset of massive lung injury or mortality threshold.

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 8.5 ft [2.6 m]) and mean group size of 14.4 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of pygmy killer whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to pygmy killer whales.

Risso's Dolphin. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 5,792 Risso's dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 97 exposures to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No Risso's dolphins would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be 12 exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, four exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, no exposures that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given their frequent surfacing, light coloration and large group size of up to several hundred animals (Leatherwood *et al.* 1982), mean group size of 15.4 Risso's dolphins and probability of trackline detection of 0.76 in Beaufort Sea States of 6 or less (Barlow 2006), it is likely that lookouts would detect a group of

Risso's dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of Risso's dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to Risso's dolphins.

Rough-Toothed Dolphin. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 207 rough-toothed dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be four exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No rough-toothed dolphins would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposures that would exceed the onset of massive lung injury or mortality threshold.

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations. Given their frequent surfacing and mean group size of 14.8 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2006), it is likely that lookouts would detect a group of rough-toothed dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of rough-toothed dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to rough-toothed dolphins.

Short-Beaked Common Dolphin. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 802 short-beaked common dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 15 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No short-beaked common dolphins would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given the frequent surfacing and their large group size of up to 1,000 animals (Leatherwood *et al.* 1982), it is likely that lookouts would detect a group of short-beaked common dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of short-beaked common dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to short-beaked common dolphins.

Short-Finned Pilot Whale. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 1,960 short-finned pilot whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 32 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No short-finned pilot whale would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given their size (up to 20 ft [6.1 m]), and large mean group size of 22.5 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2006). It is likely that lookouts would detect a group of short-finned pilot whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of short-finned pilot whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to short-finned pilot whales.

Spinner Dolphin. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 1,837 spinner dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 32 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No spinner dolphins would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given their frequent surfacing, aerobatics and large mean group size of 37.3 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow 2006), it is likely that lookouts would detect a group of striped dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of spinner dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to spinner dolphins.

Striped Dolphin. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 7,633 striped dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 123 exposures to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No striped dolphins would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given their frequent surfacing, aerobatics and large mean group size of 37.3 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow 2006), it is likely that lookouts would detect a group of striped dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of striped dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to striped dolphins.

Unidentified Balaenopterid Whales. Unidentified Balaenopterid whales (*Balaenoptera* spp.) would include those species, blue, fin, sei, Bryde's, and minke whales, that could not be distinguished due to distance from the survey ship and sea conditions. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 62 unidentified Balaenopterid whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be one exposure to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No unidentified Balaenopterid whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposures that would exceed the onset of massive lung injury or mortality threshold.

The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of unidentified Balaenopterid whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to unidentified Balaenopterid whales.

Unidentified Delphinids. Under the No Action Alternative, the risk function and Navy post-modeling analysis estimates 1,326 unidentified delphinids will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 21 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No unidentified delphinids would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given their frequent surfacing and generally large groups of delphinid species, it is likely that lookouts would detect a group of unidentified delphinids at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of unidentified delphinids, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under the No Action Alternative would not result in any population level effects, death, or injury to unidentified delphinids.

3.7.3.7 Alternative 1 (Preferred Alternative)

3.7.3.7.1 Nonacoustic Exposures Summary

All Stressors. In an ESA context nonacoustic associated potential impacts under Alternative 1 may affect ESA-listed whales. Based on the descriptions of vessel movements, expended materials, and other nonacoustic stressors included in subsection 3.7.3, the nonacoustic stressors are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, nonacoustic stressors would have no significant impact on marine mammals in territorial waters. Furthermore, nonacoustic stressors would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

3.7.3.7.2 Acoustic Exposures Summary

MFA/HFA Sonar Exposures. The total potential annual Level B harassment exposures from MFA and HFA sonar under Alternative 1, using the risk function (behavioral harassment and TTS) is 78,661. Behavioral effects modeling using the risk function methodology estimates 77,415 annual acoustic exposures that exceed the SPL risk function curve and would result in behavioral harassment (Level B harassment) for mid- and high-frequency sonar. The modeling estimates 1,246 annual exposures that exceed the threshold for TTS and would also result in Level B harassment. The modeling, without consideration of mitigation measures, estimates there will be two exposures to sound levels from sonar that may exceed the threshold for PTS (Level A harassment), one exposure for the pantropical spotted dolphin (*Stenella attenuata*) and one exposure for the sperm whale (*Physeter macrocephalus*). The sperm whale exposure estimate was the result of the annual accumulation of exposures whish reached the threshold of 0.05 exposure for ESA animals and no one activity reached the 0.05 exposure threshold. In addition, a sperm whale would have to be within 33 ft (10 m) of the sonar dome of a moving ship to be exposed to a sound level that could cause PTS. The summary of modeled sonar exposure harassment numbers by species are presented in Table 3.7-12 and represent potential harassment without implementation of mitigation measures.

For each of the types of exercises, marine mammals are exposed to mid-frequency sonar from several sources. Table 3.7-13 summarizes the predicted annual usage for different sonar sources under Alternative 1. Table 3.7-14 provides the number of exposures modeled based on risk function, the TTS threshold (195 dB), and the PTS threshold (215 dB). For PTS, the numbers are so small that only the total values are given. Each source is modeled separately and then the exposures are summed to get the number of exposures. This is a conservative approach in that if the more powerful 53C sonar overlaps one of the other sonars then the lesser sonar would not actually produce an exposure. However, for modeling purposes all sonar exposures were counted.

Table 3.7-12: Alternative 1—Summary of Predicted Annual Usage of Sonar Sources in the MIRC

Exercise	SQS 53C Sonar Hours	SQS 56 Sonar Hours	Sub BQQ Hours	Total Sonar Hours	Number of Dips for AQS-22	Number of DICASS Sonobuoy Deployments	MK-48 Torpedo Events
Major Exercise	1,705	77	0	1,782	288	1,282	0
Other ASW	368	64	12	444	304	172	40
Total Hours or Number of Events	**2,073**	**141**	**12**	**2,226**	**592**	**1,454**	**40**

Table 3.7-13: Sonar Exposures by Sonar Source Type

Source	Risk Function	TTS	PTS
SQS-53C	76,691	1,245	2
SQS-56	249	0	0
BQQ-10 Submarine sonar	48	0	0
AQS-22 Dipping Sonar	228	0	0
SSQ-62 DICASS Sonobuoy	123	0	0
MK-48 Torpedo Sonar	76	1	0
Total	**77,415**	**1,246**	**2**

The resulting exposure numbers are generated by the model without consideration of mitigation measures that would reduce the potential for marine mammal exposures to sonar and other activities. Table 3.7-14 provides a summary of the total sonar exposures from all Alternative 1 ASW training that will be conducted over the course of a year. Under Alternative 1, the risk function methodology estimates 77,415 annual exposures to MFA and HFA sonar that could result in a behavioral change (Level B harassment from behavioral harassment) and 1,246 annual exposures that could result in TTS (Level B harassment from TTS). The model estimates one annual exposure for a sperm whale and a pantropical spotted dolphin that exceed the PTS threshold (Level A harassment).

Table 3.7-14: Alternative 1—Summary of Estimated Level A and Level B Annual Exposures from All MFA ASW Sonar

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Function	TTS	PTS
ESA Species			
Blue whale	129	2	0
Fin whale	179	2	0
Humpback whale	0	0	0
Sei whale	317	6	0
Sei and Bryde's whale	61	1	0
Sperm whale	807	10	1
Unidentified Balaenopterid	72	1	0
Mysticetes			
Bryde's whale	448	8	0
Minke whale	437	7	0
Odontocetes			
Blainville's beaked whale	758	12	0
Common bottlenose dolphin	169	4	0
Bottlenose/rough-toothed	73	1	0
Cuvier's beaked whale	3,570	45	0
Pygmy and dwarf sperm whale	6,563	104	0
False killer whale	1,264	23	0
Fraser's dolphin	4,513	75	0
Ginkgo-toothed beaked whale	421	7	0
Killer whale	228	4	0
Longman's beaked whale	206	2	0
Melon-headed whale	2,798	47	0
Pantropical spotted dolphin	31,935	514	1
Pygmy killer whale	159	3	0
Risso's dolphin	6,608	110	0
Rough-toothed dolphin	236	5	0
Short-beaked common dolphin	915	17	0
Short-finned pilot whale	2,236	36	0
Spinner dolphin	2,096	36	0
Striped dolphin	8,705	140	0
Unidentified delphinid	1,512	24	0
Total	77,415	1,246	2

MFA and HFA Sonar Risk Function Curve 120-195 dB SPL
195 dB – TTS 195-215 dB re 1 μPa^2-s
215 dB- PTS >215 dB re 1 μPa^2-s
TTS = temporary threshold shift
PTS = permanent threshold shift

3.7.3.7.3 LFA Summary

As stated in Chapter 2 of this EIS/OEIS, the use of LFA sonar may occur during major exercises. As shown in Figure 3.7-13, the MIRC is within the SURTASS LFA western Pacific mission site area number 4, and excludes nearshore waters around shorelines. Estimates of potential effects to marine mammal stocks are below the criteria delineated by NMFS in its Final Rule. Furthermore, "small numbers" and "specified geographical region" are no longer requirements under the MMPA as amended by the National Defense Authorization Act of Fiscal Year 2004 (NDAA FY04).

The potential effects from SURTASS LFA sonar operations on any stock of marine mammals from injury (nonauditory or permanent loss of hearing) are considered negligible, and the potential effects on the stock of any marine mammal from temporary loss of hearing or behavioral change (significant change in a biologically important behavior) are considered minimal. Any auditory masking in marine mammals due to SURTASS LFA sonar signal transmissions is not expected to be severe and would be temporary. Therefore, in accordance with NEPA, LFA use during major exercises will not significantly impact marine mammals or marine mammal populations under Alternative 1. In accordance with EO 12114, Alternative 1 will not significantly harm marine mammals or marine mammal populations in non-territorial waters.

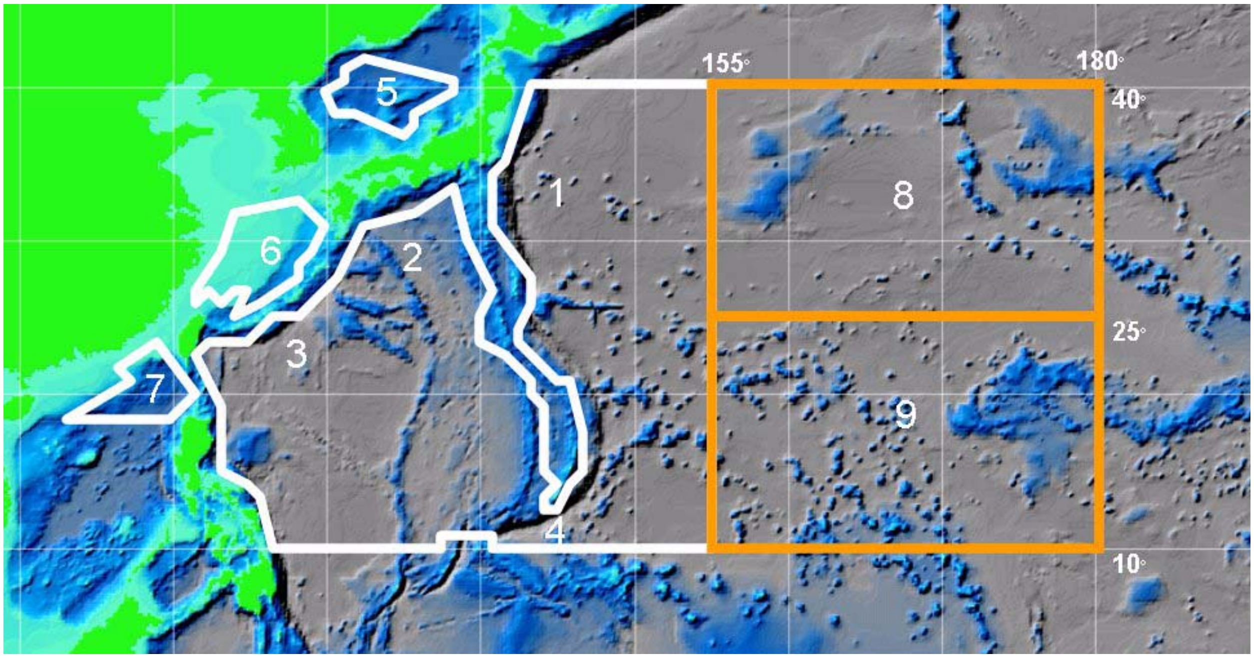


Figure 3.7-13: SURTASS LFA Mission Site Areas in the Western Pacific

3.7.3.7.4 Explosive Exposure Summary

The modeled exposure harassment numbers for Alternative 1 training operations involving explosives are presented by species in Table 3.7-15. The modeling indicates 109 annual exposures to pressure from underwater detonations that could result in behavioral harassment (part of Level B harassment) and 39 annual exposures to pressure from underwater detonations that could result in TTS (Level B harassment). The modeling indicates one exposure from pressure from underwater detonations that could cause slight injury (Level A harassment). The modeling indicates that no marine mammals would be exposed to pressure from underwater detonations that could cause severe injury or mortality.

Training events involving explosives include mine neutralization, MISSILEX, BOMBEX, SINKEX, GUNEX, and NSFS. The modeling efforts for Alternative 1 and Alternative 2 underwater detonations within Agat Bay and Apra Harbor considered 20-lb (9-kg) NEW charges. In a SINKEX, weapons are typically fired in order of decreasing range from the source with weapons fired until the target is sunk. 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 of maximum exposure. The sequence of weapons firing for a representative SINKEX is described in Chapter 2 of this EIS/OEIS. Guided weapons are nearly 100 percent accurate and are modeled as hitting the target 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. The model considers the percussive force of a direct hit; in other words, just because a target is hit does not mean that there is no effect to marine mammal. Unguided weapons are more frequently off-target and are modeled according to the statistical hit/miss ratios. These hit/miss ratios are artificially low in order to demonstrate a worst-case scenario or a higher likelihood for effect; they should not be taken as indicative of weapon or platform reliability.

Table 3.7-15: Alternative 1—Summary of Estimated Level A and Level B Annual Exposures from Underwater Detonations

Species	Level B Exposures 177 dB	Level B Exposures TTS 182 dB/23 psi	Level A Exposures 50% TM Rupture 205 dB or Slight Lung Injury 13 psi-ms	Onset Massive Lung Injury or Mortality 31 psi-ms
ESA Species				
Blue whale	0	0	0	0
Fin whale	0	0	0	0
Humpback whale	0	0	0	0
Sei whale	0	0	0	0
Sei / Bryde's whale	0	0	0	0
Sperm whale	6	2	0	0
Unidentified Balenoptera	0	0	0	0
Mysticetes				
Bryde's whale	0	0	0	0
Minke whale	0	0	0	0
Odontocetes				
Blainville's beaked whale	0	0	0	0
Bottlenose dolphin	0	0	0	0
Cuvier's beaked whale	12	4	0	0
Pygmy and dwarf sperm whale	20	6	0	0
False killer whale	0	0	0	0
Fraser's dolphin	12	4	0	0
Ginkgo-toothed beaked whale	0	0	0	0
Killer whale	0	0	0	0
Longman's beaked whale	0	0	0	0
Melon-headed whale	6	2	0	0
Pantropical spotted dolphin	12	7	0	0
Pygmy killer whale	0	0	0	0
Risso's dolphin	26	9	0	0
Rough-toothed dolphin	0	0	0	0
Short-beaked common dolphin	6	2	0	0
Short-finned pilot whale	0	0	0	0
Spinner dolphin	6	2	0	0
Striped dolphin	3	1	0	0
Unidentified balaenopterid	0	0	0	0
Unidentified delphinid	0	0	0	0
Total	109	39	0	0

dB – decibel
psi = pounds per square inch
ms = milli second
TM = Tympanic Membrane

It is highly unlikely that a marine mammal would experience any long-term effects because the large MIRC training areas makes individual mammals' repeated and/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. 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.

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 measures. The Navy will work through the MMPA incidental harassment regulatory process to discuss mitigation measures and their potential to reduce the likelihood for incidental harassment of marine mammals.

As described previously, modeling assumes that short-term noninjurious sound exposure levels predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment. This approach is an overestimation because there is no established scientific correlation between mid-frequency active sonar use and long term abandonment or significant alteration of behavioral patterns in marine mammals.

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.

3.7.3.7.5 Effects to ESA-Listed Species

The ESA-listed species that may be affected by sonar and underwater detonations as a result of Alternative 1 include the blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), and sperm whale (*Physeter macrocephalus*). The modeling estimated that no humpback whales (*Megaptera novaeangliae*) would be exposed to sound or pressure that would reach the threshold of a behavioral response.

Blue Whales. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 129 blue whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be two exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No blue whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given the large size (up to 98 ft [30 m]) of individual blue whales (Leatherwood *et al.* 1982), pronounced vertical blow, and aggregation of approximately two to three animals in a group (probability of track line detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of blue whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to

MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, behavioral patterns, acoustic abilities of blue whales, results of past training, and the implementation of mitigation measures presented for sonar and for underwater detonations, the Navy finds that the MIRC training events would not likely result in any death or injury to blue whales resulting from Alternative 1. Modeling does indicate the potential for Level B harassment, indicating the proposed ASW exercises may affect blue whales, but are not likely to cause long-term effects on their behavior or physiology or abandonment of areas that are regularly used by blue whales.

Fin Whales. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 179 fin whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be two exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No fin whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given the large size (up to 78 ft [24m]) of individual fin whales (Leatherwood *et al.* 1982), pronounced vertical blow, mean aggregation of three animals in a group (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003) it is likely that lookouts would detect a group of fin whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

In the St. Lawrence estuary area, fin whales avoided vessels with small changes in travel direction, speed and dive duration, and slow approaches by boats usually caused little response (MacFarlane 1981). Fin whales continued to vocalize in the presence of boat sound (Edds and MacFarlane 1987). Even though any undetected fin whales transiting the MIRC Study Area may exhibit a reaction when initially exposed to active acoustic energy, field observations indicate the effects would not cause disruption of natural behavioral patterns to a point where such behavioral patterns would be abandoned or significantly altered.

Based on the model results, behavioral patterns, acoustic abilities of fin whales, results of past training, and the implementation of mitigation measures for sonar and for underwater detonations, the Navy finds that the MIRC training events would not likely result in any death or injury to fin whales. Modeling does indicate the potential for Level B harassment, indicating the proposed ASW exercises may affect fin whales.

Humpback Whales. Although humpback whales are known to occur in the MIRC, their seasonal migration does not coincide with major exercises; therefore the risk function and Navy post-modeling analysis estimates that under Alternative 1, no humpback whales will be exposed to sound levels that exhibit behavioral responses that NMFS will classify as harassment under the MMPA. Modeling also indicates there would be no exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No humpback whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, none that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Based on the model results, the nature of Navy's training, and behavioral patterns of humpback whales, the Navy finds that the MIRC sonar and underwater detonation training events under Alternative 1 would not affect humpback whales.

Sei Whales. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 317 sei whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be six exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No sei whales would be exposed to sound levels that could cause PTS.

Bryde's and sei whales are often difficult to distinguish at sea and the Navy's 2007 survey in the Mariana Islands had three sightings which were classified as Bryde's/sei whales (DoN 2007b). Therefore, estimates were also made using the density for this group. The risk function and Navy post-modeling analysis estimates 61 Bryde's/sei whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be one exposure to accumulated acoustic energy above 195 dB re 1 μPa^2-s.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given the large size (up to 53 ft [16m]) of individual sei whales (Leatherwood *et al.* 1982), pronounced vertical blow, aggregation of approximately three animals (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of sei whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, behavioral patterns, acoustic abilities of sei whales, results of past training, and the implementation of mitigation measures presented for sonar and underwater detonations, the Navy finds that the MIRC training events would not likely result in any death or injury to sei whales. Modeling does indicate the potential for Level B harassment, indicating the proposed ASW exercises may affect sei whales.

Sperm Whales. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 807 sperm whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 10 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. One sperm whale would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be six exposures that would exceed the threshold for behavioral harassment, two exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, none that would exceed the onset of slight injury threshold and no exposure that would exceed the onset of massive lung injury or mortality threshold.

Given the large size (up to 56 ft [17m]) of individual sperm whales (Leatherwood *et al.* 1982), pronounced blow (large and angled), mean group size of approximately seven animals (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow 2003; 2006), it is likely that lookouts would detect a group of sperm whales at the surface. Sperm whales can make prolonged dives of up to two hours making detection more difficult but passive acoustic monitoring can detect and localize sperm whales from their calls (Watwood *et al.* 2006). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

The estimated PTS exposures are the accumulation of all exposures that exceeded the threshold of 215 dB re 1 μPa^2-s for an entire year and, therefore, rise to the threshold of one Level A exposure from active sonar (0.05 exposure threshold for ESA species). When analyzing the exposures of individual activites, including the multi-strike group (0.04 PTS exposures), TRACKEX (0.01 PTS exposures), and TORPEX (0 exposures), the exposures associated with each activity do not reach the threshold of a Level A exposure, only the annual accumulation of all activities reach the threshold. In addition, a sperm whale would have to be within 33 ft (10 m) of an SQS-53C sonar dome to be exposed to a sound level that would cause PTS. It is unlikely that a sperm whale, which can detect mid-frequency active sonar, would be that close to a moving ship using sonar. The predicted exposures are presented without consideration of mitigation measures that may reduce exposure to active sonar by detecting this large species at the surface although due to their deep (maximum of 3,910 ft [1,192 m]) and long duration (30-40 min) diving behavior, their presence at the surface would be infrequent (Amano and Yoshioka 2003; Watwood *et al*. 2006).

Based on the model results, behavioral patterns, acoustic abilities of sperm whales, results of past training, and the implementation of mitigation measures for sonar and underwater detonations, the Navy finds that the MIRC training events may affect sperm whales. It is unlikely that MIRC training activities under Alternative 1 would result in any death or injury to sperm whales. Modeling does indicate the potential for Level B harassment, indicating the proposed ASW exercises may affect sperm whales but are not likely to cause long-term effects on their behavior or physiology or abandonment of areas that are regularly used by sperm whales.

3.7.3.7.6 Estimated Exposures for Non-ESA Species

Bryde's Whale. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 448 Bryde's whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be eight exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Bryde's whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given the large size (up to 46 ft. [14 m]) of individual Bryde's whales, pronounced blow, and mean group size of approximately 1.5 animals (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow 2003; 2006), it is likely that lookouts would detect a group of Bryde's whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of Bryde's whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to Bryde's whales.

Minke Whale. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 437 minke whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be seven exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No minke whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposures that would exceed the onset of massive lung injury or mortality threshold.

Minke whales are difficult to spot visually but can be detected using passive acoustic monitoring (when available). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of minke whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to minke whales.

Blainville's Beaked Whale. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 758 Blainville's beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 12 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Blainville's beaked whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given the size (up to 15.5 ft. [4.7 m]) of individual Blainville's beaked whales, aggregation of 2.3 animals, it is likely that lookouts would detect a group of Blainville's beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird *et al*. 2004). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to Blainville's beaked whales.

Bottlenose Dolphin. The risk function and Navy post-modeling analysis estimates 169 bottlenose dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be four exposures to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No bottlenose dolphins would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given the frequent surfacing, aggregation of approximately nine animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of bottlenose dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of bottlenose dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to bottlenose dolphins.

Cuvier's Beaked Whale. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 3,570 Cuvier's beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 45 exposures to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No Cuvier's beaked whale would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be 12 behavioral disturbance events and four TTS exposures from impulsive sound or pressures from underwater detonations. There would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposure that would exceed the onset of massive lung injury or mortality threshold.

Given the medium size (up to 23 ft. [7.0 m]) of individual Cuvier's beaked whales, aggregation of approximately two animals (Barlow 2006), it is likely that lookouts would detect a group of Cuvier's beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird *et al.* 2004). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of Cuvier's beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to Cuvier's beaked whales.

Dwarf and Pygmy Sperm Whales. Dwarf and pygmy sperm whales are difficult to distinguish from each other at sea, therefore, the two species were combined for acoustic exposure modeling. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 6,563 dwarf/pygmy sperm whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 104 exposures to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No dwarf/pygmy sperm whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be 20 exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, six exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, none that would exceed the onset of slight injury threshold, and no exposure that would exceed the onset of massive lung injury or mortality threshold.

The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of dwarf/pygmy sperm whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to dwarf/pygmy sperm whales.

False Killer Whale. The risk function and Navy post-modeling analysis estimates 1,264 false killer whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 23 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No false killer whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposure that would exceed the onset of massive lung injury or mortality threshold.

Given their size (up to 19.7 ft [6 m]) and large mean group size of 10.3 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of false killer whales at the surface. Additionally, mitigation measures call for continuous visual observation during training with active sonar; therefore, false killer whales that are present in the vicinity of ASW training events would be detected by visual observers. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of false killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to false killer whales.

Fraser's Dolphin. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 4,513 Fraser's dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 75 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Fraser's dolphins would be exposed to sound levels that could cause PTS.

Modeling indicates there would be 12 exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, four exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury or onset of massive lung injury.

Given their large aggregations, mean group size of 286.3 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow 2006), it is likely that lookouts would detect a group of Fraser's dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of Fraser's dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to Fraser's dolphins.

Ginkgo-Toothed Beaked Whale. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 421 ginkgo-toothed beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be seven exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No ginkgo-toothed beaked whale would be exposed to sound levels that could cause PTS.

There would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposure that would exceed the onset of massive lung injury or mortality threshold.

Given the size (up to 15.5 ft. [4.7 m]) of individual ginkgo-toothed beaked whales, aggregation of 2.3 animals, lookouts may detect a group of ginkgo-toothed beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird *et al.* 2004). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of ginkgo-toothed beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to ginkgo-toothed beaked whales.

Killer Whale. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 228 killer whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be four exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No killer whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposure that would exceed the onset of massive lung injury or mortality threshold.

Given their size (up to 23 ft [7.0 m]), conspicuous coloring, pronounced dorsal fin and large mean group size of 6.5 animals (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow

2003), it is likely that lookouts would detect a group of killer whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to killer whales.

Longman's Beaked Whale. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 206 Longman's beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be two exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Longman's beaked whale would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposure that would exceed the onset of massive lung injury or mortality threshold.

Given the size (up to 15.5 ft. [4.7 m]) of individual Longman's beaked whales, aggregation of 2.3 animals, lookouts may detect a group of Longman's beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird *et al.* 2004). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of Longman's beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to Longman's beaked whales.

Melon-Headed Whale. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 2,798 melon-headed whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 47 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No melon-headed whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be six exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, two exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, no exposures that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 8.2 ft [2.5 m]) and large group size (mean of 89.2 whales, probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of melon-headed whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of melon-headed whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to melon-headed whales.

Pantropical Spotted Dolphin. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 31,935 pantropical spotted dolphin will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 514 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. One pantropical spotted dolphin would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be 12 exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, seven exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, no exposures that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations. Given their frequent surfacing and large group size of hundreds of animals (Leatherwood *et al.* 1982), and probability of trackline detection of 1.00 in Beaufort Sea States of 6 or less (Barlow 2006), it is likely that lookouts would detect a group of pantropical spotted dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of pantropical spotted dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to pantropical spotted dolphins. The exposures estimated by the model are the accumulation of all exposures for the entire year and therefore rise to the threshold of one PTS exposure (0.93 modeled exposure for active sonar) for a pantropical spotted dolphin.

Pygmy Killer Whale. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 159 pygmy killer whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be three exposure to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No pygmy killer whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposure that would exceed the onset of massive lung injury or mortality threshold.

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 8.5 ft [2.6 m]) and mean group size of 14.4 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of pygmy killer whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to pygmy killer whales.

Risso's Dolphin. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 6,608 Risso's dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 110 exposures to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No Risso's dolphins would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be 26 exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, nine exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, no exposures that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given their frequent surfacing, light coloration, large group size of up to several hundred animals (Leatherwood *et al.* 1982) with mean group size of 15.4 Risso's dolphins, and probability of trackline detection of 0.76 in Beaufort Sea States of 6 or less (Barlow 2006), it is likely that lookouts would detect a group of Risso's dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of Risso's dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to Risso's dolphins.

Rough-Toothed Dolphin. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 236 rough-toothed dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be five exposures to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No rough-toothed dolphins would be exposed to sound levels that could cause PTS.

There would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no PTS exposures.

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations. Given their frequent surfacing and mean group size of 14.8 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2006), it is likely that lookouts would detect a group of rough-toothed dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of rough-toothed dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to rough-toothed dolphins.

Short-Beaked Common Dolphin. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 915 short-beaked common dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 17 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No short-beaked common dolphins would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be six exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, two exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, no exposures that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given the frequent surfacing and their large group size of up to 1,000 animals (Leatherwood *et al.* 1982), it is likely that lookouts would detect a group of short-beaked common dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of short-beaked common dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to short-beaked common dolphins.

Short-Finned Pilot Whale. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 2,236 short-finned pilot whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 36 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No short-finned pilot whale would be exposed to sound levels that could cause PTS.

There would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposure that would exceed the onset of massive lung injury or mortality threshold.

Given their size (up to 20 ft [6.1 m]), and large mean group size of 22.5 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2006), it is likely that lookouts would detect a group of short-finned pilot whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of short-finned pilot whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to short-finned pilot whales.

Spinner Dolphin. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 2,096 spinner dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 36 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No spinner dolphins would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be six exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, two exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, no exposures that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given their frequent surfacing, aerobatics and large mean group size of 37.3 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow 2006), it is likely that lookouts would detect a group of striped dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of spinner dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to spinner dolphins.

Striped Dolphin. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 8,705 striped dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 140 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No striped dolphins would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be three exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, one exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, no exposures that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given their frequent surfacing, aerobatics and large mean group size of 37.3 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow 2006), it is likely that lookouts would detect a group of striped dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of striped dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to striped dolphins.

Unidentified Balaenopterid Whales. Unidentified Balaenopterid whales (*Balaenoptera* spp.) would include those species, blue, fin, sei, Bryde's, and minke whales, that could not be distinguished due to distance from the survey ship and sea conditions. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 72 unidentified Balaenopterid whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be one exposure to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No unidentified balaenopterid whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposure that would exceed the onset of massive lung injury or mortality threshold.

The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of unidentified Balaenopterid whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to unidentified Balaenopterid whales.

Unidentified Delphinids. Under Alternative 1, the risk function and Navy post-modeling analysis estimates 1,512 unidentified dephinids will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 24 exposures to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No unidentified delphinids would be exposed to sound levels that could cause PTS.

There would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposure that would exceed the onset of massive lung injury or mortality threshold.

Given their frequent surfacing and generally large groups of delphinid species, it is likely that lookouts would detect a group of striped dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of unidentified delphinids, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 1 would not result in any population level effects, death, or injury to unidentified delphinids.

3.7.3.8 Alternative 2

3.7.3.8.1 Nonacoustic Exposures Summary

All Stressors. Under Alternative 2, the potential impacts associated with nonacoustic stressors may affect ESA-listed whales. Based on the descriptions of vessel movements, expended materials, and other nonacoustic stressors included in section 3.7.3, the nonacoustic stressors are not expected to result in Level A or Level B harassment as defined by the MMPA. In accordance with NEPA, nonacoustic stressors would have no significant impact on marine mammals in territorial waters. Furthermore, nonacoustic stressors would not cause significant harm to marine mammals in non-territorial waters in accordance with EO 12114.

3.7.3.8.2 Acoustic Exposures Summary

MFA/HFA Sonar Exposures. Table 3.7-16 summarizes the predicted annual usage for different sonar sources under Alternative 1. Table 3.7-17 provides the number of exposures modeled based on risk function, the TTS threshold, and the PTS threshold. Table 3.7-18 provides a summary of the total sonar exposures from all Alternative 2 ASW training that will be conducted over the course of a year. As many as 91,534 behavioral disturbance events, 1,470 TTS exposures, and two PTS exposures were estimated for marine mammals under Alternative 2.

LFA Sonar Exposures. The number of major exercises that will employ SURTASS LFA within the MIRC Study Area will not change under Alternative 2, relative to Alternative 1. The potential effects from SURTASS LFA sonar operations on any stock of marine mammals from injury (nonauditory or permanent loss of hearing) are considered negligible, and the potential effects on the stock of any marine mammal from temporary loss of hearing or behavioral change (significant change in a biologically important behavior) are considered minimal. Any auditory masking in marine mammals due to SURTASS LFA sonar signal transmissions is not expected to be severe and would be temporary. Therefore, in accordance with NEPA, LFA use during major exercises will not significantly impact marine mammals or marine mammal populations under Alternative 2. In accordance with EO 12114, LFA use under Alternative will not significantly harm marine mammals or marine mammal populations in non-territorial waters.

3.7.3.8.3 Explosive Exposure Summary

The modeled exposure harassment numbers for Alternative 2 training operations involving explosives are presented by species in Table 3.7-19. The modeling indicates 111 annual exposures to pressure from underwater detonations that could result in behavioral harassment (part of Level B harassment) and 40 annual exposures to pressure from underwater detonations that could result in TTS (Level B harassment). The modeling indicates one exposure from pressure from underwater detonations that could cause slight injury (Level A harassment). The modeling indicates that no marine mammals would be exposed to pressure from underwater detonations that could cause severe injury or mortality.

Table 3.7-16: Alternative 2—Summary of Predicted Annual Usage of Sonar Sources in the Mariana Islands Range Complex

Exercise	SQS 53C Sonar Hours	SQS 56 Sonar Hours	Sub BQQ Hours	Total Sonar Hours	Number of Dips for AQS-22	Number of DICASS Sonobuoy Deployments	MK-48 Torpedo Events
Major Exercise	1,705	77	0	1,782	288	1,282	0
Other ASW	720	120	15	855	608	354	48
Total Hours or Number of Events	2,425	197	15	2,637	896	1,636	48

Table 3.7-17: Sonar Exposures by Sonar Source Type

Source	Risk Function	TTS	PTS
SQS-53C	90,509	1,469	2
SQS-56	365	0	0
BQQ-10 Submarine sonar	57	0	0
AQS-22 Dipping Sonar	349	0	0
SSQ-62 DICASS Sonobuoy	137	0	0
MK-48 Torpedo Sonar	94	1	0
Total	**91,534[(1)]**	**1,470**	**2**

[(1)] Total value may be different from column sum due to rounding error.

3.7.3.8.4 Effects to ESA-Listed Species

The ESA-listed species that may be affected by MFA sonar and underwater detonations as a result of Alternative 2 include the blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), and sperm whale (*Physeter macrocephalus*). Modeling results indicate that no level of exposures for MFA sonar or underwater detonations will be experienced by humpback whale (*Megaptera novaeangliae*). As with Alternative 1, all ESA-listed marine mammals considered in this EIS/OEIS may be affected the use of SURTASS LFA; however, takes of marine mammals are not expected because effects are considered to be temporary behavioral impacts, and the timing of SURTASS LFA use (during biennial major exercises) are not likely sufficient to exceed thresholds for takes.

Table 3.7-18: Alternative 2—Summary of Estimated Level A and B Annual Exposures from All MFA ASW Sonar

Species	Level B Sonar Exposures		Level A Sonar Exposures
	Risk Function	TTS	PTS
ESA Species			
Blue whale	152	3	0
Fin whale	212	3	0
Humpback whale	0	0	0
Sei whale	374	7	0
Sei and Bryde's whale	73	1	0
Sperm whale	954	11	1
Unidentified balaenopterid	85	1	0
Mysticetes			
Bryde's whale	550	10	0
Minke whale	517	9	0
Odontocetes			
Blainville's beaked whale	895	14	0
Common bottlenose dolphin	200	4	0
Cuvier's beaked whale	4,219	53	0
Pygmy and dwarf sperm whale	7,759	123	0
False killer whale	1,496	27	0
Fraser's dolphin	5,336	89	0
Ginkgo-toothed beaked whale	497	8	0
Killer whale	269	4	0
Longman's beaked whale	243	3	0
Melon-headed whale	3,310	55	0
Pantropical spotted dolphin	37,757	605	1
Pygmy killer whale	189	3	0
Bottlenose rough-toothed dolphin	87	2	0
Risso's dolphin	7,815	130	0
Rough-toothed dolphin	280	6	0
Short-beaked common dolphin	1,083	20	0
Short-finned pilot whale	2,643	43	0
Spinner dolphin	2,479	43	0
Striped dolphin	10,292	165	0
Unidentified delphinid	1,786	28	0
Total	91,534	1,470	2

MFA and HFA Sonar Risk Function Curve 120-195 dB SPL
195 dB – TTS 195-215 dB re 1 µPa^2-s
215 dB- PTS >215 dB re 1 µPa^2-s
TTS = temporary threshold shift
PTS = permanent threshold shift

Table 3.7-19: Alternative 2—Summary of Estimated Level A and Level B Annual Exposures from Underwater Detonations

Species	Level B Exposures 177 dB	Level B Exposures TTS 182 dB/23 psi	Level A Exposures 50% TM Rupture 205 dB or Slight Lung Injury 13 psi-ms	Onset Massive Lung Injury or Mortality 31 psi-ms
ESA Species				
Blue whale	0	0	0	0
Fin whale	0	0	0	0
Humpback whale	0	0	0	0
Sei whale	0	0	0	0
Sperm whale	6	2	0	0
Unidentified balaenopterid	0	0	0	0
Mysticetes				
Bryde's whale	0	0	0	0
Minke whale	0	0	0	0
Odontocetes				
Blainville's beaked whale	0	0	0	0
Bottlenose dolphin	0	0	0	0
Cuvier's beaked whale	12	4	0	0
Pygmy and Dwarf sperm whale	20	6	0	0
False killer whale	0	0	0	0
Fraser's dolphin	12	4	0	0
Ginkgo-toothed beaked whale	0	0	0	0
Killer whale	0	0	0	0
Longman's beaked whale	0	0	0	0
Melon-headed whale	6	2	0	0
Pantropical spotted dolphin	12	8	0	0
Pygmy killer whale	0	0	0	0
Risso's dolphin	28	9	0	0
Rough-toothed dolphin	0	0	0	0
Short-beaked common dolphin	6	2	0	0
Short-finned pilot whale	0	0	0	0
Spinner dolphin	6	2	0	0
Striped dolphin	3	1	0	0
Unidentified balaenopterid	0	0	0	0
Unidentified delphinid	0	0	0	0
Total	**111**	**40**	**0**	**0**

dB – decibel
psi = pounds per square inch
ms = milli second
TM = Tympanic Membrane

Blue Whales. The risk function and Navy post-modeling analysis estimates 152 blue whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be three exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No blue whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS thresholds or cause behavioral disturbance.

Given the large size (up to 98 ft [30 m]) of individual blue whales (Leatherwood *et al.* 1982), pronounced vertical blow, and aggregation of approximately two to three animals in a group (probability of track line detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of blue whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, behavioral patterns, acoustic abilities of blue whales, results of past training, and the implementation of mitigation measures presented for underwater detonations, the Navy finds that the MIRC training events would not likely result in any death or injury to blue whales resulting from the Alternative 2. Modeling does indicate the potential for Level B harassment, indicating the proposed ASW exercises may affect blue whales.

Fin Whales. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 212 fin whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be three exposure to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No fin whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS thresholds or cause behavioral disturbance.

Given the large size (up to 78 ft [24m]) of individual fin whales (Leatherwood *et al.* 1982), pronounced vertical blow, mean aggregation of three animals in a group (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003) it is likely that lookouts would detect a group of fin whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

In the St. Lawrence estuary area, fin whales avoided vessels with small changes in travel direction, speed and dive duration, and slow approaches by boats usually caused little response (MacFarlane 1981). Fin whales continued to vocalize in the presence of boat sound (Edds and MacFarlane 1987). Even though any undetected fin whales transiting the MIRC Study Area may exhibit a reaction when initially exposed to active acoustic energy, field observations indicate the effects would not cause disruption of natural behavioral patterns to a point where such behavioral patterns would be abandoned or significantly altered.

Based on the model results, behavioral patterns, acoustic abilities of fin whales, results of past training, and the implementation of procedure mitigation measures for sonar and for underwater detonations, the Navy finds that the MIRC training events would not likely result in any death or injury to fin whales.

Modeling does indicate the potential for Level B harassment, indicating the proposed ASW exercises may affect fin whales.

Humpback Whales. Although humpback whales are known to occur in the MIRC, their seasonal migration does not coincide with major exercises; therefore the risk function and Navy post-modeling analysis estimates that under Alternative 2, no humpback whales will be exposed to sound levels that exhibit behavioral responses that NMFS will classify as harassment under the MMPA. Modeling also indicates there would be no exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No humpback whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, none that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Based on the model results, the nature of Navy's training, and behavioral patterns of humpback whales, the Navy finds that the MIRC sonar and underwater detonation training events under Alternative 2 would not affect humpback whales.

Sei Whales. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 374 sei whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be seven exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No sei whales would be exposed to sound levels that could cause PTS.

Bryde's and sei whales are often difficult to distinguish at sea and the Navy's 2007 survey in the Mariana Islands had three sightings which were classified as Bryde's/sei whales (DoN 2007b). Therefore, estimates were also made using the density for this group. The risk function and Navy post-modeling analysis estimates 73 Bryde's/sei whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be one exposure to accumulated acoustic energy above 195 dB re 1 μPa^2-s.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given the large size (up to 53 ft [16 m]) of individual sei whales (Leatherwood *et al.* 1982), pronounced vertical blow, aggregation of approximately three animals (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of sei whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, behavioral patterns, acoustic abilities of sei whales, results of past training, and the implementation of procedure mitigation measures presented for sonar and underwater detonations, the Navy finds that the MIRC training events would not likely result in any death or injury to sei whales. Modeling does indicate the potential for Level B harassment, indicating the proposed ASW exercises may affect sei whales.

Sperm Whales. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 954 sperm whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 11 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. One sperm whale would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be six exposures that would exceed the threshold for behavioral harassment, two exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, none that would exceed the onset of slight injury threshold and no exposure that would exceed the onset of massive lung injury or mortality threshold.

Given the large size (up to 56 ft [17m]) of individual sperm whales (Leatherwood *et al.* 1982), pronounced blow (large and angled), mean group size of approximately seven animals (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow 2003; 2006), it is likely that lookouts would detect a group of sperm whales at the surface. Sperm whales can make prolonged dives of up to two hours making detection more difficult but passive acoustic monitoring can detect and localize sperm whales from their calls (Watwood *et al.* 2006). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

The estimated PTS exposures are the accumulation of all exposures that exceeded the threshold of 215 dB re 1 μPa^2-s for an entire year and, therefore, rise to the threshold of one Level A exposure from active sonar (0.05 exposure threshold for ESA species). When analyzing the exposures of individual activities, the exposures associated with each activity do not reach the threshold of a Level A exposure, only the annual accumulation of all activities reach the threshold. In addition, a sperm whale would have to be within 33 ft (10 m) of an SQS-53C sonar dome to be exposed to a sound level that would cause PTS. It is unlikely that a sperm whale, which can detect mid-frequency active sonar, would be that close to a moving ship using sonar. The predicted exposures are presented without consideration of mitigation measures that may reduce exposure to active sonar by detecting this large species at the surface although due to their deep (maximum of 3,910 ft [1,192 m]) and long duration (30-40 min) diving behavior, their presence at the surface would be infrequent (Amano and Yoshioka 2003; Watwood *et al*. 2006).

Based on the model results, behavioral patterns, acoustic abilities of sperm whales, results of past training, and the implementation of mitigation measures for sonar and underwater detonations, the Navy finds that the MIRC training events may affect sperm whales. It is unlikely that MIRC training activities under Alternative 2 would result in any death or injury to sperm whales. Modeling does indicate the potential for Level B harassment, indicating the proposed ASW exercises may affect sperm whales but are not likely to cause long-term effects on their behavior or physiology or abandonment of areas that are regularly used by sperm whales.

3.7.3.8.5 Estimated Exposures for Non-ESA Species

Bryde's Whale. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 550 Bryde's whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 10 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Bryde's whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, Bryde's whales would not be exposed to impulsive sound or pressures from underwater detonations that would exceed the TTS thresholds or cause behavioral disturbance.

Given the large size (up to 46 ft. [14 m]) of individual Bryde's whales, pronounced blow, and mean group size of approximately 1.5 animals (probability of trackline detection = 0.87 in Beaufort Sea States of 6 or less; Barlow 2003; 2006), it is likely that lookouts would detect a group of Bryde's whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of Bryde's whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to Bryde's whales.

Minke Whale. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 517 minke whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be nine exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No minke whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, minke whales would not be exposed to impulsive sound or pressures from underwater detonations that would exceed the TTS thresholds or cause behavioral disturbance.

Minke whales are difficult to spot visually but can be detected using passive acoustic monitoring (when available). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS. Population level effects would be negligible with the Navy's proposed use of MFA sonar, based on vital rates of reproduction.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of minke whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to minke whales.

Blainville's Beaked Whale. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 895 Blainville's beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 14 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Blainville's beaked whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, Blainville's beaked whales would not be exposed to impulsive sound or pressures from underwater detonations that would exceed the TTS thresholds or cause behavioral disturbance.

Given the size (up to 15.5 ft. [4.7 m]) of individual Blainville's beaked whales, aggregation of 2.3 animals, it is likely that lookouts would detect a group of Blainville's beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird *et al.* 2004). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to Blainville's beaked whales.

Bottlenose Dolphin. The risk function and Navy post-modeling analysis estimates 200 bottlenose dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be four exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No bottlenose dolphins would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, bottlenose dolphins would not be exposed to impulsive sound or pressures from underwater detonations that would exceed the TTS thresholds or cause behavioral disturbance.

Given the frequent surfacing, aggregation of approximately nine animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of bottlenose dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of bottlenose dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to bottlenose dolphins.

Cuvier's Beaked Whale. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 4,219 Cuvier's beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 53 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Cuvier's beaked whale would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be 12 exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, four exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, none that would exceed the onset of slight injury threshold, and no exposure that would exceed the onset of massive lung injury or mortality threshold.

Given the medium size (up to 23 ft. [7.0 m]) of individual Cuvier's beaked whales, aggregation of approximately two animals (Barlow 2006), it is likely that lookouts would detect a group of Cuvier's beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird *et al.* 2004). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of Cuvier's beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to Cuvier's beaked whales.

Dwarf and Pygmy Sperm Whales. Dwarf and pygmy sperm whales are difficult to distinguish from each other at sea, therefore, the two species were combined for acoustic exposure modeling. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 7,759 dwarf/pygmy sperm whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 123 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No dwarf/pygmy sperm whales would be exposed to.sound levels that could cause PTS.

Without consideration of clearance procedures, there would be 20 exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, six exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, none that would exceed the onset of slight injury threshold, and no exposure that would exceed the onset of massive lung injury or mortality threshold.

The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of dwarf/pygmy sperm whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to dwarf/pygmy sperm whales.

False Killer Whale. The risk function and Navy post-modeling analysis estimates 1,496 false killer whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 27 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No dwarf sperm whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, false killer whales would not be exposed to impulsive sound or pressures from underwater detonations that would exceed the TTS thresholds or cause behavioral disturbance.

Given their size (up to 19.7 ft [6 m]) and large mean group size of 10.3 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of false killer whales at the surface. Additionally, mitigation measures call for continuous visual observation during training with active sonar; therefore, false killer whales that are present in the vicinity of ASW training events would be detected by visual observers. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of false killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to false killer whales.

Fraser's Dolphin. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 5,336 Fraser's dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 89 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Fraser's dolphins would be exposed to sound levels that could cause PTS.

Modeling indicates there would be 12 exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, four exposures to impulsive noise or pressures from underwater detonations of 182 dB or 23 psi, which is the threshold indicative of onset TTS, and no exposures to impulsive noise or pressures from underwater detonations that would cause slight physical injury or onset of massive lung injury.

Given their large aggregations, mean group size of 286.3 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow 2006), it is likely that lookouts would detect a group of Fraser's dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of Fraser's dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to Fraser's dolphins.

Ginkgo-Toothed Beaked Whale. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 497 ginkgo-toothed beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be eight exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No ginkgo-toothed beaked whale would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, ginkgo-toothed beaked whales would not be exposed to impulsive sound or pressures from underwater detonations that would exceed the TTS thresholds or cause behavioral disturbance.

Given the size (up to 15.5 ft. [4.7 m]) of individual ginkgo-toothed beaked whales, aggregation of 2.3 animals, lookouts would likely detect a group of ginkgo-toothed beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird *et al.* 2004). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of ginkgo-toothed beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to ginkgo-toothed beaked whales.

Killer Whale. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 269 killer whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be four exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No killer whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, killer whales would not be exposed to impulsive sound or pressures from underwater detonations that would exceed the TTS thresholds or cause behavioral disturbance.

Given their size (up to 23 ft [7.0 m]), conspicuous coloring, pronounced dorsal fin and large mean group size of 6.5 animals (probability of trackline detection = 0.90 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of killer whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to killer whales.

Longman's Beaked Whale. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 243 Longman's beaked whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be three exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Longman's beaked whale would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, Longman's beaked whales would not be exposed to impulsive sound or pressures from underwater detonations that would exceed the TTS thresholds or cause behavioral disturbance.

Given the size (up to 15.5 ft. [4.7 m]) of individual Longman's beaked whales, aggregation of 2.3 animals, lookouts may detect a group of Longman's beaked whales at the surface although beaked whales make prolonged dives that can last up to an hour (Baird *et al.* 2004). The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of Longman's beaked whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to Longman's beaked whales.

Melon-Headed Whale. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 3,310 melon-headed whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 55 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No melon-headed whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be six exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, two exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, no exposures that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 8.2 ft [2.5 m]) and large group size (mean of 89.2 whales with probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would likely detect a group of melon-headed whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of melon-headed whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to melon-headed whales.

Pantropical Spotted Dolphin. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 37,757 pantropical spotted dolphin will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 605 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. One pantropical spotted dolphin would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be 12 exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, eight exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, no exposures that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations. Given their frequent surfacing and large group size of hundreds of animals (Leatherwood *et al.* 1982) (probability of trackline detection of 1.00 in Beaufort Sea States of 6 or less (Barlow 2006), it is likely that lookouts would detect a group of pantropical spotted dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of pantropical spotted dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to pantropical spotted dolphins. The exposures estimated by the model are the accumulation of all exposures for the entire year and therefore rise to the threshold of one PTS exposure for a pantropical spotted dolphin.

Pygmy Killer Whale. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 189 pygmy killer whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be three exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No pygmy killer whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be no exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold and none that would exceed the onset of slight injury threshold. There would be no exposure that would exceed the onset of massive lung injury or mortality threshold.

Mitigation measures call for continuous visual observation during training with active sonar. Given their size (up to 8.5 ft [2.6 m]) and mean group size of 14.4 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2003), it is likely that lookouts would detect a group of pygmy killer whales at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of killer whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to pygmy killer whales.

Risso's Dolphin. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 7,815 Risso's dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 130 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No Risso's dolphins would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be 28 exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, nine exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, no exposures that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given their frequent surfacing, light coloration and large group size of up to several hundred animals (Leatherwood *et al.* 1982) (mean group size of 15.4 Risso's dolphins and probability of trackline detection of 0.76 in Beaufort Sea States of 6 or less (Barlow 2006), it is likely that lookouts would detect a group of Risso's dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of Risso's dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to Risso's dolphins.

Rough-Toothed Dolphin. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 280 rough-toothed dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be six exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No rough-toothed dolphins would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, rough-toothed dolphins would not be exposed to impulsive sound or pressures from underwater detonations that would exceed the TTS thresholds or cause behavioral disturbance.

Mitigation measures call for continuous visual observation during training with active sonar and underwater detonations. Given their frequent surfacing and mean group size of 14.8 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2006), it is likely that lookouts would detect a group of rough-toothed dolphins at the surface during ASW training events. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of rough-toothed dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to rough-toothed dolphins.

Short-Beaked Common Dolphin. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 1,083 short-beaked common dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 20 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No short-beaked common dolphins would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be six exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, two exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, no exposures that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given the frequent surfacing and their large group size of up to 1,000 animals (Leatherwood *et al.* 1982), it is likely that lookouts would detect a group of short-beaked common dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of short-beaked common dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to short-beaked common dolphins.

Short-Finned Pilot Whale. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 2,643 short-finned pilot whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 43 exposures to accumulated acoustic energy above 195 dB re 1 μPa^2-s, which is the threshold established indicative of onset TTS. No short-finned pilot whale would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, short-finned pilot whales would not be exposed to impulsive sound or pressures from underwater detonations that would exceed the TTS thresholds or cause behavioral disturbance.

Given their size (up to 20 ft [6.1 m]), and large mean group size of 22.5 animals (probability of trackline detection = 0.76 in Beaufort Sea States of 6 or less; Barlow 2006), it is likely that lookouts would detect a group of short-finned pilot whales at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of short-finned pilot whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to short-finned pilot whales.

Spinner Dolphin. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 2,479 spinner dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 43 exposures to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No spinner dolphins would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be six exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, two exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, no exposures that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given their frequent surfacing, aerobatics and large mean group size of 37.3 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow 2006), it is likely that lookouts would detect a group of striped dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of spinner dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to spinner dolphins.

Striped Dolphin. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 10,292 striped dolphins will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 165 exposures to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No striped dolphins would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, there would be three exposures from impulsive sound or pressures from underwater detonations that would exceed the behavioral harassment threshold, one exposures from impulsive sound or pressures from underwater detonations that would exceed the TTS threshold, no exposures that would exceed the onset of slight injury threshold, and no exposures that would exceed the onset of massive lung injury or mortality threshold.

Given their frequent surfacing, aerobatics and large mean group size of 37.3 animals (probability of trackline detection = 1.00 in Beaufort Sea States of 6 or less; Barlow 2006), it is likely that lookouts would detect a group of striped dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of striped dolphins, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to striped dolphins.

Unidentified Balaenopterid Whales. Unidentified Balaenopterid whales (*Balaenoptera* spp.) would include those species, blue, fin, sei, Bryde's, and minke whales, that could not be distinguished due to distance from the survey ship and sea conditions. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 85 unidentified Balaenopterid whales will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be one exposure to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No unidentified Balaenopterid whales would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, unidentified balaenopterid whales would not be exposed to impulsive sound or pressures from underwater detonations that would exceed the TTS thresholds or cause behavioral disturbance.

The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of unidentified Balaenopterid whales, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to unidentified Balaenopterid whales.

Unidentified Delphinids. Under Alternative 2, the risk function and Navy post-modeling analysis estimates 1,786 unidentified delphinids will exhibit behavioral responses NMFS will classify as harassment under the MMPA. Modeling also indicates there would be 28 exposures to accumulated acoustic energy above 195 dB re 1 µPa^2-s, which is the threshold established indicative of onset TTS. No unidentified delphinids would be exposed to sound levels that could cause PTS.

Without consideration of clearance procedures, unidentified delphinids would not be exposed to impulsive sound or pressures from underwater detonations that would exceed the TTS thresholds or cause behavioral disturbance.

Given their frequent surfacing and generally large groups of delphinid species, it is likely that lookouts would detect a group of striped dolphins at the surface. The implementation of mitigation measures to reduce exposure to short duration and intermittent high levels of sonar sound, minimizes the likelihood that exposure to MFA/HFA sonar sound would cause a behavioral response that may affect vital functions (reproduction or survival), TTS or PTS.

Based on the model results, the nature of the Navy's MFA/HFA sonar, behavioral patterns and acoustic abilities of unidentified delphinids, observations made during past training events, and the planned implementation of mitigation measures, the Navy finds that the MIRC training events under Alternative 2 would not result in any population level effects, death, or injury to unidentified delphinids.

3.7.4 Unavoidable Significant Environmental Effects

The analysis presented above indicates that Alternatives 1 and 2 would not result in unavoidable significant adverse effects to marine mammals.

3.7.5 Summary of Environmental Effects

3.7.5.1 Endangered Species Act

The Navy is consulting with NMFS regarding its determination of effect for Federally listed marine mammals. Table 3.7-20 provides a summary of the Navy's determination of effect for Federally listed marine mammals that potentially occur in the MIRC Study Area. The analyses presented above indicate that Alternative 1 (Preferred Alternative) may affect the following ESA-listed endangered species within the Mariana Islands: blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*) and sperm whale (*Physeter macrocephalus*). Other nonacoustic stressors of Alternative 1 may affect ESA-listed species, but the effects are expected to be discountable and not result in Level B or Level A harassments. Critical habitat for marine mammals has not been designated within the MIRC Study Area.

Table 3.7-20: Summary of ESA Effects Determinations for Marine Mammals

Species Name	Stressor	Alternative		
		No Action Alternative	Alternative 1	Alternative 2
Blue whale				
Nonacoustic effects		May Affect	May Affect	May Affect
Acoustic effects	ASW Sonar	May Affect	May Affect	May Affect
	Underwater Detonations	May Affect	May Affect	May Affect
Fin whale				
Nonacoustic effects		May Affect	May Affect	May Affect
Acoustic effects	ASW Sonar	May Affect	May Affect	May Affect
	Underwater Detonations	May Affect	May Affect	May Affect
Humpback whale				
Nonacoustic effects		May Affect	May Affect	May Affect
Acoustic effects	ASW Sonar	No Effect	No Effect	No Effect
	Underwater Detonations	No Effect	No Effect	No Effect
Sei whale				
Nonacoustic effects		May Affect	May Affect	May Affect
Acoustic effects	ASW Sonar	May Affect	May Affect	May Affect
	Underwater Detonations	May Affect	May Affect	May Affect
Sperm whale				
Nonacoustic effects		May Affect	May Affect	May Affect
Acoustic effects	ASW Sonar	May Affect	May Affect	May Affect
	Underwater Detonations	May Affect	May Affect	May Affect

3.7.5.2 Marine Mammal Protection Act

The analysis presented within this section indicates that non-ESA listed marine mammals could be exposed to impacts associated with sonar, underwater detonations, and explosive ordnance use under the No Action Alternative, Alternative 1 (preferred alternative), and Alternative 2 that could result in Level A or Level B harassment as defined by MMPA provisions that are applicable to the Navy. Exposure estimates are provided in Tables 3.7-9 though 3.7-20. Other nonacoustic stressors associated with the No Action Alternative, Alternative 1, or 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.

Overall, the conclusions in this analysis find that impacts to marine mammal species and stocks would be negligible for the following reasons:

- Most acoustic harassments are within the noninjurious TTS or behavioral effects zones (Level B harassment). Only one exposure to sound levels causing PTS/injury (Level A harassment) resulted from the summation of the modeling under Alternative 2, but this exposure is not expected to occur.

- Although the numbers presented in Tables 3.7-9 through Table 3.7-20 represent estimated harassment under the MMPA for the No Action Alternative, Alternative 1, and Alternative 2, they are conservative estimates of harassment, primarily by behavioral disturbance. In addition, the model calculates harassment without taking into consideration standard mitigation measures, and is not indicative of a likelihood of either injury or harm.
- Additionally, the mitigation measures described in Chapter 5 of this EIS/OEIS are designed to reduce sound exposure of marine mammals to levels below those that may cause “behavioral disruptions,” and to achieve the least practicable adverse effect on marine mammal species or stocks.

Consideration of negligible impact is required for NMFS to authorize incidental take of marine mammals under the MMPA. By definition, an activity has a “negligible impact” on a species or stock when it is determined that the total taking is not likely to reduce annual rates of adult survival or recruitment (*i.e.*, offspring survival, birth rates).

The analysis conducted by the Navy assumes that short-term noninjurious sound exposure levels predicted to cause TTS or temporary behavioral disruptions qualify as Level B harassment. As discussed, this will overestimate reactions qualifying as harassment under MMPA because there is no established scientific correlation between mid-frequency active sonar use and long-term abandonment or significant alteration of behavioral patterns in marine mammals.

As part of the Navy’s formal consultations with NMFS, the Navy has requested the take, by serious injury or mortality, of 10 beaked whales, although the Navy does not anticipate that marine mammal strandings or mortality will result from conducting MIRC training activities within the Study Area. The request is for mid- and high-frequency active sonar (does not include low-frequency active), underwater detonation and training events within the MIRC Study Area. The request is for a 5-year period commencing in January 2010.

3.7.5.3 National Environmental Policy Act and Executive Order 12114

As summarized in Table 3.7-21, the No Action Alternative, Alternative 1, and Alternative 2 would have no significant impact on marine mammals in territorial waters in accordance with NEPA. Furthermore, in accordance with Executive Order 12114, the No Action Alternative, Alternative 1, and Alternative 2 would not cause significant harm to marine mammals in non-territorial waters.

Table 3.7-21: Summary of Environmental Effects of the Alternatives on Marine Mammals in the MIRC Study Area

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 Alternative		
Vessel Movements	Short-term behavioral responses would result from general vessel disturbance. Potential for injury or mortality from vessel collisions.	The effects and impacts in non-territorial waters would be similar to those in territorial waters.
Aircraft Overflights	Potential exposure to aircraft noise inducing short-term behavior changes. No long-term population or community-level effects.	The effects and impacts in non-territorial waters would be similar to those in territorial waters.
Sonar	Potential occurrences of Level B harassment events (TTS), behavioral disturbance exposures, and a potential Level A exposure.	The effects and impacts in non-territorial waters would be similar to those in territorial waters.
	Modeling results for all waters (territorial and non-territorial) indicate potentially 1,097 Level B harassment events (TTS), 67,872 behavioral disturbance exposures, and one potential Level A exposure resulting from the summation of MFA modeling is estimated for the pantropical spotted dolphin.	
Weapons Firing/Non-Explosive Ordnance Use	No effect based on extremely low probability of direct strikes.	The effects and impacts in non-territorial waters would be similar to those in territorial waters.
Underwater Detonations and Explosive Ordnance	Potential occurrences of Level B harassment (TTS) events and behavior disturbances.	The effects and impacts in non-territorial waters would be similar to those in territorial waters.
	Modeling results for all waters (territorial and non-territorial) indicate potentially 15 Level B harassment (TTS) events and 42 behavior disturbances.	
Expended Materials	Low potential for ingestion of ordnance related materials and chaff and/or flare plastic end caps and pistons.	The effects and impacts in non-territorial waters would be similar to those in territorial waters.
Endangered Species Act	The No Action Alternative may affect the blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*) and sperm whale (*Physeter macrocephalus*). Critical habitat for marine mammals has not been designated within the MIRC Study Area. Navy is consulting with NMFS regarding this determination for the preferred alternative, Alternative 1.	
Marine Mammal Protection Act	The No Action Alternative could expose non-ESA listed marine mammals to impacts associated with sonar, underwater detonations, and explosive ordnance use that could result in Level A or Level B harassment as defined by MMPA provisions that are applicable to the Navy. Accordingly, the Navy is working with NMFS through the MMPA permitting process to ensure compliance with the MMPA.	
Impact Conclusion	No significant impact to marine mammals.	No significant harm to marine mammals.

Table 3.7-21: Summary of Environmental Effects of the Alternatives on Marine Mammals in the MIRC Study Area (Continued)

Alternative and Stressor	Summary of Effects and Impact Conclusion	
	NEPA (Territorial Waters, 0 to 12 nm)	**Executive Order 12114 (Non-Territorial Waters, >12 nm)**
Alternative 1		
Vessel Movements	Short-term behavioral responses would result from general vessel disturbance. Potential for injury or mortality from vessel collisions.	The effects and impacts in non-territorial waters would be similar to those in territorial waters.
Aircraft Overflights	Potential exposure to aircraft noise inducing short-term behavior changes. No long-term population or community-level effects.	The effects and impacts in non-territorial waters would be similar to those in territorial waters.
Sonar	Potential occurrences of Level B harassment events (TTS), behavioral disturbance, and potential Level A exposures.	Potential occurrences of Level B harassment events (TTS), behavioral disturbance, and potential Level A exposures.
	Modeling results for all waters (territorial and non-territorial) indicate potentially 1,246 Level B harassment events (TTS), 77,415 behavioral disturbance exposures, and two potential Level A exposures resulting from the summation of MFA modeling; one is estimated for the pantropical spotted dolphin, and one for the sperm whale.	
Weapons Firing/Non-Explosive Ordnance Use	No effect based on extremely low probability of direct strikes.	The effects and impacts in non-territorial waters would be similar to those in territorial waters.
Underwater Detonations and Explosive Ordnance	Potential occurrences of Level B harassment (TTS) events and behavior disturbances. No Level A (harassment) and no mortality exposures resulted from the summation of the modeling.	The effects and impacts in non-territorial waters would be similar to those in territorial waters.
	Modeling results for all waters (territorial and non-territorial) indicate potentially of 39 Level B harassment (TTS) events and 109 behavior disturbances.	
Expended Materials	Low potential for ingestion of ordnance related materials and chaff and/or flare plastic end caps and pistons.	The effects and impacts in non-territorial waters would be similar to those in territorial waters.
Endangered Species Act	Alternative 1 may affect the blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*) and sperm whale (*Physeter macrocephalus*). Critical habitat for marine mammals has not been designated within the MIRC Study Area. Navy is consulting with NMFS regarding this determination for the preferred alternative, Alternative 1.	
Marine Mammal Protection Act	Alternative 1 could expose non-ESA listed marine mammals to impacts associated with sonar, underwater detonations, and explosive ordnance use that could result in Level A or Level B harassment as defined by MMPA provisions that are applicable to the Navy. Accordingly, the Navy is working with NMFS through the MMPA permitting process to ensure compliance with the MMPA.	
Impact Conclusion	No significant impact to marine mammals.	No significant harm to marine mammals.

Table 3.7-21: Summary of Environmental Effects of the Alternatives on Marine Mammals in the MIRC Study Area (Continued)

Alternative and Stressor	Summary of Effects and Impact Conclusion	
	NEPA (Territorial Waters, 0 to 12 nm)	**Executive Order 12114 (Non-Territorial Waters, >12 nm)**
Alternative 2		
Vessel Movements	Short-term behavioral responses would result from general vessel disturbance. Potential for injury or mortality from vessel collisions.	The effects and impacts in non-territorial waters would be similar to those in territorial waters.
Aircraft Overflights	Potential exposure to aircraft noise inducing short-term behavior changes. No long-term population or community-level effects.	The effects and impacts in non-territorial waters would be similar to those in territorial waters.
Sonar	Potential occurrences of Level B harassment events (TTS), behavioral disturbance, and potential Level A exposures.	Potential occurrences of Level B harassment events (TTS), behavioral disturbance, and potential Level A exposures.
	Modeling results for all waters (territorial and non-territorial) indicate potentially 1,470 Level B harassment events (TTS), 91,534 behavior disturbances, and two potential Level A exposures resulting from the summation of MFA modeling; one is estimated for the pantropical spotted dolphin, and one for the sperm whale.	
Weapons Firing/Non-Explosive Ordnance Use	No effect based on extremely low probability of direct strikes.	The effects and impacts in non-territorial waters would be similar to those in territorial waters.
Underwater Detonations and Explosive Ordnance	Potential occurrences of Level B harassment (TTS) events and behavior disturbances; no Level A (harassment) and no mortality exposures.	The effects and impacts in non-territorial waters would be similar to those in territorial waters.
	Modeling results for all waters (territorial and non-territorial) indicate potentially 40 Level B harassment (TTS) events and 111 behavior disturbances.	
Expended Materials	Low potential for ingestion of ordnance related materials and chaff and/or flare plastic end caps and pistons.	The effects and impacts in non-territorial waters would be similar to those in territorial waters.
Endangered Species Act	Alternative 2 may affect the blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*) and sperm whale (*Physeter macrocephalus*). Critical habitat for marine mammals has not been designated within the MIRC Study Area. Navy is consulting with NMFS regarding this determination for the preferred alternative, Alternative 1.	
Marine Mammal Protection Act	Alternative 2 could expose non-ESA listed marine mammals to impacts associated with sonar, underwater detonations, and explosive ordnance use that could result in Level A or Level B harassment as defined by MMPA provisions that are applicable to the Navy. Accordingly, the Navy is working with NMFS through the MMPA permitting process to ensure compliance with the MMPA.	
Impact Conclusion	No significant impact to marine mammals.	No significant harm to marine mammals.

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3.8 SEA TURTLES

3.8.1 Introduction and Methods

3.8.1.1 Regulatory Framework

3.8.1.1.1 Federal Laws and Regulations

Endangered Species Act. The 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 U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) jointly administer the ESA and also are responsible for the listing of species (*i.e.*, the labeling of a species as either threatened or endangered). The USFWS has primary 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). For sea turtles, USFWS and NMFS share sea turtles as trust resources in each agency's regulatory authority. Sea turtles are a trust resource of NMFS during migrations at sea and while foraging in offshore habitats, while the USFWS generally has regulatory oversight of sea turtles on nesting grounds and locations where sea turtles rest on land. 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.

All five species of sea turtles that potentially occur in the MIRC Study Area are listed as threatened or endangered under the ESA. Therefore, the ESA regulatory framework described above is applicable to the analysis of sea turtles.

3.8.1.1.2 Territory and Commonwealth Laws and Regulations

Pursuant to Section 6 of the ESA, a cooperative agreement exists between Guam Division of Aquatic and Wildlife Resources (DAWR), USFWS, and NMFS that provides for funding and implementation of programs for endangered species research and recovery. Guam DAWR administers the Guam Endangered Species Act (Guam Public Law 15-36) and the Fish, Game, Forestry, and Conservation Act (5 Guam Code Annotated [GCA] 63101-63117). Although Guam lists only the hawksbill sea turtle under Public Law 15-36, green sea turtles are considered a species of concern. The other three species of sea turtles (loggerhead, leatherback, olive ridley) are not listed under Public Law 15-36 because these species are not associated with nearshore habitats of Guam. Other Guam resource agencies, such as the Bureau of Statistics and Plans (BSP), have specific mandates in relation to sea turtle conservation. The BSP administers the Guam Coastal Management Plan (GCMP) through the Coastal Zone Management Act of 1972 (Guam Public Law 92-583 and Public Law 94-370). The GCMP guides the use, protection, and development of land and ocean resources within Guam's coastal zone, which includes all non-Federal property and all submerged lands and waters out to 3 nm (5.6 km) from the shoreline.

Commonwealth of the Northern Mariana Islands. Similar to Guam, the CNMI Division of Fish and Wildlife (CNMI DFW) receives Federal assistance to implement Federal and CNMI natural resource programs through Section 6 ESA agreements with USFWS. CNMI Public Law 2-51 lists the hawksbill and leatherback sea turtles as endangered. Public Law 2-51 also lists green sea turtles and loggerhead sea turtles as threatened.

3.8.1.2 Assessment Methods and Data Used

3.8.1.2.1 General Approach to Analysis

The general approach to analysis for sea turtles is the same as the approach described for marine mammals in Section 3.7.1.2.

3.8.1.2.2 Study Area

The Study Area for sea turtles includes open water, nearshore, and nesting habitats within the MIRC. As discussed within this subsection, different species of sea turtles are expected to occur in different habitats. For instance, loggerhead turtles, olive ridley sea turtles, and leatherback sea turtles are not known to occur in nearshore habitats, nor are they expected to nest within the MIRC; however, green sea turtles (primarily) and hawksbill sea turtles are known to nest and frequent some nearshore areas.

3.8.1.2.3 Data Sources

A comprehensive and systematic review of relevant literature and data has been conducted to complete this analysis of sea turtles within the MIRC Study Area. The primary sources of information used to describe the affected environment for sea turtles included the following:

- The Navy's MRA for the Marianas Operating Area (DoN 2005a);
- Relevant Integrated Natural Resources Management Plans (INRMPs) that are in effect on Navy lands on Guam (DoN 2001a), Navy leased lands within the CNMI (DoN 2003a), and Andersen AFB (2003);
- Monthly monitoring surveys for sea turtle nesting or nearshore activity on beaches on Guam and Tinian, and nearshore waters of FDM (as discussed in this subsection, surveys on FDM are limited to nearshore aerial surveys for sea turtle activity as FDM does not contain suitable nesting habitat); and
- The Mariana Islands Sea Turtle and Cetacean Survey (MISTCS), discussed in detail in Section 3.7.2.1 of this EIS/OEIS. Although only one sea turtle was observed during surveys (most likely due to high sea states), future surveys following systematic protocols will increasingly add to the environmental baseline for sea turtles in the MIRC Study Area.

3.8.1.2.4 Factors Used to Assess the Significance of Effects

This EIS/OEIS analyzes potential effects to sea turtles 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 (*e.g.*, 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 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 (*i.e.*, slight impacts that would not harass or harm a member of an ESA-listed 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 NEPA and EO 12114.

3.8.1.3 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 sea turtles. Navy subject matter experts de-constructed the warfare areas and events 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. As summarized in Table 3.8-1, potential stressors to sea turtles include vessel movements (disturbance and collisions), land-based training activities (disturbance and direct nest mortality), aircraft overflights (disturbance), mid-frequency active (MFA) and high-frequency active (HFA) sonar (harassment), weapons firing/ordnance use (disturbance and strikes), explosions, and expended materials (ordnance-related materials, targets, chaff, self-protection flares, and marine markers). The potential effects of these stressors on sea turtles are analyzed in detail in Section 3.8.3 (Environmental Consequences).

As discussed in Section 3.3 (Water Resources) and Section 3.4 (Air Quality), some water and air pollutants would be released into the environment as a result of the Proposed Action. The analyses presented in Sections 3.3 and 3.4 indicate that any increases in water or air pollutant concentrations resulting from Navy training in the Study Area would be negligible and localized, and impacts to water and air quality would be less than significant. Based on the analyses presented in Sections 3.3 and 3.4, water and air quality changes would have no effect on sea turtles. Accordingly, the effects of water and air quality changes on sea turtles are not addressed further in this EIS/OEIS.

Table 3.8-1: Summary of Potential Stressors to Sea Turtles

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Sea Turtles
Army Training			
Surveillance and Reconnaissance (S&R)		None	None
Field Training Exercise (FTX)		None	None
Live Fire		None	None
Military Operations in Urban Terrain (MOUT)		None	None
Marine Corps Training			
Ship to Objective Maneuver (STOM) / Tinian Exclusive Military Use Area (EMUA)		Vessel Movements	Potential for vessel movements to induce behavioral and/or physiological responses in sea turtles. Low potential for vessel strike resulting in mortality or injury.
Operational Maneuver		None	None
Noncombatant Evacuation Order (NEO)		None	None
Assault Support (AS) / Polaris Point Field, Orote Point Known Distance (KD) Range, Tinian EMUA		Aircraft Overflights	Potential for short-term behavioral responses to overflights at access insertion locations in the Main base and within the EMUA on Tinian.
Reconnaissance and Surveillance (R&S)		None	None
MOUT		None	None
Direct Fires / FDM, Orote Point KD Range, Air Traffic Control Assigned Airspace (ATCAA) 3A		Aircraft Overflights Weapons Firing Expended Materials	Potential for short-term behavioral responses to overflights to access firing sights at Farallon de Medinilla (FDM) and Orote Point KD Range. Potential for direct strike of sea turtles. Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities and coralline systems surrounding marine environments, which presents opportunities for ingestion and/or entanglement.
Exercise Command and Control (C2) / Andersen AFB		None	None
Protect and Secure Area of Operations		None	None

Table 3.8-1: Summary of Potential Stressors to Sea Turtles (Continued)

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Sea Turtles
Navy Training			
Anti-Submarine Warfare (ASW) / Open Ocean		Vessel Movements	Potential for vessel movements to induce behavioral and/or physiological changes in sea turtles. Low potential for vessel strike resulting in mortality or injury.
		Aircraft Overflights	Potential for short-term behavioral responses to overflights.
		Underwater Explosions	Potential for short-term behavioral or physiological responses from explosive noise and pressure changes. Potential for injury or mortality within limited zone of influence (ZOI).
		Sonar	Potential for limited masking effects of MFA sonar (minimum frequency of MFA is 3.5 kHz, upper limit of effective sea turtle hearing is 1 kHz)
		Expended Materials	Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities and coralline systems surrounding marine environments which presents opportunities for ingestion and/or entanglement. Possible entanglement with expended materials on the surface before the expended material descends through the water column.
Mine Warfare (MIW) / Agat Bay, Inner Apra Harbor		Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions within Apra Harbor and Agat Bay.
		Underwater Explosions	Potential for short-term behavioral responses from explosive noise and pressure changes. Potential for injury or mortality within limited ZOI.
		Expended Materials	Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities and coralline systems surrounding Apra Harbor and Agat Bay, which presents opportunities for ingestion and/or entanglement.
Air Warfare (AW)/ W-517, R-7201		Expended Materials	Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities and coralline systems surrounding marine environments, which presents opportunities for ingestion and/or entanglement.
		Weapons Firing	Potential for short-term behavioral responses to firing noise, potential ingestion of expended materials. Potential for direct strike of sea turtles.
Surface Warfare (SUW) / W-517	Surface to Surface Gunnery Exercise (GUNEX)	Expended Materials	Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities and coralline systems surrounding marine environments, which presents opportunities for ingestion and/or entanglement.
		Weapons Firing	Potential for short-term behavioral responses to firing noise, potential ingestion of expended materials. Potential for direct strike of sea turtles.

Table 3.8-1: Summary of Potential Stressors to Sea Turtles (Continued)

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Sea Turtles
Surface Warfare (SUW) / W-517 (continued)	Air to Surface GUNEX	Aircraft Overflights Weapons Firing Expended Materials	Potential for short-term behavioral responses to overflights in W-517. Potential for direct strike of sea turtles. Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities and coralline systems surrounding marine environments, which presents opportunities for ingestion and/or entanglement.
	Visit Board Search and Seizure (VBSS)	Aircraft Overflights Vessel Movements	Potential for short-term behavioral responses to overflights. Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
Strike Warfare (STW) / FDM	Air to Ground Bombing Exercises (Land)(BOMBEX-Land)	Aircraft Overflights Expended Materials	Potential for short-term behavioral responses to overflights to sea turtles near FDM. Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities and coralline systems surrounding FDM, which presents opportunities for ingestion and/or entanglement.
	Air to Ground Missile Exercises (MISSILEX)	Aircraft Overflights Expended Materials	Potential for short-term behavioral responses to overflights to sea turtles near FDM. Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities and coralline systems surrounding FDM, which presents opportunities for ingestion and/or entanglement.

Table 3.8-1: Summary of Potential Stressors to Sea Turtles (Continued)

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Sea Turtles
Naval Special Warfare (NSW) / Orote Point Training Areas, Ordnance Annex Breacher House, Apra Harbor, Andersen South, Northwest Field, Reserve Craft Beach, Polaris Point Field, Dan Dan Drop Zone	Naval Special Warfare (NSW)	Aircraft Overflights	Potential for short-term behavioral responses to overflights.
		Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
		Amphibious Landings	Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. Long-term effects of accelerated beach erosion from vehicle tracks on the beach and craft wakes in the water. Potential for nest failures for green sea turtles due to possible compaction from vehicles and false crawls of females attempting to nest due to vehicle landing activity.
		Weapons Firing	Potential for direct strike of sea turtles.
		Expended Materials	Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities and coralline systems surrounding beach areas, which presents opportunities for ingestion and/or entanglement.
	Insertion/Extraction	Aircraft Overflights	Potential for short-term behavioral responses to overflights.
		Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
		Amphibious Landings	Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. Long-term effects of accelerated beach erosion from vehicle tracks on the beach and craft wakes in the water. Potential for nest failures for green sea turtles due to possible compaction from vehicles and false crawls of females attempting to nest due to vehicle landing activity.
		Weapons Firing	Potential for direct strike of sea turtles.
		Expended Materials	Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities and coralline systems surrounding nearshore waters of Orote Peninsula, Gab Gab Beach, and Apra Harbor. This presents opportunities for ingestion and/or entanglement, especially with parachutes while the parachute assembly resides on the surface.

Table 3.8-1: Summary of Potential Stressors to Sea Turtles (Continued)

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Sea Turtles
Naval Special Warfare (NSW) / Orote Point Training Areas, Ordnance Annex Breacher House, Apra Harbor, Andersen South, Northwest Field, Reserve Craft Beach, Polaris Point Field, Dan Dan Drop Zone (continued)	Direct Action	Aircraft Overflights Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Potential for short-term behavioral responses to overflights. Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions. Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. Long-term effects of accelerated beach erosion from vehicle tracks on the beach and craft wakes in the water. Potential for nest failures for green sea turtles due to possible compaction from vehicles and false crawls of females attempting to nest due to vehicle landing activity. Potential for direct strike of sea turtles. Potential for ingestion of chaff and/or flare plastic end caps and pistons.
Naval Special Warfare (NSW) / Orote Point Training Areas, Ordnance Annex Breacher House, Apra Harbor, Andersen South, Northwest Field, Reserve Craft Beach, Polaris Point Field, Dan Dan Drop Zone (continued)	MOUT	None	None
Naval Special Warfare (NSW) / Orote Point Training Areas, Ordnance Annex Breacher House, Apra Harbor, Andersen South, Northwest Field, Reserve Craft Beach, Polaris Point Field, Dan Dan Drop Zone (continued)	Airfield Seizure	None	None
Naval Special Warfare (NSW) / Orote Point Training Areas, Ordnance Annex Breacher House, Apra Harbor, Andersen South, Northwest Field, Reserve Craft Beach, Polaris Point Field, Dan Dan Drop Zone (continued)	Over the Beach (OTB)	Aircraft Overflights Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Potential for short-term behavioral responses to overflights. Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions. Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. Long-term effects of accelerated beach erosion from vehicle tracks on the beach and craft wakes in the water. Potential for nest failures for green sea turtles due to possible compaction from vehicles and false crawls of females attempting to nest due to vehicle landing activity. Potential for direct strike of sea turtles. Potential for ingestion of chaff and/or flare plastic end caps and pistons.
Naval Special Warfare (NSW) / Orote Point Training Areas, Ordnance Annex Breacher House, Apra Harbor, Andersen South, Northwest Field, Reserve Craft Beach, Polaris Point Field, Dan Dan Drop Zone (continued)	Breaching	None	None
Amphibious Warfare (AMW) / FDM, Orote Point and Finegayan Small Arms Ranges, Orote Point KD Range, Reserve Craft Beach, Outer Apra Harbor, Tipalo Cove, Tinian EMUA	Naval Surface Fire Support (FIREX Land)	Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions. Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. Long-term effects of accelerated beach erosion from vehicle tracks on the beach and craft wakes in the water. Potential for nest failures for green sea turtles due to possible compaction from vehicles and false crawls of females attempting to nest due to vehicle landing activity. Potential for direct strike of sea turtles. Potential for ingestion of chaff and/or flare plastic end caps and pistons.
Amphibious Warfare (AMW) / FDM, Orote Point and Finegayan Small Arms Ranges, Orote Point KD Range, Reserve Craft Beach, Outer Apra Harbor, Tipalo Cove, Tinian EMUA	Marksmanship	None	None

Table 3.8-1: Summary of Potential Stressors to Sea Turtles (Continued)

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Sea Turtles
Amphibious Warfare (AMW) / FDM, Orote Point and Finegayan Small Arms Ranges, Orote Point KD Range, Reserve Craft Beach, Outer Apra Harbor, Tipalo Cove, Tinian EMUA (continued)	Expeditionary Raid	Aircraft Overflights	Potential for short-term behavioral responses to overflights.
		Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
		Amphibious Landings	Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. Long-term effects of accelerated beach erosion from vehicle tracks on the beach and craft wakes in the water. Potential for nest failures for green sea turtles due to possible compaction from vehicles and false crawls of females attempting to nest due to vehicle landing activity.
		Weapons Firing	Potential for direct strike of sea turtles.
		Expended Materials	Potential for ingestion of chaff and/or flare plastic end caps and pistons.
	Hydrographic Surveys	Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
		Amphibious Landings	Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. Long-term effects of accelerated beach erosion from vehicle tracks on the beach and craft wakes in the water. Potential for nest failures for green sea turtles due to possible compaction from vehicles and false crawls of females attempting to nest due to vehicle landing activity.
Explosive Ordnance Disposal (EOD) / Outer Apra Harbor, Piti and Agat Bay Floating Mine Neutralization Areas	Land Demolition / Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point Training Areas, Ordnance Annex Breacher House, Ordnance Annex Detonation Range, Fire Break #3, Ordnance Annex Galley Building 460, SLNA, Barrigada Housing	None	None
	Underwater Demolition / Outer Apra Harbor, Piti and Agat Bay Floating Mine Neutralization areas	Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
		Explosive Ordnance	Potential for short-term behavioral responses from explosive noise and pressure changes. Potential for injury or mortality within limited ZOI.
		Expended Materials	Potential for ingestion of chaff and/or flare plastic end caps and pistons.

Table 3.8-1: Summary of Potential Stressors to Sea Turtles (Continued)

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Sea Turtles
Logistics and Combat Services Support/ Orote Point Airfield/ Runway, Reserve Craft Beach	Combat Mission Area	Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
		Amphibious Landings	Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. Long-term effects of accelerated beach erosion from vehicle tracks on the beach and craft wakes in the water. Potential for nest failures for green sea turtles due to possible compaction from vehicles and false crawls of females attempting to nest due to vehicle landing activity.
		Weapons Firing	Potential for direct strike of sea turtles.
		Expended Materials	Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities and coralline systems surrounding in nearshore waters of Orote Peninsula and Reserve Craft Beach which presents opportunities for ingestion and/or entanglement.
	Command and Control (C2)	None	None
Combat Search and Rescue (CSAR) / North Field (Tinian)	Embassy Reinforcement	None	None
	Anti-Terrorism (AT)	None	None
Air Force Training			
Counter Land		None	
Counter Air (Chaff) / W-517, ATCAAs 1 and 2		Expended Materials	Long-term, minor, and localized accumulation of expended materials (including end caps and pistons) in soft bottom benthic communities and coralline systems surrounding marine environments, which presents opportunities for ingestion.
Airlift		None	None
Air Expeditionary		None	None
Force Protection		None	None
Intelligence, Surveillance, Reconnaissance (ISR) and Strike Capacity/ R-7201, FDM, Andersen AFB	Air-to-Air Training	None	None
	Air-to-Ground Training	None	None

Table 3.8-1: Summary of Potential Stressors to Sea Turtles (Continued)

Training Event Type / Location	Training Event Name	Potential Stressor	Potential Activity Effect on Sea Turtles
Rapid Engineer Deployable Heavy Operational Repair Squadron Engineer (RED HORSE) / Northwest Field	Silver Flag Training	None	None
	Commando Warrior Training	None	None
	Combat Communications	None	None

3.8.2 Affected Environment

3.8.2.1 Overview of Sea Turtles

Sea turtles are long lived reptiles that can be found throughout the world's tropical, subtropical, and temperate seas (Spotila 2004). There are seven living species of sea turtles from two distinct families, the Cheloniidae (hard-shelled sea turtles; six species) and the Dermochelyidae (non–hard-shelled sea turtles; one species). These two families can be distinguished from one another on the basis of their carapace (upper shell) and other morphological features. Over the last few centuries, sea turtle populations have declined dramatically due to anthropogenic (human-related) activities such as coastal development, oil exploration, commercial fishing, marine-based recreation, pollution, and over-harvesting (NRC, 1990; Eckert, 1995). As a result, all six species of sea turtles found in U.S. waters are currently listed as either threatened or endangered under the ESA.

Sea turtles are highly adapted for life in the marine environment. Unlike terrestrial and freshwater sea turtles, sea turtles possess powerful, modified forelimbs (or flippers) that enable them to swim continuously for extended periods of time (Wyneken 1997). They also have compact and streamlined bodies that help to reduce drag. Additionally, sea turtles are among the longest and deepest diving of the air-breathing vertebrates, spending as little as 3 to 6 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, which makes the aforementioned adaptations important (Ernst *et al.* 1994; Meylan 1995). Sea turtle traits and behaviors also help protect them from predation. Sea turtles have a tough outer shell and grow to a large size as adults; mature leatherback turtles can range in mass from 440 and 1,540 lb (200 and 700 kg) (Eckert and Luginbuhl 1988). Sea turtles cannot withdraw their head or limbs into their shell, so growing to a large size as adults is important because a larger sea turtle is less susceptible to 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 2 months as eggs and an additional few minutes to a few hours as hatchlings scrambling to the surf, some sea turtles are rarely encountered out of the water. Sexually mature females return to land in order to nest. Certain species in the Hawaiian Islands, Australia, and the Galapagos Islands haul out on land in order to bask (Carr 1995; Spotila *et al.* 1997). Sea turtles bask to thermoregulate, elude predators, avoid harmful mating encounters, possibly to accelerate the development of their eggs, accelerate their metabolism, and destroy aquatic algae growth on their carapaces (Whittow and Balazs 1982; Spotila *et al.* 1997). On occasion, sea turtles can unintentionally end up on land if they are dead, sick, injured, or cold-stunned. These events, also known as strandings, can be caused by either biotic (*e.g.*, predation and disease) or abiotic (*e.g.*, water temperature) factors.

Female sea turtles nest in tropical, subtropical, and warm-temperate latitudes, often in the same region or on the same beach where they hatched (Miller 1997). Upon returning to their natal beach area, most sea turtles tend to re-nest in close proximity during subsequent nesting attempts. The leatherback turtle is a notable divergence from this pattern. This species nests primarily on beaches with little reef or rock offshore. On these types of beaches erosion reduces the probability of nest survival. To compensate, leatherbacks scatter their nests over larger geographic areas and lay on average two times as many clutches as other species (Eckert 1987).

At times, sea turtles may fail to nest after emerging from the ocean. These nonnesting emergences, known as false crawls, can occur if sea turtles are obstructed from laying their eggs (by debris, rocks, roots, or other obstacles), are distracted by surrounding conditions (by noise, lighting, or human presence), or are uncomfortable with the consistency or moisture of the sand on the nesting beach. Sea turtles that are successful at nesting usually lay several clutches of eggs during a nesting season with each clutch containing between 50 and 200 eggs, depending on the species (Witzell 1983; Dodd 1988; Hirth 1997). Most sea turtle species do not nest in consecutive years; instead, they will often skip 2 or 3 years before returning to the nesting grounds (Márquez-M. 1990; Ehrhart 1995). Nesting success is vital to the long-term existence of sea turtles, since it is estimated that only 1 out of every 1,000 hatchlings survives long enough to reproduce (Frazer 1986).

During the nesting season, daytime temperatures can be lethal on tropical, subtropical, and warm-temperate beaches. As a result, adult sea turtles most often nest and hatchlings most often emerge from their nest at night (Miller 1997). After emerging from the nest, sea turtle hatchlings use visual cues (*e.g.*, light intensity or wavelengths) to orient themselves toward the sea (Lohmann *et al.* 1997).

Hatchlings that make it into the water will spend the first few years of their lives in offshore waters, drifting in convergence zones or amidst floating vegetation, where they find food (mostly pelagic invertebrates) and refuge in flotsam that accumulates in surface circulation features (Carr 1987). Originally labeled the "lost years," this stage in a sea turtle's life history is now known to be much longer in duration, possibly lasting a decade or more (Chaloupka and Musick 1997; Bjorndal *et al.* 2000). Sea turtles will spend several years growing in the early juvenile "nursery habitat," which is usually pelagic and oceanic, before migrating to distant feeding grounds that comprise the later juvenile "developmental habitat," which is usually demersal and neritic (in shallow water) (Musick and Limpus 1997; Frazier, 2001). Hard-shelled sea turtles most often utilize shallow offshore and inshore waters as later juvenile developmental habitats, whereas leatherback turtles, depending on the season, can utilize either coastal feeding areas in temperate waters or offshore feeding areas in tropical waters (Frazier 2001).

Once in the later juvenile developmental habitat, most sea turtles change from surface to benthic feeding and begin to feed on larger items such as crustaceans, mollusks, sponges, coelenterates, fishes, macroalgae, and seagrasses (Bjorndal 1997). A sea turtle's diet varies according to its feeding habitat and its preferred prey. Upon moving from the later juvenile developmental habitat to the adult foraging habitat, sea turtles may demonstrate further changes in prey preference, dietary composition, and feeding behavior (Bjorndal 1997; Musick and Limpus 1997).

Throughout their life cycles, sea turtles undergo complex seasonal movements. Sea turtle movement patterns are influenced by changes in ocean currents, turbidity, salinity, and food availability. In addition to these factors, the distribution of many sea turtle species is dependent upon and often restricted by water temperature (Epperly *et al.* 1995; Davenport 1997; Coles and Musick 2000). Most sea turtles become lethargic at temperatures below 50°F (10°C) and above 104°F (40°C) (Spotila *et al.* 1997).

3.8.2.1.1 Sea Turtle Hearing

Sea turtles do not have an auditory meatus or pinna that channels sound to the middle ear, nor do they have a specialized tympanum (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 sound to the extracolumella (a cartilaginous disk) located at the entrance to the columella, a long, thin bone that extends from the middle ear cavity to the entrance of the inner ear or otic cavity (Ridgway *et al.* 1969a). Sound arriving at the inner ear via the columella is transduced by the bones of the middle ear. Sound also arrives by bone conduction through the skull.

Sea turtle auditory sensitivity is not well studied, though a few preliminary 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). The range of maximum sensitivity for sea turtles is 100 to 800 Hz, with an upper limit of about 2,000 Hz (Lenhardt 1994). Hearing below 80 Hz is less sensitive but still potentially usable to the animal (Lenhardt 1994). Ridgway *et al.* (1969a) 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 sea turtle's hearing threshold was about 64 dB in air. At 70 Hz, it was about 70 dB in air. Bartol *et al.* (1999) reported that juvenile loggerhead sea turtles hear sounds between 250 and 1,000 Hz. Lenhardt *et al.* (1983) 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 sea 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. Finally, sensitivity even within the optimal hearing range is apparently low as threshold detection levels in water are relatively high at 160 to 200 dB re 1 µPa-m (Lenhardt 1994).

3.8.2.2 Sea Turtles within the MIRC Study Area

Five of the world's seven living species of sea turtles may occur within waters around Guam and the CNMI (Pritchard 1995; Kolinski 2001). These include the green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*), and olive ridley (*Lepidochelys olivacea*) turtles. The loggerhead turtle (*Caretta caretta*) is also known to occur in the North Pacific Ocean but has never been sighted in the Marianas region (NMFS and USFWS 1998c). However, due to this species' wide-ranging nature, there is a slight possibility that it could occur in this region. As a result, a total of five sea turtle species are known to occur, or have the potential to occur, in the MIRC Study Area (Table 3.8-2). Of the five species discussed in this EIS/OEIS, only green sea turtles and hawksbill turtles are known to nest within the MIRC Study Area. Navy biologists conduct monthly sea turtle nest surveys on beaches within Navy-owned and Navy-leased lands on Guam and the CNMI. These surveys provide important trend data and assist military planners to avoid and minimize impacts to sea turtles and their nesting habitats.

Table 3.8-2: Sea Turtles Known to Occur within the MIRC Study Area

Common Name	Scientific Name	ESA Status	Potential Occurrence
Green turtle	*Chelonia mydas*	Threatened	Regular
Hawksbill turtle	*Eretmochelys imbricata*	Endangered	Regular
Loggerhead turtle	*Caretta caretta*	Threatened	Extralimital
Olive ridley turtle	*Lepidochelys olivacea*	Threatened	Extralimital
Leatherback turtle	*Dermochelys coriacea*	Endangered	Rare

3.8.2.2.1 Green Turtle (*Chelonia mydas*)

Description. The green turtle is the largest hard-shelled sea turtle; adults are commonly 40 in (100 cm) straight carapace length and 330 lb (150 kg) in mass (NMFS and USFWS 1998a). Very young green turtles are omnivorous (Bjorndal 1985; Bjorndal 1997). Adult green turtles feed primarily on seagrasses, macroalgae, and reef-associated organisms (Burke *et al.* 1992; Bjorndal 1997). They also consume jellyfish, salps, and sponges (Mortimer 1995; Bjorndal 1997).

Green turtles typically make dives shallower than 100 ft (31 m) (Hays *et al.* 1999; Hochscheid *et al.* 1999; Hays *et al.* 2000; Godley *et al.* 2002; Hatase *et al.* 2006). Green turtles are known to forage and rest at depths of 64 to 160 ft (20 to 50 m) (Balazs 1980; Brill *et al.* 1995).

Status and Management. Green turtles are classified as threatened under the ESA throughout their Pacific range, except for the population that nests on the Pacific coast of Mexico (identified by the NMFS and USFWS [1998b] as *C. m. agassizii*), which is classified as endangered. East Pacific green turtles are recognized as a distinct population segment by the NMFS and are managed under a separate recovery plan. With the exception of Hawaii, green sea turtle populations are in serious decline throughout the Pacific Ocean, including green sea turtles within the MIRC.

The primary threats to green turtles at Guam and the CNMI include direct harvesting of sea turtles and eggs as well as habitat loss due to rapidly expanding tourism, including increased coastal development on nesting beaches (NMFS and USFWS 1998a, 1998b). Another primary threat to green turtles that may be related to human activity is the disease fibropapillomatosis. Fibropapillomatosis may be caused by exposure in marine areas affected by agricultural, industrial, or urban pollution (Aquirre and Lutz 2004). Other threats include habitat degradation by ungulates and nest predation by pigs, as well as destruction of strand vegetation, compaction of sand on nesting beaches by vehicles and heavy equipment, and the use of excessive or inappropriate lighting on beaches.

Habitat. Post-hatchling and early juvenile green turtles reside in convergence zones in the open ocean, where they spend an undetermined amount of time in the pelagic environment (Carr 1987; Witherington and Hirama 2006). Once green turtles reach a carapace length of 7.9 to 9.8 in (20 to 25 cm), they migrate to shallow nearshore areas (<165 ft [50 m] deep) where they spend the majority of their lives as late juveniles and adults. The optimal developmental habitats for late juveniles and foraging adults are warm, shallow waters (10 to 16.5 ft [3 to 5 m] in bottom depth), with an abundance of submerged aquatic vegetation, and located proximal to nearshore reefs or rocky areas, used by green turtles for resting (Holloway-Adkins and Provancha 2005; Witherington *et al.* 2006a).

Status within the MIRC Study Area. Green turtles are by far the most abundant sea turtle found throughout the Marianas archipelago. Aerial surveys conducted by the Guam DAWR indicate the presence of a year-round resident population in Guam's nearshore waters (NMFS and USFWS 1998a). Aggregations of foraging and resting green turtles are often seen in close proximity to Guam's well-developed seagrass beds and reef flats, which are found in Cocos Lagoon, Apra Harbor, along Tarague Beach and Hilaan, in deeper waters south of Falcona Beach, and at several other locations throughout the island's shelf (Wiles *et al.* 1995; DoN 2003a). Recreational SCUBA divers regularly see green turtles at the following sites off Guam: Boulder Alley, Ane Caverns, Napoleon Cut, Gab Gab I, and the Wall. Green turtle nesting on Guam is most prevalent at the northern and southern ends of the island. Currently, the Guam DAWR regularly surveys eight separate stretches of beach for green turtle nesting activity (Gutierrez 2004). The most utilized nesting beaches in Guam are Tarague Beach, Falcona Beach, Ritidian Beach, Asiga Beach, Urunao Point, and the beaches along Cocos Island and Sella Bay (Pritchard 1995; Wiles *et al.* 1995; Gutierrez 2004). However, beaches that are not currently being surveyed could be equally as important.

On Tinian, green turtle abundance and density are highest along the island's relatively uninhabited east coast. The most recent estimate of the number of green turtles inhabiting the nearshore waters around Tinian was 832 green turtles in 2001 (Kolinski *et al.* 2006). Green turtle numbers are projected to be greater at Tinian than at Saipan, even though Saipan is a larger island with more extensive seagrass habitats. The Navy conducts monthly surveys on green turtle nesting beaches. The presence of seagrasses around Tinian is limited, so green turtles occurring there likely feed on algae. At least 24 known forage species of algae were found at Tinian during recent habitat surveys (Kolinski *et al.* 2001). Nesting surveys have indicated that adult green turtles utilize most, if not all, beaches on Tinian for nesting (NMFS and USFWS 1998a). The beaches that are most often utilized are Unai Dankulo (Long Beach), Unai Barcinas, Unai Leprosarium, and Unai Lamlam (Pultz *et al.* 1999; DoN 2005b). In 1995, an adult green turtle nesting at Tinian was later recovered in the Philippines. This event provided evidence that adult green turtles nesting in the Marianas archipelago have geographically distinct foraging grounds that are often located thousands of miles away. In June 2002, a team of personnel from the Navy, CNMI DFW, Guam DAWR, and USFWS satellite-tagged three adult female green turtles on their nesting beaches at Tinian. This project was implemented to further study the movements and migrations of green sea turtles from waters and beaches owned and leased by the Navy on and around Tinian (Knutson and Vogt 2002). At FDM, four green turtles were observed at the northern end of the island during Navy sponsored marine tow and SCUBA surveys in 2003 (DoN 2004). At least nine green turtles were observed during underwater surveys in both 1999 and 2000, while at least 12 green turtles were observed during surveys in 2001. Most green turtles at FDM were found either swimming over the reef platform or resting in holes or caves (Belt Collins 2001).

Green turtles are not as abundant at FDM as they are at some of the larger islands of the Marianas chain. Due to strong current and tidal conditions, the beaches at FDM are highly unsuitable for nesting (DoN 2004), which suffer frequent inundation. Also, seagrasses and benthic algae are relatively sparse around the island and can probably support no more than a few green turtles at a time (NMFS and USFWS 1998a). Seven sea turtles were documented in 2006 and 19 in 2007 during monthly monitoring (helicopter surveys) of FDM (NAVFACPAC 2008d). Monthly observations are usually low (between one and three sea turtle observations); however, twelve sea turtles were observed in waters off FDM on November 13, 2007 (NAVFACPAC 2008d). Identifying sea turtles to the species level is not possible due to safe flying heights of the helicopter, although due to the higher abundance of green sea turtles relative to hawksbill turtles, the majority of sea turtle observations are assumed to be green sea turtles (NAVFACPAC 2008d).

Based on the above information, green turtles are expected to occur year-round in all shelf waters of the MIRC from FDM to Guam. Around the larger islands of Tinian, Saipan, Rota, and Guam, green turtle occurrence is concentrated in waters less than 164 ft (50 m) deep. It is at these water depths where green turtle foraging and resting habitats (*e.g.*, fringing reefs, reef flats, and seagrass beds) are usually found. Beyond the shelf break, green turtle occurrence is rare/unknown. Nesting females and early juveniles are known to move through oceanic waters of the Marianas chain during their reproductive and developmental migrations (Gutierrez 2004; Kolinski *et al.* 2006), but likely do not do so in large enough numbers every year to warrant those waters being designated as additional areas of expected occurrence.

3.8.2.2.2 Hawksbill Turtle (*Eretmochelys imbricata*)

Description. The hawksbill turtle is a small to medium-sized sea turtle. Adults range between 25 and 35 in (65 and 90 cm) in carapace length and typically weigh around 176 lb (80 kg) (Witzell 1983). Hawksbills are easily distinguished from other sea turtles by their sharp, curving beak with prominent tomium, and the saw-like appearance of its shell margins. While the hawksbill turtle lives a part of its life in the open ocean, it is most often encountered in shallow lagoons and coral reefs where it feeds on its preferred prey, sea sponges. Some of the sponges eaten by hawksbills are known to be highly toxic and lethal when eaten by other organisms. In addition, the sponges that hawksbills eat are usually those with high silica content, making the hawksbill turtles one of few animals capable of eating siliceous organisms.

Status and Management. Hawksbill turtles are classified as endangered under the ESA. In U.S. waters, hawksbill populations are noted as neither declining nor showing indications of recovery (Plotkin 1995). Only five regional populations worldwide remain with more than 1,000 females nesting annually (Seychelles, the Mexican Atlantic, Indonesia, and two populations in Australia) (Meylan and Donnelly 1999).

The status of the hawksbill is clearly of greater concern in the Pacific due to the serious depletion of the species caused by international harvest (eggs, hatchlings, juveniles, and adults) and habitat destruction (NMFS and USWFS 1998b). Major threats to hawksbill turtle populations in the Pacific island habitats include increased human populations, beach erosion and strand habitat degradation (human disturbance or ungulate impacts), nest predation (rats, pigs, cats), inappropriate or excessive lighting on beaches, boat collisions, and driving vehicles on beaches.

Habitat. Hawksbill turtles inhabit oceanic waters as post-hatchlings and small juveniles, where they are sometimes associated with driftlines and floating patches of *Sargassum* (Parker 1995; Witherington and Hirama 2006). The developmental habitats for juvenile benthic-stage hawksbills are the same as the primary feeding grounds for adults. They include tropical, nearshore waters associated with coral reefs, hard bottoms, or estuaries with mangroves (Musick and Limpus 1997). Coral reefs are recognized as optimal hawksbill habitat for juveniles, subadults, and adults (NMFS and USFWS 1993; Diez and Van Dam, 2003). In neritic habitats, resting areas for late juvenile and adult hawksbills are typically located in deeper waters than their foraging areas, such as sandy bottoms at the base of a reef flat (Houghton *et al.* 2003). Late juveniles generally reside on shallow reefs less than 59 ft (18 m) deep. However, as they mature into adults, hawksbills move to deeper habitats and may forage to depths greater than 297 ft (90 m). Benthic stage hawksbills are seldom found in waters beyond the continental or insular shelf, unless they are in transit between distant foraging or nesting grounds (NMFS and USFWS 1993).

Status within the MIRC Study Area. Although there are only a few recent hawksbill occurrence records in the MIRC (DoN 2005a; Michael 2004), historical records indicate a likely presence of this species in the coastal waters surrounding the islands of the southern Marianas arc (*i.e.*, from FDM south to Guam) (Wiles *et al.* 1989, 1990, 1995; Kolinski *et al.* 2001; Gutierrez 2004). As a result, hawksbill turtles are expected to occur in all waters located inside the shelf break within the MIRC, including within Guam's Apra Harbor. Since hawksbill turtles are highly endangered and do not occur in large numbers anywhere within the region, there are no areas of concentrated occurrence around Guam and the CNMI. In deeper waters beyond the shelf break (*e.g.*, throughout W-517), the occurrence of the hawksbill turtle is low/unknown.

During aerial surveys between 1989 and 1991, hawksbills represented 13.2 percent of all sea turtles sighted around Guam. Wiles *et al.* (1995) indicate that hawksbills are typically found near river mouths as well as inside Apra Harbor. These are areas where sponges, their preferred food, are common. Sasa Bay, which is located in Apra Harbor, is the largest estuary in the Marianas, and appears to be an area where hawksbills are most often encountered (Kolinski *et al.* 2001). Randall *et al.* (1975) noted that hawksbills were also sighted in the protected waters of Cocos Lagoon. One hawksbill nest was recorded between Urunao Point and Tarague Beach (northern Guam) in 1984 and single nesting events were recorded on a small beach at Sumay Cove, Apra Harbor in 1991 and 1992 (NMFS and USFWS 1998a).

Hawksbill turtles are also regular inhabitants of Tinian nearshore waters, although in much fewer numbers than green turtles. Even though past surveys at Tinian (1984/1985, 1994/1995, and 2001) failed to produce a single sighting record, time and area constraints may have led to foraging hawksbills being missed (Wiles *et al.* 1989; Pultz *et al.* 1999; Kolinski *et al.* 2001).

The only occurrence records that exist for FDM are two in-water sightings at the southwestern corner of the island in 2001, and one at the northwest corner of the island in 2004 (DoN 2003b, 2004). Each of these observations was recorded during Navy-sponsored marine tow and SCUBA dive surveys around the island. Both of the hawksbills sighted in 2001 were immature individuals less than 20 in (50 cm) in carapace length, while the individual observed in 2004 was somewhat larger at approximately 28 in (70 cm) in carapace length (DoN 2004). There are only a few documented records of hawksbills nesting in the Marianas region although only a subset of the region's beaches is adequately surveyed for sea turtle nesting activity.

Hawksbill turtles were not observed to nest on Tinian, although nesting attempts could be made at times and locations where surveys are not being conducted. Since hawksbills prefer to nest in areas with sufficient vegetative cover, it is possible that some nests are never found on surveyed beaches. Lund (1985) notes that hawksbill nests are often very difficult to identify when qualified observers are not present. Hawksbills are unlikely to be encountered on the beaches of FDM, which are unsuitable for nesting because of tidal inundation of beach areas (DoN 2003a).

3.8.2.2.3 Loggerhead Turtle (*Caretta caretta*)

Description. Loggerheads are large, hard-shelled sea turtles. The average carapace length of an adult female loggerhead is between 35 and 38 in (90 and 95 cm) and the average mass is 220 to 330 lb (100 to 150 kg) (Dodd 1988; NMFS and USFWS 1998c). The size of a loggerhead turtle's head compared to the rest of its body (*i.e.*, aspect ratio) is substantially larger than that of other sea turtles. Adults are mainly reddish brown in color on top and yellowish underneath. A loggerhead turtle's diet includes fish, crustaceans, zooplankton, and invertebrates such as mollusks, cnidarians, echinoderms, and marine worms (Dodd 1988).

Status and Management. Loggerhead turtles are classified as threatened under the ESA. Incidental bycatch in commercial fisheries is a tremendous source of loggerhead mortality. Lewison *et al.* (2004) noted that an estimated 30,000 to 75,000 loggerhead turtles were taken as pelagic longline bycatch in the Pacific Ocean in 2000. Rapid declines in nesting females at all major Pacific nesting beaches suggest that longline bycatch is leading to increased levels of loggerhead mortality in the Pacific Ocean (Kamezaki *et al.* 2003; Limpus and Limpus 2003). In 2004, the NMFS concluded that the pelagic longline fishery is likely to jeopardize the continued existence of loggerhead turtles in the Pacific Ocean. As a protective measure, NMFS is now prohibiting U.S. vessels from fishing with shallow longline sets throughout the Pacific Ocean (NMFS 2004).

Habitat. The loggerhead turtle occurs worldwide in habitats ranging from coastal estuaries to waters far beyond the continental shelf (Dodd 1988). The species may be found hundreds of miles out to sea, as well as in inshore areas such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers. The neritic juvenile stage and adult foraging stage both occur in the neritic (nearshore) zone. Coral reefs, rocky places, and ship wrecks are often used as feeding areas. The loggerhead turtles here are active and feed primarily on the bottom (epibenthic/demersal), though prey is also captured throughout the water column (Bjorndal 2003; Bolten 2003). The neritic zone not only provides crucial foraging habitat, but can also provide inter-nesting and overwintering habitat. Tagging data revealed that migratory routes may be coastal or may involve crossing deep ocean waters; an oceanic route may be taken even when a coastal route is an option (Schroeder *et al*. 2003).

The loggerhead sea turtle occurs throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. However, the majority of loggerhead nesting is at the western rims of the Atlantic and Indian oceans (Encalada *et al.*, 1998). South Florida and Masirah, Oman, are the only two nesting beaches in the world with greater than 10,000 females nesting per year. The total estimated nesting in the U.S. is approximately 68,000 to 90,000 nests per year. The major nesting concentrations in the U.S. are found in South Florida; however loggerheads nest from Padre Island in South Texas to Virginia (NMFS and USFWS 1998c). The only known nesting areas for loggerheads in the North Pacific are found in southern Japan (USFWS 1998e; Erhart *et al.* 2003).

Status within the MIRC Study Area. There are no sighting, stranding, or nesting records for loggerhead turtles around Guam and the CNMI. The nearest occurrences of this species are from the waters off Palau and the Philippines (Sagun *et al*. 2005). This species is more apt to be found in temperate waters of the North Pacific Ocean (*i.e.*, north of 25°N) off of countries such as Japan, China, Taiwan, northwestern Mexico, and the southwestern U.S. including Hawaii (NMFS and USFWS 1998c; Polovina *et al.* 2001, 2004). However, Guam and the CNMI are identified as being within the species' overall range (USFWS 2005). Also, the westward flowing current of the NPSG system, which late juvenile stage loggerheads use when returning to the WestPack, passes through the Marianas region (Pickard and Emery 1982; Polovina *et al.* 2000). As a result, the occurrence of the loggerhead turtle would be considered rare throughout the year in all oceanic waters of the MIRC Study Area. Since loggerhead occurrences in the waters off Guam and the CNMI would most likely involve individuals in transit, occurrence is not expected in coastal (*i.e*., shelf) waters around any of the islands in the MIRC Study Area.

3.8.2.2.4 Olive Ridley Turtle (*Lepidochelys olivacea*)

Description. The olive ridley is a small, hard-shelled sea turtle named for its olive green-colored shell. Adults often measure between 23 and 28 in (60 and 70 cm) in carapace length and rarely weigh over 110 lb (50 kg). The carapace of an olive ridley turtle is wide and almost circular in shape. The olive ridley differs from the Kemp's ridley, the other member of the genus *Lepidochelys*, in that it possesses a smaller head, a narrower carapace, and several more lateral carapace scutes. Kemp's ridley sea turtles only occur in the Atlantic Ocean (Eckert *et al.* 1999). Existing reports suggest that the olive ridley's diet includes crabs, shrimp, rock lobsters, jellyfish, and tunicates. In some parts of the world, algae has been reported as its principal food (Pandav *et al.*,1997; Eckert *et al.* 1999).

Status and Management. Olive ridleys are classified as threatened under the ESA, although the Mexican Pacific coast nesting population is labeled as endangered. There has been a general decline in the abundance of this species since its listing in 1978. Even though there are no current estimates of worldwide abundance, the olive ridley is still considered the most abundant of the world's sea turtles. However, the number of olive ridley turtles occurring in U.S. territorial waters is believed to be small (USFWS 1998a-f).

Habitat. The olive ridley is mainly a pelagic sea turtle, but has been known to inhabit coastal areas, including bays and estuaries. Olive ridleys mostly breed annually and have an annual migration from pelagic foraging, to coastal breeding and nesting grounds, back to pelagic foraging. Trans-Pacific ships have observed olive ridleys over 2,400 mi (4,000 km) from shore (Plotkin *et al.* 1994).

The largest nesting aggregation in the world now occurs in the Indian Ocean along the northeast coast of India (Orissa), where in 1991 over 600,000 turtles nested in a single week (Mrosovsky 1993). The second most important nesting area occurs in the eastern Pacific, along the west coast of Mexico and Central America (USFWS 1998f). Although increasing numbers of nests and nesting females have been observed in Mexico in recent years, the decline of the species continues in the eastern Pacific countries of Costa Rica, Guatemala, and Nicaragua. Egg loss has occurred from both legal and illegal collection, as well as natural loss due to nesting sea turtles inadvertently digging up previously laid nests. Population growth rate parameters calculated for the primary nesting site of Escobilla Beach, Oaxaca, Mexico indicate a negligible risk of extinction over the next several decades, given that current conservation practices are continued (Snover 2005).

Status within the MIRC Study Area. Only one olive ridley record exists for Guam and the CNMI, an alleged capture in the waters near Saipan (Pritchard 1977). The exact location of this capture, however, is unknown since the turtle was offered for sale in a local souvenir shop. The nearest in-water sightings of this species have occurred within the Yap and Palau Districts (Eckert 1993; Pritchard 1995). It is possible that future occurrences could occur in the MIRC Study Area and vicinity. Since olive ridleys are a tropical species, they are the most abundant sea turtles in the Pacific Ocean, and they have been satellite-tracked through North Pacific waters as far south as 8°N during developmental migrations (Polovina *et al.* 2004). The occurrence of the olive ridley turtle is rare throughout the year in all waters surrounding Guam and the CNMI that are seaward of the shelf break because they are primarily an oceanic species. In portions of the MIRC Study Area located inside the shelf break (*e.g.*, Apra Harbor, Agat Bay, nearshore waters around northern Tinian), olive ridley turtle sightings would be rare.

3.8.2.2.5 Leatherback Turtle (*Dermochelys coriacea*)

Description. The leatherback turtle is the largest living sea turtle. A leatherback turtle's carapace lacks the outer layer of horny scutes 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 and tapered to the rear, with seven longitudinal dorsal ridges, and is almost completely black with variable spotting. All adults possess a unique spot on the dorsal surface of their head, a marking that can be used by scientists to identify specific individuals (McDonald and Dutton 1996). Adult carapace lengths range from 48 to 71 in (119 to 176 cm) with an average around 57 in (145 cm) (NMFS and USFWS 1998c). Adult leatherbacks weigh between 440 and 1,540 lb (200 and 700 kg). Surveys of nesting leatherbacks in the Atlantic and Pacific Oceans indicate gene flow between nesting beaches within ocean basins and also that western Atlantic and eastern Pacific leatherbacks shared a common ancestor in recent evolutionary history (Dutton *et al.* 1994). Jellyfish are the main staple of the leatherbacks, but the diet also consists of sea urchins, squid, crustaceans, tunicates, fish, blue-green algae, and floating seaweed (Spotila *et al.* 2000).

Status and Management. Leatherback turtles in the Pacific Ocean are classified as endangered under the ESA. The leatherback turtle is distributed worldwide in tropical and temperate waters of the Atlantic, Pacific, and Indian Oceans. It is also found in small numbers as far north as British Columbia, Newfoundland, and the British Isles, and as far south as Australia, Cape of Good Hope, and Argentina. Recent estimates of global nesting populations indicate 26,000 to 43,000 nesting females annually, which is a dramatic decline from the 115,000 estimated in 1980. This is due to exponential declines in leatherback nesting that have occurred over the last two decades along the Pacific coasts of Mexico and Costa Rica. The Mexico leatherback nesting population, once considered to be the world's largest leatherback nesting population (65 percent of worldwide population), is now less than one percent of its estimated size in 1980. The largest nesting populations now occur in the western Atlantic in French Guiana (4,500 to 7,500 females nesting per year) and Colombia (estimated several thousand nests annually), and in the western Pacific in West Papua (formerly Irian Jaya) and Indonesia (about 600 to 650 females nesting per year). In the U.S., small nesting populations occur on the Florida east coast (35 females per year), Sandy Point, U.S. Virgin Islands (50 to 100 females per year), and Puerto Rico (30 to 90 females per year).

Habitat. Throughout their lives, leatherbacks are essentially oceanic, yet they enter into coastal waters for foraging and reproduction. There is limited information available regarding the habitats utilized by post-hatchling and early juvenile leatherbacks as these age classes are entirely oceanic. These life stages are restricted to waters greater than 79°F (26°C) and, therefore, spend much time in tropical waters (Eckert 2002a). Late juvenile and adult leatherback turtles are known to range from mid-ocean to continental shelf and nearshore waters (Schroeder and Thompson 1987; Shoop and Kenney 1992; Grant and Ferrell 1993). Juvenile and adult foraging habitats include both coastal feeding areas in temperate waters and offshore feeding areas in tropical waters (Frazier 2001). Adults may also feed in cold waters at high latitudes (James *et al.* 2006a). The movements of adult leatherbacks appear to be linked to the seasonal availability of their prey and the requirements of their reproductive cycle (Collard 1990; Davenport and Balazs 1991; Luschi *et al.* 2006).

Status within the MIRC Study Area. Of the three sea turtle species that have been sighted around Guam and the CNMI during marine surveys, the leatherback turtle is the least common (DoN 2005a). This species is occasionally encountered in the deep, pelagic waters of the Marianas archipelago, although only a few occurrence records exist (Eckert 1993; Wiles *et al.* 1995). In 1978, a 249-lb (113-kg) leatherback was rescued from waters southeast of Cocos Island, Guam (Eldredge 2003). From 1987 to 1989, divers reported seeing leatherbacks in the waters off Harnom Point, Rota; however, none have been seen in the area in recent times (Michael 2004). Leatherbacks do not nest at any of the islands in Micronesia. As a result, the occurrence of leatherback turtles would be considered rare throughout the year in all oceanic waters of the MIRC Study Area. Since leatherback occurrences in the waters off Guam and the CNMI would most likely involve individuals in transit, occurrence is not expected in coastal (*i.e.*, shelf) waters around any of the islands in the MIRC Study Area.

3.8.3 Environmental Consequences

3.8.3.1 No Action Alternative

3.8.3.1.1 Vessel Movements

Many of the ongoing and proposed training activities within the MIRC 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 sea turtles by disturbing or directly striking individual animals. Vessel movements associated with training in the MIRC Study Area occur during a major exercise, which can last up to 2 or 3 weeks. Elements of this event are widely dispersed throughout the MIRC Study Area. The probability of ship and sea turtle interactions occurring in the MIRC Study Area is dependent on several factors including numbers, types, and speeds of vessels; the regularity, duration, and spatial extent of activities; the presence/absence and density of sea turtles; and protective measures implemented by the Navy. Currently, the number of Navy ships operating in the Study Area varies based on training schedules and can range from 0 to about 10 ships at any given time. Ship sizes range from 362 ft (173 m) for a nuclear submarine (SSN) to 1,092 ft (341 m) for a nuclear aircraft carrier (CVN) and speeds range from 10 to 14 knots (18.5 to 26.0 km/hr). Training activities involving vessel movements occur intermittently and are short in duration, ranging from a few hours up to a few weeks.

Disturbance Associated with Vessel Movements. The ability of sea turtles to detect approaching water vessels via auditory and/or visual cues would be expected based on knowledge of their sensory biology (Bartol and Musick 2003; Levenson *et al.* 2004; Ketten and Bartol 2006; Moein Bartol and

Ketten 2006). Little information is available on how sea turtles respond to vessel approaches. Hazel *et al.* (2007) reported that greater vessel speeds increased the probability sea turtles would fail to flee from an approaching vessel. Sea turtles fled frequently in encounters with a slow-moving (2.2 knots [4 km/hr]) vessel, but infrequently in encounters with a moderate-moving (5.9 knots [11 km/hr]) vessel, and only rarely in encounters with a fast-moving (10.3 knots [19 km/h]) vessel. It is difficult to differentiate whether a sea turtle reacts to a vessel due to auditory cues (hearing the vessel), visual cues (seeing the vessel), or a combination of both.

Sea turtle hearing sensitivity is not well studied. Several studies regarding green, loggerhead, and Kemp's ridley sea turtles suggest that sea turtles are most sensitive to low-frequency sounds, although this sensitivity varies slightly by species and age class (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 that sea turtles can hear approaching vessels given their hearing range.

Behavioral Responses. Sea turtles may become habituated to sounds, including high levels of ambient noise found in areas of high vessel traffic (Moein *et al.* 1994; Hazel *et al.* 2007). Moein *et al.* (1994) conducted a study using a fixed sound source to repel sea turtles away from hopper dredges. Three decibel levels (175, 177, and 179 dB re 1 µPa at 1 m) were used for the study. It was found that while sea turtles avoided the sound upon first exposure, they appeared to habituate to the stimulus over a period of time (Lenhardt 1994; Moein *et al.* 1994). Adult loggerheads have been observed to initially respond (*i.e.*, increase swimming speeds) and avoid air guns when received levels range from 151 to 175 dB re 1 µPa, but they eventually habituate to these sounds (Lenhardt 2002). Sea turtles exposed to the general disturbance associated with a passing Navy vessel could exhibit a short-term behavioral response such as fleeing.

Given the current ambient sound levels in the marine environment, the amount of sound contributed by the use of Navy vessels in the MIRC Study Area is low. It is anticipated that any sea turtles exposed would exhibit only short-term reactions and would not suffer any long-term consequences from ship sound.

Physiological Responses. Although there is little information regarding physiological responses to vessel movements, the behavioral responses described by Hazel *et al. (*2007) may also be accompanied by physiological responses. Immature Kemp's ridley turtles have shown physiological responses to the acute and excessive stress of capture and handling through increased levels of corticosterone (Gregory and Schmid 2001). For sea turtles, this can include intense behavioral reactions such as biting and rapid flipper movement (Gregory and Schmid 2001). Maurer-Spurej (2005) discovered the occurrence of serotonin in green sea turtles. Stress-induced changes in serotonin, a chemical that regulates thermoregulation in warm-blooded animals may influence respiratory function in non-mammalian species and may decrease ability of green sea turtles to maintain prolonged times under water. In the short term, exposure to stressors results 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. At this time, it is unknown what the long-term implications of chronic stress may be on sea turtle species.

Ship Strikes. Collisions with commercial and Navy ships can cause major wounds and may occasionally cause fatalities to sea turtles. In addition, sound from surface vessel traffic may cause behavioral responses of sea turtles. If the response does not induce a sea turtle to flee the area of vessel movement, the behavioral response may induce confusion, thereby increasing the possibility of a collision. Although no similar study has been conducted in the Mariana Islands, a study of green sea turtle strandings in the Hawaiian Archipelago from 1982 to 2003 showed that 97 percent of the 3,861 sea turtle strandings are green turtles. Causes for strandings were reported as follows: boat strikes, 2.5 percent; shark attacks, 2.7 percent; fishing gear and gill net induced trauma, 12 percent; and miscellaneous causes, 5.4 percent. Boat strikes are in general from small craft. The most common cause of the strandings was the tumor-forming disease, fibropapillomatosis (28 percent); 49 percent of the strandings could not be attributed to any known cause (Chaloupka *et al.* 2008).

The Navy has adopted protective measures that reduce the potential for collisions between Navy surface vessels and sea turtles (refer to Chapter 5). 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 during at-sea movements. If a sea turtle is sighted, appropriate action will be taken to avoid the animal. Given the protective measures and the relatively few number of sea turtles and Navy vessels in the open ocean, the Navy believes collisions with sea turtles are unlikely.

General vessel disturbance (vessel movements and ship collisions) under the No Action Alternative may affect ESA-listed sea turtles; therefore, the Navy has entered into Section 7 ESA consultation with NMFS. In accordance with NEPA, disturbance from vessels (vessel movements and ship strikes) in territorial waters would have no significant impact on sea turtles. Furthermore, disturbance from vessels in non-territorial waters would not cause significant harm to sea turtles in accordance with EO 12114.

3.8.3.1.2 Aircraft Overflights

The general aircraft overflight exposure information presented for marine mammals is also applicable to sea turtles. Aircraft overflights would produce airborne noise and some of this energy would be transmitted into the water. Sea turtles could be exposed to noise associated with subsonic and supersonic fixed-wing aircraft overflights and helicopter training events while at the surface or while submerged. In addition, low-flying aircraft passing overhead could create a shadow effect that could induce a reaction in sea turtles. It is difficult to differentiate between reactions to the presence of aircraft and reactions to sound. Exposure to elevated noise levels would be brief (seconds) and infrequent based on the transitory and dispersed nature of the overflights. Sound exposure levels would be relatively low because a majority of the overflights would be above 3,000 ft (938 m).

Fixed-wing Aircraft. Fixed-wing aircraft overflights may occur throughout the MIRC Study Area. Little information regarding sea turtle reactions to fixed-wing aircraft overflights is available. Based on knowledge of their sensory biology (Bartol and Musick 2003; Ketten and Bartol 2006; Lenhardt 1994; Ridgway *et al.* 1969; Bartol *et al.* 1999), sound from low flying aircraft could be heard by a sea turtle at or near the surface. Sea turtles also might detect low flying aircraft via visual cues such as the aircraft's shadow. 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. As discussed in Section 3.7.4.1, subsonic and supersonic fixed-wing aircraft overflights are not expected to generate underwater sound levels that would result in harm of sea turtles (Eller and Cavanagh 2000; Laney and Cavanagh 2000).

Sea turtles exposed to aircraft overflights may exhibit no response or behavioral reactions such as quick diving. Any behavioral avoidance reaction would be short-term and would not permanently displace sea turtles or result in physical harm. Fixed-wing aircraft overflights are not expected to result in chronic stress because it is unlikely that individual sea turtles would be repeatedly exposed to low altitude overflights. Therefore, fixed-wing aircraft overflights under the No Action Alternative may affect sea turtles, but the effects would be insignificant because the effects would not be sufficient to harm or harass sea turtles.

Helicopters. Helicopter overflights occur in conjunction with several different exercises in the MIRC Study Area. Animals would only be exposed to the sound and water disturbance if they are at or near the water surface. The sound exposure levels would be relatively low for sea turtles since they spend the majority of their time underwater. However, unlike fixed-wing aircraft, helicopter training events often occur at low altitudes (75 to 100 ft [23 to 31 m]), which increases the likelihood that sea turtles would respond to helicopter overflights.

Based on results of a comprehensive literature review, no information regarding sea turtle reactions to helicopter overflights is available. However, based on knowledge of the auditory capabilities of sea turtles (Bartol and Musick 2003; Levenson *et al.* 2004; Ketten and Bartol 2006; Moein Bartol and Ketten 2006), as well as their response to visual cues (Hazel *et al.* 2007) discussed above (fixed-wing aircraft overflights), it is reasonable to assume that if exposed, sea turtles may react to helicopter overflights. In addition to the auditory and visual cues, animals may react to the disturbance of the water by the downdraft. Helicopter overflights are not expected to result in chronic stress because it is unlikely that individual animals would be repeatedly exposed.

Aircraft overflights (helicopters and fixed-wing aircraft) under the No Action Alternative may affect ESA-listed sea turtles, but the effects are insignificant because the effects would not exceed the thresholds for take (harm or harassment). The No Action Alternative may affect ESA-listed sea turtles; therefore, the Navy has entered into Section 7 ESA consultation with NMFS and USFWS. In accordance with NEPA, aircraft overflights in territorial waters would have no significant impact on sea turtles. Furthermore, disturbance from vessels in non-territorial waters would not cause significant harm to sea turtles in accordance with EO 12114.

3.8.3.1.3 Land-Based Training (Amphibious Landings)

Amphibious landings are conducted to transport troops and equipment from ship to shore for subsequent inland maneuvers. The selection of suitable landing craft at each landing beach is based on environmental and training criteria. Concerns associated with sea turtles and potential impacts of amphibious landing activities in the Mariana Islands include potential impacts, such as:

(1) Temporary disturbance of sea turtle food species (displaced algae or squashed sponges),

(2) Degradation of coral reef habitats (landing craft breaking coralline structures),

(3) False crawls and nesting attempt failures of female sea turtles during landing activities,

(4) Erosion and scour of beach deposits from landing vehicles that may compromise nests and reduce the suitability of beaches for nesting, and

(5) Crushing and trampling of sea turtle nests by vehicles and/or disembarking troops.

Currently, landing beaches that have been authorized for Landing Craft Air Cushion (LCAC), Landing Craft Utility (LCU), Amphibious Assault Vehicles (AAVs), Combat Rubber Raiding Craft (CRRC), Rigid-Hulled Inflatable Boats (RHIBs), Over The Beach (OTB) swimmer insertions, and combat swimmer special training against ships occur at sites on Guam Navy lands within the Apra Harbor Naval Complex (Main Base), Apra Inner and Outer Harbor areas, Tipalao, and Dadi; on Guam Air Force lands; and on Tinian within the Exclusive Military Use Area (EMUA), Leaseback Area (LBA), and non-DoD lease lands.

As shown in Table 2-7, under the No Action Alternative, one annual amphibious landing activity event would be conducted, involving assault, offload, and backload training at landing locations on Tinian and within Main Base (Guam).

Apra Harbor Naval Complex (Main Base) Amphibious Landing Sites

- Toyland Beach – a recreational beach suitable for LCAC, LCU, and AAV landings. Sea turtle nesting is possible at Toyland Beach in sandy areas.
- Polaris Point – suitable for LCAC, LCU, and AAV. Sea turtle nesting is not known to occur at Polaris Point.
- Former World War II refueling pier – suitable for LCU landings and not suitable for sea turtle nesting.
- Sumay Channel – suitable for AAV landings; however, restrictions are in place to reduce wake impacts of passing boats on potential sea turtle nesting sites. There are no records of green sea turtles nesting here, although sea turtles observed within Sumay Channel may suggest a potential for nesting activity. There is one record of a hawksbill sea turtle nesting at Sumay Cove. This location is too narrow to support LCU and only AAVs land at this location. The training restrictions at Sumay Channel were developed in consultation with USFWS (1998, 1999) and include the minimal use of Sumay Channel during sea turtle nesting season (January through October), cessation of landing activities if a sea turtle or sea turtle nest is present, and implementation of a "no wake" rule for approaching AAVs to reduce wave scour of the beach.
- Tipalao Beach – suitable for LCAC and AAV landings. This location is suitable for sea turtle nesting.

Tinian Amphibious Landings

- Unai Chulu – The beach at Unai Chulu is suitable for LCAC landings, one craft at a time. The shallow nearshore reef is not damaged by the air cushion vehicle as long as the craft is not brought off-cushion until fully on the beach. The LCAC, like all "hovercraft," rides on a cushion of air; it can proceed inland on its air cushion. As long as the craft is not brought off-cushion, no portion of the LCAC hull structure penetrates the water surface (http://www.fas.org/man/dod-101/sys/ship/lcac.htm). Offshore from Unai Chulu, Kolinski (2001) noted shallow reef pavement and scattered live corals. Unai Chulu is also a known green sea turtle nesting beach and is included in monthly monitoring surveys conducted by Navy biologists for sea turtle nesting activity. Unai Chulu is the only beach on Tinian that has been used for LCAC landings in the past; however, recent storm events require beach repairs prior to use.
- Unai Babui – The beach area at Unai Babui is rocky, but capable of supporting AAV landings with improvements. Off shore from Unai Babui, Kolinski (2001) noted shallow reef pavement and scattered live corals. Unai Babui is a known green sea turtle nesting beach and is included in monthly monitoring surveys conducted by Navy biologists for sea turtle nesting activity.
- Unai Dankulo (Long Beach) – The beach at Unai Dankulo (Long Beach) on the eastern shore of Tinian is suitable for LCAC landings and is a known green sea turtle nesting location. This beach is included in monthly monitoring surveys conducted by Navy biologists for sea turtle nesting activity. Unlike the beaches on the western shore of Tinian (Unai Chulu and Unai Babui), the eastern coast is characterized by little fringing reef. Unai Dankulo (Long Beach) contains the most conspicuous fringing reef on the eastern coast of Tinian (Kolinski, 2001).
- Tinian Harbor – The shoreline at Tinian Harbor has suitable locations for AAV landings. Within Tinian Harbor, a small barrier reef has been modified into a breakwater, and other reef patch locations are noted by Kolinski (2001). Green sea turtles are known to occur in waters of Tinian

Harbor. Kolinski (2001) estimated sea turtle density at 2.2 green sea turtles per square kilometer (km^2).

Sea turtle nests can be crushed resulting in direct mortality of potentially hundreds of preemergent hatchlings from activities associated with amphibious landings. Further, sea turtles resting onshore may be impacted by associated training activities. Nesting females are likely to abandon nesting efforts if they are concurrent with night-time exercises. Wakes can scour and accelerate beach erosion rates and compromise sea turtle nests during the incubation phase. To reduce effects to sea turtles associated with amphibious landing activities, the Navy implements the following training measures, which were minimization measures included in previous consultations with USFWS (USFWS 1988, 1999):

- The Navy maintains “No Wildlife Disturbance” (NWD) and “No Training” (NT) areas at Orote Peninsula, Tarague Beach, Unai Chulu, Unai Chiget, and Unai Dankulo (Long Beach). Cross-country off-road vehicle travel, pyrotechnics, demolition, digging/excavation (without prior approval of COMNAVMARIANAS or 36 Civil Engineering Squadron (CEV) environmental monitors), open fires, mechanical vegetation clearing, live ammunition, firing blanks, flights below 1,000 ft (313 m), and helicopter landings (except for designated landing zones) are prohibited in NWD areas. All entry or training, except specifically authorized administrative troop and vehicle movement on designated roads or trails, are prohibited in NT areas, in addition to prohibitions in NWD areas.
- The Navy evaluates NWD and NT boundaries based on additional survey information obtained during monthly monitoring surveys for sea turtle nesting activity.
- Prior to beach landings by amphibious vehicles, known sea turtle nesting beaches are surveyed by Navy biologists for the presence of sea turtle nests no more than 6 hours prior to a landing exercise. Areas free of nests are flagged, and vehicles are directed to remain within these areas.
- Navy biologists monitor beaches during night-time landing exercises. If sea turtles are observed or known to be within the area, training activities are halted until all nests have been located and sea turtles have left the area. Identified nests are avoided during the night-time landing exercise.
- LCAC landings on Tinian are scheduled for high-tide and LCACs are instructed to maintain full cushion inflation until the vehicles reach the top of the beach (off sand) and after completion of the 180-degree turn to terminate the LCAC activity.
- On Tinian, pre- and postexercise surveys for sea turtles are conducted after each LCAC and AAV landing exercise, along with semiannual surveys at Unai Chulu and Unai Babui. Surveys also are conducted semiannually at Unai Lamlam to serve as a control site for baseline sea turtle activity where no landings occur. Semiannual surveys measure percent coral cover, turbidity, fish assemblage, sedimentation rates, and site topography.
- Restoration of beach topography after LCACs or offloaded vehicle use is conducted by smoothing out ruts in the sand at Unai Chulu.

Amphibious beach landing activities occur in nesting and nearshore habitat areas for sea turtles. Most nesting activity within the MIRC is associated with green sea turtles; however, hawksbill sea turtle nesting has been reported from Guam (Sumay Cove). Loggerhead turtles, olive ridley turtles, and leatherback turtles are expected to occur in offshore oceanic areas of the MIRC Study Area; therefore, only the green sea turtle and hawksbill turtles may be affected by amphibious landings. Navy protective measures described in Chapter 5 are expected to avoid or minimize these impacts. The No Action Alternative may affect ESA-listed sea turtles; therefore, the Navy has entered into Section 7 ESA consultation with NMFS and USFWS. In accordance with NEPA, amphibious landings will not significantly impact sea turtles in marine environments or nesting activity. EO 12114 is not applicable because amphibious landings do not occur in non-territorial waters.

3.8.3.1.4 MFA/HFA Sonar

Extrapolation from human and marine mammal data to sea turtles is inappropriate given the morphological differences between the auditory systems of mammals and sea turtles. As discussed in Section 3.8.2.1, however, the measured hearing threshold for green turtles (and by extrapolation from this species to other hard-shelled sea turtles, *e.g.* hawksbill, loggerhead, and olive ridley sea turtles) is lower than the maximum levels to which these species could be exposed. 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 hard-shelled sea turtles. It is not likely that a temporary threshold shift (TTS) would occur at such a small margin over threshold in any species. Therefore, no threshold shifts in green, olive ridley, loggerhead, hawksbill, or leatherback turtles are expected.

As described in Section 3.8.2.1, sea turtle hearing is generally most sensitive between 100 Hz to 800 Hz for hard shell sea turtles, frequencies that are at the lower end of the sound spectrum. Although low-frequency hearing has not been studied in many sea turtle species, most of those that have been tested exhibit low audiometric and behavioral sensitivity to low-frequency sound. As stated previously sea turtle hearing may extend up to 2,000 Hz (Lenhardt 1994) although practical hearing is most likely below 1000 Hz (Ridgway *et al.* 1969). It appears, therefore, that if there were the potential for the MFA (1,000 Hz to 10,000 Hz with most sources above 3 kHz) and/or HFA (greater than 10,000 Hz) to increase masking effects of any sea turtle species, it would be expected to be minimal as most sea turtle species are apparently low-frequency specialists. Any potential role of long-range acoustical perception in sea turtles has not been studied. Anecdotal information, however, suggests that the acoustic signature of a sea turtle's natal beach might serve as a cue for nesting returns. However, the sources used in the MIRC are above sea turtle's most sensitive hearing range.

As demonstrated by Jessop *et al.* (2002) for breeding adult male green turtles, there is a complex relationship between stress/physiological state and plasma hormone responses. Even if sea turtles were able to sense the sonar output, it is unlikely that any physiological stress leading to endocrine and corticosteroid imbalances would result in long term effects, such as allostatic loading (McEwen and Lashley 2002). Although there may be many hours of active ASW sonar events, the active "pings" of the sonar generally only occur only twice a minute, as it is necessary for the ASW operators to listen for the return echo of the sonar ping before another ping is transmitted. Given the time between pings and relative high ship speed in comparison to sea turtles and the relatively low hearing sensitivity even within the frequency ranges that sea turtles hear best, which is for the most part below the frequency range of MFA/HFA sonar, it is unlikely that sea turtles would be affected by this type of 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 is difficult, if not impossible, to apply to sea turtles. Although low-frequency hearing has not been studied in many sea turtle species, most of those that have been tested exhibit low audiometric and behavioral sensitivity to low-frequency sound. It appears that if there were the potential for the mid-frequency sonar to increase masking effects for any sea turtle species, it would be expected to be minimal. Based on the current available data, MFA/HFA sonar use may affect sea turtles by masking; therefore, the Navy has entered into Section 7 ESA consultation with NMFS. In accordance with NEPA, MFA/HFA sonar use within territorial waters would have no significant impact on sea turtles. Furthermore, MFA/HFA sonar use in non-territorial waters would not cause significant harm to sea turtles in accordance with EO 12114.

3.8.3.1.5 Low-Frequency Active (LFA) Sonar

Surveillance Towed-Array Sensor System (SURTASS) LFA sonar is not currently in use in the MIRC Study Area; therefore, under the No Action Alternative, the effect of LFA sonar is not analyzed.

3.8.3.1.6 Weapons Firing/Nonexplosive Practice Munitions

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 degrees, as measured from the vertical) can be calculated to determine the region of transmission in relation to a ship and gun (DoN 2006a).

The largest proposed shell size for training in the MIRC is a 5-inch shell. This will produce the highest pressure and analysis is conducted 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 5-inch gun. Average pressure measured approximately 200 dB (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 100 m (DoN 2000) and as the distance increases, the pressure would decrease.

In reference to the energy flux density harassment criteria, the energy flux density levels (greatest in any 1/3 octave band above 10 Hz) of a 5-inch gun muzzle blast were calculated to be 190 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 (DoN 2006c). The rapid dissipation of the sound pressure wave, coupled with the protective measures implemented by the Navy (refer to Chapter 5 for details) to detect sea turtles in the area prior to commencing training, would result in a blast from a gun muzzle having discountable and insignificant effects on sea turtle species.

Sound Transmitted through Ship Hull. A gun blast will also transmit sound waves through the structure of the ship that 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 (DoN 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 (DoN 2006c).

The structural component for a standard round was calculated to be 6.19 percent of the air blast (DoN 2006c). 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 discountable and insignificant effects on ESA-listed sea turtle species.

Previous Section 7 ESA consultations between the Navy and NMFS have established that live-fire events associated with the No Action Alternative may affect ESA-listed sea turtles (NMFS 1998, 2007; USFWS 1998, 1999). Because of the clearance requirements for live-fire events, and the large amount of area within the MIRC available for weapons firing, effects to sea turtles would be discountable and unlikely to result in harm or harassment. Under the No Action Alternative, weapons firing/nonexplosive practice munitions will not significantly affect sea turtles within territorial waters in accordance with NEPA. Furthermore, weapons firing/nonexplosive practice munitions will not significantly harm sea turtles in non-territorial waters in accordance with EO 12114.

3.8.3.1.7 Explosive Ordnance

Events involving underwater detonation involve Extended Echo Ranging (EER)/Improved EER (IEER), Mine Laying Exercise (MINEX), MISSILEX, BOMBEX, Sinking Exercise (SINKEX), GUNEX, and Naval Surface Fire Support (NSFS). Criteria and thresholds for estimating the impacts on sea turtles (and marine mammals) from a single underwater detonation event were defined and publicly vetted through the NEPA process during the environmental assessments for the two Navy ship-shock trials: the SEAWOLF Final EIS (FEIS) (DoN 1998b) and the Churchill FEIS (DoN 2001b). 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 the best of these experiments to the injury levels that would be predicted using the modified Goertner method and found them to be similar (DoN 2001b; Goertner 1982). The criteria and thresholds for injury and harassment, which are the same for both sea turtles and marine mammals, are summarized in Table 3.8-3. Modeling for explosive ordnance exposures only included marine mammals because sea turtle density data within the MIRC training areas are not available.

Table 3.8-3: Summary of Criteria and Acoustic Thresholds for Underwater Detonation – Impacts on Sea Turtles

Harassment Level	Criterion	Threshold
Level A Harassment		
Mortality	Onset of severe lung injury	"Goertner" modified positive impulse indexed to 31 psi-ms
Injury	Tympanic membrane rupture	50 percent rate of rupture 205 dB re 1 μPa^2-s (Energy Flux Density)
	Onset of slight lung injury	Goertner Modified Positive Impulse Indexed to 13 psi-ms
Level B Harassment		
Noninjury	Onset Temporary Threshold Shift (TTS) (Dual Criteria)	182 dB re 1 μPa^2-s (Energy Flux Density) in any 1/3-octave band at frequencies above 100 Hz for all toothed whales (*e.g.*, sperm whales, beaked whales); above 10 Hz for all baleen whales
	Onset of TTS (Dual Criteria)	23 psi peak pressure level (for small explosives; less than 2,000 lb NEW)
	Sub-TTS behavioral disturbance	177 dB re 1 μPa^2-s (Energy Flux Density) for multiple successive explosions

Notes: psi = pounds per square inch; psi-ms = pounds per square inch-milliseconds; μPa^2-s = squared micropascal-second; dB = decibel; Hz = hertz; NEW = net explosive weight

<u>Sea Turtle Injury and Harassment Thresholds</u>

Injury Thresholds. When analyzing underwater detonations, two criteria are used for injury: onset of slight lung injury and 50 percent eardrum rupture (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 26.9 lb [12 kg]), and is given in terms of the "Goertner modified positive impulse," indexed to 13 psi-milliseconds in the Churchill FEIS (DoN 2001b). 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 energy level 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 PTS at the same threshold).

Harassment Thresholds. There are two thresholds for noninjurious harassment from underwater explosives. The first is TTS, which is a temporary, recoverable, loss of hearing sensitivity (DoN 2001b). The second threshold, termed "sub-TTS," applies to multiple explosions in succession (separated by less than 2 seconds). The sub-TTS threshold is used to account for behavioral disturbance significant enough to be judged as harassment, but occurring at lower sound exposure levels than those that may cause TTS.

There are dual criteria for TTS when analyzing underwater detonations. The first is 182 dB re 1 μPa^2-s maximum Energy Flux Density Level (EL) level in any 1/3-octave band at frequencies >100 Hz for marine mammals and sea turtles. The second criterion for impact analysis when considering underwater detonations and a TTS threshold is 12 psi peak pressure that was developed for 10,000-lb charges as part of the Churchill FEIS (DoN 2001b). 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). Navy policy is to use a 23-psi criterion for explosive charges less than 2,000 lb (909 kg) and the 12-psi criterion for explosive charges larger than 2,000 lb (909 kg). All explosives modeled for the MIRC EIS/OEIS are less than 1,500 lb (682 kg); therefore, the 23-psi criterion will be used in this EIS/OEIS.

Multiple Successive Explosions (MSE). There may be rare occasions when MSE are part of a static location event such as during MINEX, MISSILEX, BOMBEX, SINKEX, GUNEX, and NSFS (when using other than inert weapons). For these events, the Churchill FEIS approach was extended to cover MSE events occurring at the same static 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 the Churchill FEIS. For positive impulse, it is consistent with the Churchill FEIS to use the maximum value over all impulses received.

For MSE, 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 exposure levels than those that may cause TTS. The sub-TTS threshold is derived following the approach of the Churchill 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 µPa2-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 5 dB lower than those causing TTS. The sub-TTS threshold is therefore derived by subtracting 5 dB from the 182 dB re 1 µPa2-s in any 1/3 octave band threshold, resulting in a 177 dB re 1 µPa2-s (EL) sub-TTS behavioral disturbance threshold for MSE.

Preliminary modeling undertaken for other Navy compliance documents using the sub-TTS threshold of 177 dB re 1 µPa2-s has demonstrated that for events involving MSE using small (NEW) explosives (MINEX, GUNEX, NSFS, and underwater detonation), the footprint of the threshold for explosives onset TTS criteria based on the 23 psi pressure component dominates and supersedes any exposures at a received level involving the 177 dB re 1 µPa2-s EL threshold. Since modeling for sub-TTS would not result in any additional harassment takes for MINEX, GUNEX, NSFS, and underwater detonation using the 23-psi criterion, analysis of potential for behavioral disturbance using the sub-TTS criteria was not undertaken for MINEX, GUNEX, NSFS, and underwater detonation.

For the remainder of the MSE events (BOMBEX, SINKEX, and MISSILEX) where the sub-TTS exposures may need to be considered, these potential behavioral disturbances were estimated by extrapolation from the acoustic modeling results for the explosives TTS threshold (182 dB re 1 μPa^2-s in any 1/3 octave band). To account for the 5 dB lower sub-TTS threshold, a factor of 3.17 was applied to the TTS modeled numbers in order to extrapolate the number of sub-TTS exposures estimated for MSE events. This multiplication factor is used to calculate the increased area represented by the difference between the 177 dB re 1 μPa2-s sub-TTS threshold and the modeled 182 dB re 1 μPa2-s threshold. The factor is based on the increased range 5 dB would propagate (assuming spherical spreading), where the range increases by approximately 1.78 times, resulting in a circular area increase of approximately 3.17 times that of the modeled results at 182 dB re 1 μPa2-s.

Potential overlap of exposures from multiple explosive events within a 24-hour period was not taken into consideration in the modeling resulting in the potential for some double counting of exposures. However, because an animal would generally move away from the area following the first explosion, the overlap is likely to be minimal.

In 1993, NMFS issued a Biological Opinion (BO) in consultation with the Navy for MIW training within Apra Harbor (NMFS 1993). The Navy was permitted through the Section 7 ESA consultation process to take up to 10 sea turtles per year through harassment. Of these authorized harassment takes, the NMFS authorized one injury or mortality per year of the sea turtle species that occur within Apra Harbor. As part of the BO, NMFS recommended several conservation measures to reduce the adverse effect. Since the 1993 BO, the Navy has expanded many conservation measures to reduce impacts to sea turtles associated with Navy activities within Apra Harbor. It should be noted that no injury or mortality of sea turtles have been observed by Naval Facilities Engineering Command Pacific (NAVFACPAC) natural resource specialists and no such events have ever been associated with Underwater Detonations (UNDET) training within Apra Harbor. UNDET activities associated with Agat Bay, as with Apra Harbor, are not expected to result in injuries or mortalities of sea turtles.

It should be emphasized that there is a lead time for set up and clearance of any area before an event using explosives takes place (this may be 30 minutes for an underwater detonation to several hours for a SINKEX). There will, therefore, be a long period of rather intense activity before the event takes place when the area is under observation and before any detonation or live fire occurs. Ordnance cannot be released until the target area is determined clear of sea turtles (or marine mammals). In addition, the event is immediately halted if sea turtles are observed within the target area and the training is delayed until the animal clears the area. Implementation of the protective measures determines if the area is clear and serves to minimize the risk of harming sea turtles.

As for EER/IEER buoys, the explosive payload is suspended below the surface at a depth where sea turtles are unlikely to be present in the open ocean. Given the size of the ocean, it is unlikely that a sea turtle will be present in the vicinity of an EER/IEER buoy when detonated. In addition, in the rare event that a sea turtle is present when an EER/IEER buoy is detonated, the depth of the approximately 4-lb charge will likely preclude there being any adverse effects.

Although exercises that utilize explosive ordnance pose a greater risk to sea turtles than inert or other nonexplosive ordnance, the area affected by the explosive is relatively small, and target area clearance procedures will further reduce the potential for such an extremely unlikely event to occur. Previous Section 7 ESA consultations between the NMFS and USFWS have established that explosive ordnance and underwater detonations associated with the No Action Alternative may affect sea turtles (NMFS

1993, 1998, 2007; USFWS 1998, 1999). Explosive ordnance and underwater detonations will not significantly impact sea turtles within territorial waters in accordance with NEPA. Furthermore, explosive ordnance and underwater detonations will not significantly harm sea turtles in non-territorial waters in accordance with EO 12114.

3.8.3.1.8 Expended Materials

A variety of military materials are expended during training exercises conducted in the MIRC 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 3.2 (Hazardous Materials). The analyses presented predict that the majority of the expended materials would rapidly sink to the sea floor, become encrusted by natural processes, and be 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. Nonetheless, sea turtles could be exposed to some expended materials via contact and ingestion.

Sea turtles of all sizes and species are known to ingest a wide variety of marine debris, which might be mistaken for prey. Plastic bags and plastic sheeting are most commonly ingested by sea turtles but balloons, styrofoam beads, monofilament fishing line, and tar are also known to be ingested (NRC 1990; Lutz 1990; Bjorndal 1994; Tomás *et al.* 2002). Marine debris could pass through the digestive tract and be voided naturally without causing harm, or it could cause sublethal effects or lethal effects (Balazs 1985). Sublethal effects may have a greater influence on populations than lethal effects through nutrient dilution. Nutrient dilution occurs when nonnutritive debris displaces nutritious food in the gut leading to decreased nutrient gain and ultimately slowing somatic growth or reducing reproductive output (McCauley and Bjorndal 1999). Lutz (1990) 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 4 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; Bjorndal 1994; McCauley and Bjorndal 1999; Tomás *et al.* 2002).

Sonobuoys. A sonobouy is an expendable device used for detection of underwater acoustic energy and conducting vertical water column temperature measurements. Sonobuoys are cylindrical devices about 4.9 in (12.5 cm) in diameter and 36 in (91 cm) in length, weighing from 14 to 39 lb (6 to 18 kg). Following deployment, sonobuoys descend to specified depths and transmit data measurements to a surface unit via an electrical suspension cable or radio frequency signal. At water impact, a seawater battery activates and deployment initiates. If deployed from aircraft, the parachute assembly is jettisoned and sinks away from the unit, while a float containing an antenna is inflated. The subsurface assembly descends to a selected depth, and the sonobuoy case falls away and sea anchors deploy to stabilize the hydrophone (underwater microphone). The operating life of the seawater battery is 8 hours, after which the sonobuoy scuttles itself and sinks to the ocean bottom. Expended materials associated with sonobouys include the following:

- Parachute assembly (12 to 18 in [30.5 to 45.7 cm] diameter nylon chute) and nylon cord;
- Lead chloride, cuprous thiocyanate, or silver chloride batteries; lithium batteries or lithium iron disulfide thermal batteries (XBT does not contain a battery); and
- Plastic casing, metal clips, nylon strap, and electrical wiring.

All of the material is negatively buoyant and will sink to the ocean floor. Many of the components are metallic and will sink rapidly. The expended material will accumulate on the ocean floor and will be covered by sediments over time, thereby remaining on the ocean floor, reducing the potential for entanglement. This accrual of material is not expected to cause an increased potential for sea turtle 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 sea turtle encountering a parachute assembly and the potential for accidental entanglement in the canopy or suspension lines is considered to be unlikely. Entanglement may also occur while materials are at the surface before they sink, and the risk continues as the materials descend through the water column.

In consideration of the wide area of dispersal of expended materials, possibility of sea turtles ingesting nylon parachute fabric or other expended materials associated with sonobouys is unlikely. Likewise, sea turtle entanglement with expended material associated with sonobouys within the water column or on the surface is unlikely.

Torpedo Guidance Wire. Torpedoes are equipped with a single-strand guidance wire, which is laid behind the torpedo as it moves through the water. At the end of a torpedo run, the wire is released from the firing vessel and the torpedo to enable torpedo recovery. The wire sinks rapidly and settles on the ocean floor. Guidance wires are expended with each exercise torpedo launched.

DoN (1996) analyzed the potential entanglement effects of torpedo guidance wires on sea turtles. The Navy analysis concluded that the potential for entanglement effects will be low for the following reasons:

- The guidance wire is a very fine, thin-gauge copper-cadmium core with a polyolefin coating. The tensile breaking strength of the wire is a maximum of 42 lb (19 kg) and can be broken by hand. With the exception of a chance encounter with the guidance wire while it was sinking to the sea floor (at an estimate rate of 0.5 ft [0.2 m] per second), a sea turtle would be vulnerable to entanglement only if its diving and feeding patterns place it in contact with the bottom. Due to the low breaking strength of the guidance wire and the relative wide distribution of this activity within the MIRC, sea turtle exposure would be low.
- The torpedo guidance wire is held stationary in the water column by drag forces as it is pulled from the torpedo in a relatively straight line until its length becomes sufficient for it to form a chain-like droop. When the wire is cut or broken, it is relatively straight and the physical characteristics of the wire prevent it from tangling, unlike the monofilament fishing lines and polypropylene ropes identified in the entanglement literatures.

Given the low potential probability of sea turtles and sea turtle entanglement with guidance wires, the potential for any harm or harassment to these species is low.

Torpedo Flex Hoses. DoN (1996) analyzed the potential for the flex hoses to affect sea turtles. This analysis concluded that the potential entanglement effects to marine animals will be insignificant for reasons similar to those stated for the potential entanglement effects of guidance wires:

- Due to its weight, the flex hoses will rapidly sink to the bottom upon release. With the exception of a chance encounter with the flex hose while it was sinking to the sea floor, a sea turtle would be vulnerable to entanglement only if the sea turtle's diving and feeding patterns placed it in contact with the bottom.
- Due to its stiffness, the 250 ft (76.2 m) long flex hose will not form loops that could entangle sea turtles.

Given the low potential probability of sea turtles in the area and of sea turtle entanglement with flex hoses, the potential for any harm or harassment to these species is unlikely.

Chaff, End Caps, and Pistons. Similar to marine mammals, sea turtles could be exposed to chaff through direct body contact, inhalation, and ingestion. Sea turtles are not expected to respond to direct contact with chaff or inhalation of chaff. In addition, any changes in water quality from chaff use would be negligible and would not be expected to affect sea turtles.

Based on the small size of chaff fibers, sea turtles would not confuse the fibers with prey items or purposefully feed on them. However, sea turtles could occasionally ingest chaff incidentally while feeding on prey items on the surface, in the water column, or on the bottom. Exposures would increase if these expended materials were concentrated in marine vegetation.. While no studies have been conducted to evaluate the effects of chaff ingestion on sea turtles or other reptiles, the effects are expected to be negligible based on the low concentrations that could reasonably be ingested, the small size of chaff fibers, and available data on the toxicity of chaff constituents. It is highly unlikely that a sea turtle would ingest a toxic dose of chaff based on the anticipated environmental concentration of chaff (1.8 fibers/square foot [ft^2] [0.16 fibers/square meter {m^2}] for a worst-case scenario of 360 chaff cartridges simultaneously released at a single drop point).

The potential also exists for sea turtles to ingest end caps and pistons. However, the probability of sea turtles ingesting plastic end caps and pistons is low because these materials sink in saltwater (Spargo 2007) and the environmental concentration would be low relative to the release of end caps and pistons to the size of the training area. A majority of the end caps and pistons are expected to sink in offshore, deepwater areas and ultimately become incorporated into bottom sediments where minimal sea turtle foraging occurs. A very small percentage of the end caps and pistons released could be transported by currents to benthic foraging areas, where the probability of ingestion would be greater. Since young pelagic turtles feed indiscriminately within marine vegetation and are known to ingest anthropogenic debris (McCauley and Bjorndal 1999), it is possible that sea turtles would be exposed to and ingest end caps and pistons. However, the overall probability of sea turtles ingesting an end cap or piston appears to be low due to the low density of sea turtles in the area and end caps and pistons dispersed over a wide area during training activities.

Should a sea turtle encounter and ingest a discarded piston or end cap, the animal could experience effects ranging from sublethal effects such as nutritional dilution (McCauley and Bjorndal 1999) to mortality (NRC 1990; Bjorndal 1994; Tomas 2002). However, these effects are not expected because ingestion of end caps and pistons would be unlikely due to the low concentration of approximately 2.4 pieces/square nautical mile (nm^2) per year (8.4 pieces/km^2 per year). The effects of chaff use on sea turtles would be discountable or insignificant.

Self-Protection Flares. Self-protection flares consist of a magnesium/Teflon formulation that, when ignited and released from an aircraft, burn for a short period of time (less than 10 seconds) at very high temperatures. Flares release heat and light to disrupt tracking of Navy aircraft by enemy infrared tracking devices or weapons. Flares are designed to burn completely, thus reducing the amount of material that falls to the sea surface. Under normal conditions, the only material that would enter the water would be a small, round plastic end cap (approximately 1.4 in [3.6 cm] diameter), although some dud flares may not combust and fall into the ocean.

An extensive literature review and controlled experiments conducted by the U.S. Air Force reveal that self-protection flare use poses little risk to the environment or animals (USAF 1997). Nonetheless, sea turtles within the MIRC Study Area could be exposed to light generated by the flares and flare plastic end caps. The light generated by flares would have no effect on sea turtles based on short burn time, relatively high altitudes where they are used, and the widely dispersed and infrequent use. Similar to chaff end caps and pistons, sea turtles could potentially ingest flare end caps and dud flares. Ingestion of flare end caps and dud flares under the No Action Alternative may affect sea turtles, but the effects would be considered discountable because ingestion is unlikely to occur based on the low number of end caps and dud flares.

Marine Markers. Expended marine markers are a potential ingestion hazard for sea turtles while they are floating or after they sink to the bottom. However, the probability of ingestion is low based on the low number of marine markers expended per year and the low concentration. Marine marker ingestion under the No Action Alternative may affect sea turtles, but the effects would be considered discountable because ingestion is unlikely to occur.

The MK-25 and 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. 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 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. 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 21.78 in (54 cm) long and 5.03 in (12.6 km) in diameter, weighs 12.8 lb (5.8 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. Expended marine markers are a potential ingestion hazard for sea turtles 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 (300) and the low concentration (0.01/nm^2 per year [0.04/km^2 per year]).

Targets. A variety of at-sea targets are used in the MIRC Study Area, ranging from high-tech remotely operated airborne drones and surface targets to low-tech floating at-sea targets. Specific targets include MK-42 Floating At-Sea Target (FAST), MK-58 marker (smoke) buoys, and 55 gallon (209 liters) drums. Many of the targets are designed to be recovered for reuse and are not destroyed during training because ordnance is set to detonate before impacting the target. The only expendable airborne targets used in the MIRC Study Area are Tactical Air-Launched Decoys, which are nonpowered, constructed of extruded aluminum, weigh about 400 lb (181 kg), and are about 7 ft (2.1 m) long. Expendable targets such as floating at-sea inflatable targets are recovered after use and properly disposed of onshore. Some targets such as 55-gallon (208-liter) metal drums cannot be recovered and sink to the sea floor after use. Unrecoverable floating materials generated by target use are expected to be minimal.

As discussed above for ordnance-related materials, sea turtles that feed on or near the bottom may encounter an expended target while feeding; however, the size of the target would prohibit any listed species from ingesting it. Targets on the surface or target constituents within the water column may represent an entanglement risk to sea turtles; however, as the targets used in the MIRC are not towed along the surface, entanglement is unlikely. Therefore, the use of targets under the No Action Alternative may affect sea turtles, although the effects would be expected to be discountable because they would be unlikely to occur.

Expended Ordnance. The probability of sea turtles ingesting expended ordnance would depend on factors such as the size of the materials, the likelihood the materials would be mistaken for prey, 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. Some materials such as an intact nonexplosive training bomb would be too large to be ingested by a sea turtle, but other materials such as cannon shells, small caliber ammunition, and shrapnel are small enough to be ingested. While the literature indicates that commonly ingested items such as drifting balloons or plastic bags might be mistaken as 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 expended ordnance colonized by epibenthic fauna could be mistaken for prey or that expended ordnance could be incidentally ingested while foraging on natural prey items.

The Navy has conducted annual marine and fisheries surveys of FDM since 2005, and the most recent surveys were completed in October 2008 (Smith, 2008). The 2008 annual assessment consisted of 68 person dives which included qualitative and semi-quantitative observations of the physical environment, macroscopic algae, macroscopic invertebrates including corals, fishes, and sea turtles. As discussed in Section 3.6 (Marine Communities), the survey noted minor impacts despite the recent use of the FDM range by an Aircraft Carrier Battle Group. These impacts were small in number and size, and no visual evidence of any abnormalities, disease or stress in any of the algae, invertebrates, fishes, or sea turtles were observed. Based upon the techniques utilized and the physical and biological parameters assessed, there appears to have been an improvement in the overall health and abundance of marine natural resources every year since 2005 in near shore waters surrounding FDM. Further, the 2008 survey concludes that there is evidence to support that the military training activities conducted at FDM are likely to have a significant adverse impact on the near shore marine natural resources surrounding the island.

Water depth in areas where ordnance is fired ranges from about 65 ft (20 m) to well over 650 ft (200 m) in areas more than 3 nm (5.6 km) offshore. While some benthic foraging could occur in these offshore areas, a majority of benthic foraging by green and hawksbill turtles occurs in nearshore areas (Lutcavage *et al.* 1997). Consequently, ingestion of expended ordnance by these species could occur, but would be considered unlikely. Ingestion of ordnance under the No Action Alternative would have no effect on leatherback turtles, but may affect other sea turtle species.

Expended materials are dispersed widely over the MIRC Study Area; therefore, expended materials are not found in high concentrations in any one area. Nonetheless, sea turtles could be exposed to expended materials via direct contact, including entanglement, and via ingestion; expended materials in the MIRC Study Area may affect sea turtles. Therefore, the Navy has entered into Section 7 ESA consultation with NMFS. Under the No Action Alternative, expended materials will not significantly impact ESA-listed sea turtles within territorial waters in accordance with NEPA. Furthermore, expended materials will not significantly harm sea turtles in non-territorial waters in accordance with EO 12114.

3.8.3.2 Alternative 1

3.8.3.2.1 Vessel Movements

An additional major exercise involving vessel movements will be added under Alternative 1. Unlike the Multiple Strike Group exercise, the additional exercise will be an Amphibious Assault exercise, which will not involve as many vessel movements as a Multiple Strike Group exercise. These changes would result in increased potential for short-term behavioral reactions to vessels. Potential for collision would increase slightly compared to the No Action Alternative; however, Navy protective measures (as detailed in Chapter 5) would minimize impacts. Protective measures relevant to vessels include watch duties to alert vessel pilots of sea turtle proximity in nearshore and offshore waters. The increased amount of vessel movements coupled with the Navy protective measures would not increase the threat of collisions. As with the No Action Alternative, vessel movements associated with Alternative 1 may affect sea turtles; therefore, the Navy has initiated ESA consultation with NMFS. Under Alternative 1, vessel movements will not significantly impact sea turtles in accordance with NEPA. Furthermore, vessel movements will not significantly harm sea turtles in non-territorial waters in accordance with EO 12114.

3.8.3.2.2 Aircraft Overflights

The number of events involving fixed-wing aircraft overflights would increase from 704 to 2,942 in the MIRC Study Area under Alternative 1. Most of these increases are associated with activities around FDM and in other Air Traffic Control Assigned Airspace (ATCAA). These changes would result in increased exposures of sea turtles to fixed-wing overflights. Elevated numbers of overflights would increase the potential for behavioral disturbance from sound and shadow effects. Training events involving helicopter overflights would increase from 717 to 1,123 per year. Behavioral reactions to fixed-wing and helicopter overflights would be the same as discussed under the No Action Alternative. Aircraft overflights under Alternative 1 may affect sea turtles, but the effects are expected to be insignificant (where take is unlikely to occur). The Navy has initiated ESA consultation with NMFS for aircraft overflights in the marine environment. Under Alternative 1, aircraft overflights will not significantly impact sea turtles in accordance with NEPA. Furthermore, aircraft overflights will not significantly harm sea turtles in non-territorial waters in accordance with EO 12114.

3.8.3.2.3 Land-Based Training (Amphibious Landings and Over the Beach Training)

As shown in Table 2-7, increases in amphibious landing activities and OTB under Alternative 1 include addition of six annual training events involving assault, raid, offload, and backload training at landing locations on Tinian and within Main Base (Guam). Protective measures described under the No Action Alternative will continue under Alternative 1. These protective measures include pre-activity surveys on Tinian landing beaches (Unai Chulu and Unai Dankulo) and within landing areas within the Apra Harbor Naval Complex (Main Base) (Sumay Channel and Dry Dock Island) and adherence to NWD and NT area restrictions on Guam and Tinian.

Because amphibious landing activity may affect ESA-listed sea turtles in the nearshore marine environment and nesting habitats, the Navy has initiated an ESA consultation with NMFS and USFWS. Under Alternative 1, amphibious landing activities will not significantly impact sea turtles within territorial waters in accordance with NEPA. Training associated with amphibious landings will not occur in non-territorial waters; therefore, EO 12114 is not applicable.

3.8.3.2.4 MFA/HFA Sonar

The number of ASW exercises involving MFA and HFA sonar use would increase from 9 to 18 events under Alternative 1. These changes would result in the increased exposure of sea turtles to MFA and HFA sonar energy. The increase in potential exposures would not necessarily increase impacts to sea turtles. As described previously, sea turtle hearing is generally most sensitive between 100 Hz to 800 Hz for hard shell turtles, frequencies that are at the lower end of the sound spectrum. Sea turtle hearing may extend up to 2,000 Hz (Lenhardt 1994) although practical hearing is most likely below 1000 Hz (Ridgway *et al*. 1969). It appears, therefore, that if there were the potential for the MFA (1,000 Hz to 10,000 Hz with most sources above 3 kHz) sonar and/or HFA (greater than 10,000 Hz) sonar to increase masking effects of any sea turtle species, it would be expected to be minimal as most sea turtle species are apparently low-frequency specialists.

Because sonar associated with ASW may affect ESA-listed sea turtles in the marine environment, the Navy has initiated an ESA consultation with NMFS. Because sonar use will not affect sea turtle nesting activity or habitats, ESA consultation with USWFS is unnecessary for ASW training. Under Alternative 1, MFA and HFA will not significantly impact sea turtles within territorial waters in accordance with NEPA. In accordance with EO 12114, ASW training associated with MFA and HFA in non-territorial waters would not cause significant harm to sea turtles.

3.8.3.2.5 LFA Sonar

Effects to sea turtles from LFA sonar may be classified as (1) injury, (2) permanent hearing loss, (3) temporary hearing loss, (4) behavioral change, and (5) masking effects.

The SURTASS LFA sonar event parameters (listed below) provide a framework for analyzing the five classifications of effects to sea turtles. The training event parameters include the following:

- Small number of SURTASS LFA sonar systems to be deployed;
- Geographic restrictions imposed on system employment;
- Narrow bandwidth of SURTASS LFA sonar active signal (approximately 30 Hz);
- Slowly moving ship, coupled with low system duty cycle, meaning fish and sea turtles would spend less time in the LFA mitigation zone (180-dB sound field); further, with a ship moving in two dimensions and animals moving in three dimensions, the potential for animals being in the sonar transmit beam during the estimated 7.5 percent of the time the sonar is actually transmitting is very low; and
- Small size of the LFA mitigation zone (180-dB sound field) relative to open ocean areas.

Injury. As described in Section 3.8.2, very little is known about sea turtle hearing and what may cause injury to it. However, the New England Aquarium acoustic data collection discussion below supports the premise that, using a 180-dB injury threshold, a sea turtle would have to be within the LFA mitigation zone when the sonar was transmitting to be at risk of injury, including permanent loss of hearing (*i.e.*, permanent threshold shift [PTS]). The five SURTASS LFA sonar training event parameters listed above also apply to this conclusion.

Permanent Hearing Loss. Given the lack of scientific data on PTS in sea turtles caused by LF sound and the effects conclusion for injury (stated above), the potential for SURTASS LFA sonar to cause PTS in sea turtles must be considered to be negligible. Moreover, the majority of sea turtle species inhabit the earth's oceanic temperate zones, where sound propagation is predominantly characterized by downward refraction (higher transmission loss, shorter range), rather than ducting (lower transmission loss, longer range) which is usually found in cold-water regimes. Hence, transmission ranges within the principal water-column habitat for most sea turtles—the near-surface region—are relatively shorter in temperate water regimes versus ranges in colder-water regimes, equating to smaller zones of influence. Further, the five SURTASS LFA sonar training event parameters listed above further support this conclusion.

Temporary Hearing Loss. As with PTS, there are no published scientific data on TTS in sea turtles caused by LF sound. Further, the five SURTASS LFA sonar training event parameters listed above further support the conclusion that the potential for SURTASS LFA sonar to cause TTS in sea turtles must be considered to be negligible.

Behavioral Change. If a sea turtle happened to be within proximity of a SURTASS LFA sonar training area, it may hear the LF transmissions. Given that the majority of sea turtles encountered would probably be transiting in the open ocean from one site to another, the possibility of significant displacement would be unlikely. This is particularly due to 1) the low number of SURTASS LFA sonars that would be deployed in the open ocean, 2) the geographic restrictions imposed on system employment, 3) the narrow bandwidth of the SURTASS LFA sonar active signal (approximately 30 Hz bandwidth), 4) the fact that the ship is always moving (coupled with low system duty cycle [estimated 7.5 percent], which means sea turtles would have less opportunity to be located in a sound field that could possibly cause a behavioral change), and 5) short at-sea mission times.

Masking. Masking effects may occur for sea turtle species that have critical hearing bandwidths at the same frequencies as the SURTASS LFA sonar. However, masking would probably be temporary. The geographical restrictions imposed on all SURTASS LFA sonar training would limit the potential for masking of sea turtles in the vicinity of their nesting sites. In summary, masking effects are not expected to be severe because of the 7.5 to 20 percent duty cycle, the maximum 100-second signal duration, the fact that the ship is always moving, the limited 30 Hz sonar bandwidth, and the signals not remaining at a single frequency for more than 10 seconds.

In conclusion, sea turtles could be affected if they are inside the LFA mitigation zone (180-dB sound field) during a SURTASS LFA sonar transmission. Given that received levels from SURTASS LFA sonar training events would be below 180 dB received level (RL) within 12 nm (22 km) or greater distance of any coastlines and offshore biologically important areas, effects to a sea turtle stock could occur only if a significant portion of the stock encountered the SURTASS LFA sonar vessel in the open ocean. Further, within the waters of the MIRC Study Area, sound propagation is predominantly characterized by downward refraction (higher transmission loss, shorter range), rather than ducting (lower transmission loss, longer range) which is usually found in cold-water regimes. These factors, plus the low distribution and density of sea turtles at ranges from the coast greater than 12 nm (22 km) equate to a very small probability, if any, that a sea turtle could be found inside the LFA mitigation zone during a SURTASS LFA sonar transmission.

The above analysis focuses on the potential impacts to individual sea turtles. However, the issue of potential impact to sea turtle stocks must also be addressed. To quantify the potential impact on sea turtle stocks, the analysis provided in the SURTASS LFA Supplemental EIS (SEIS) updated the SURTASS LFA FEIS/OEIS based on more current information for leatherback sea turtles in the Pacific Ocean. The leatherbacks were chosen for this analysis because they are the largest, most pelagic, and most widely distributed of any sea turtle found between 71°N and 47°S (Plotkin, 1995), inhabit the oceanic zone and are highly migratory (Morreale *et al*. 1996; Hughes *et al*. 1998), and are capable of transoceanic migrations (Eckert 1998). They are rarely found in coastal waters and are deep, nearly continuous divers with usual dive depths around 250 m (820 ft) (Hays *et al*. 2004). The volume of Pacific Ocean habitat for leatherback sea turtles was calculated as 4.4×10^{16} cubic meters (m^3) by multiplying the total ocean area (National Geographic 2005) by a leatherback turtle diving depth of 820 ft (250 m). An annual deployment (432 transmit hours per vessel) of SURTASS LFA sonar would ensonify approximately 4.2×10^{11} m^3 to a depth of 91 m (300 ft). This represents less than 0.00001 percent of the total ocean volume. The total worldwide population of leatherback sea turtles has been estimated at 20,000 to 30,000 (Plotkin 1995). Therefore, a conservative estimate of 20,000 leatherback sea turtles was used for the Pacific basin.

Even though the leatherback distribution in the Pacific is patchy and the data on their whereabouts are sparse, SURTASS LFA sonar training events would cover enough ocean area that it is assumed that the number of animals potentially impacted would average out. The default assumption for pelagic animals is to assume even distribution for population estimates; thus, an even distribution of leatherbacks throughout the ocean volume is used here. Given this, the possible number of times a leatherback sea turtle may be in the vicinity of a SURTASS LFA sonar vessel would be less than 0.2 animals per year per vessel (20,000 animals x 0.00001 ocean volume = 0.2). Therefore, the potential for SURTASS LFA sonar training events to impact leatherback sea turtle stocks is negligible, even when up to four systems are considered.

In the unlikely event that SURTASS LFA sonar training events coincide with a sea turtle “hot spot,” the narrow bandwidth of the SURTASS LFA sonar active signal (approximately 30 Hz bandwidth), the fact that the ship is always moving (coupled with low system duty cycle [estimated 7.5 percent], which means sea turtles would have less opportunity to be located in the LFA mitigation zone during a transmission), and the monitoring mitigation incorporated into the alternatives (visual and active acoustic [HF] monitoring, when available) would minimize the probability of impacts on animals in the vicinity.

Because sonar may affect ESA-listed sea turtles in the marine environment, the Navy has initiated an ESA consultation with NMFS. Because sonar use will not affect sea turtle nesting activity or habitats, ESA consultation with USWFS is unnecessary for ASW training. Any effects that sea turtles would experience resulting from LFA exposures would most likely be short-term behavioral responses (masking) that would be short in duration and not result in any sea turtle take. Nesting activities would not be affected. The likelihood that sea turtles would be within the 180-dB mitigation zone when LFA is in use is unlikely, due to the five training event parameters described previously. Therefore, although sea turtles may be affected by exposure to LFA sound in the open ocean, adverse effects (resulting in take) can be considered discountable. In accordance with NEPA, SURTASS LFA use under Alternative 1 will not significantly impact sea turtles or sea turtle populations. In accordance with EO 12114, SURTASS LFA use under Alternative 1 will not significantly harm sea turtles or sea turtle populations.

3.8.3.2.6 Weapons Firing/Nonexplosive Practice Munitions

As shown in Table 2-8, the number of training exercises that involve weapons firing and nonexplosive practice ordnance would increase under Alternative 1. Although these changes would result in increased potential exposure for sea turtle ordnance strikes compared to baseline conditions, Navy protective measures (Chapter 5) would reduce the probability of ordnance-related exposure. The relatively small area affected by these activities and the wide dispersal of sea turtles where these activities occur suggests that the use of nonexplosive ordnance under Alternative 1 would likely not result in any mortality or injury of sea turtles.

Because this activity may affect ESA-listed sea turtles in the marine environment, the Navy has initiated an ESA consultation with NMFS. Consultation with USFWS is unnecessary for this activity because no nesting beaches will be affected by weapons firing or nonexplosive practice munitions. Under Alternative 1, weapons firing or nonexplosive practice munitions will not significantly impact sea turtles within territorial waters in accordance with NEPA. Furthermore, weapons firing or nonexplosive practice munitions will not significantly harm sea turtles in non-territorial waters in accordance with EO 12114.

3.8.3.2.7 Explosive Ordnance

Underwater detonations may occur during Alternative 1 at the MIRC, and may include the following exercises: SINKEX, MISSILEX, BOMBEX, GUNEX, IEER, and NSFS. As shown in Table 2-7, the number of these exercises per year will increase from the No Action Alternative, which would increase the exposure of sea turtles in the marine environment to acoustic and nonacoustic effects (described under the No Action Alternative). The protective measures summarized for this activity under the No Action Alternative (and described in detail in Chapter 5) would continue under Alternative 1. Although the number of training events would increase, the events are widely dispersed within the MIRC Study Area.

Because this activity may affect ESA-listed sea turtles in the marine environment, the Navy has initiated an ESA consultation with NMFS. Consultation with USFWS is unnecessary for this activity because no nesting beaches will be affected by explosive ordnance or underwater detonations. Under Alternative 1, explosive ordnance and underwater detonations will not significantly impact sea turtles within territorial waters in accordance with NEPA. Furthermore, explosive ordnance and underwater detonations will not significantly harm sea turtles in non-territorial waters in accordance with EO 12114.

3.8.3.2.8 Expended Materials

The amount of ordnance fired would increase in the MIRC Study Area under Alternative 1 (Table 2-8). Similar to the No Action Alternative, green and hawksbill turtles would potentially be exposed to expended ordnance via ingestion from foraging off the bottom. The probability of a benthic foraging sea turtle to ingest ordnance would continue to be low under Alternative 1; however,ingestion of expended materials under Alternative 1 may affect green and hawksbill turtles. Leatherback turtles are not likely to forage on the bottom; therefore, the leatherback sea turtles would not likely be subject to the lethal or sublethal effects of expended materials described under Alternative 1. Although adverse effects are unlikely to occur because the expended materials are dispersed over a wide range, sea turtles may be affected by Alternative 1. Ingestion of ordnance would have no effect on leatherback turtles under Alternative 1. The Navy has initiated ESA consultation with NMFS for the potential effects of expended materials as part of Alternative 1 (ingestion and entanglement). Expended materials will not significantly impact sea turtles within territorial waters in accordance with NEPA. Furthermore, expended materials will not significantly harm sea turtles in non-territorial waters in accordance with EO 12114.

3.8.3.3 Alternative 2

3.8.3.3.1 All Stressors

As detailed in Chapter 2, implementation of Alternative 2 would include all the actions proposed for MIRC, including the No Action Alternative and Alternative 1, increases in the number of some exercises, and additional major exercises. Impacts to sea turtles from Alternative 2 would be similar to those for the No Action Alternative and Alternative 1. Sea turtles would be affected by the increases in exposure to the various stressors considered for analysis; however, protective measures described in Chapter 5 reduce the likelihood of impacts below thresholds of significance. Alternative 2 will not significantly impact sea turtles within territorial wasters in accordance with NEPA. In accordance with EO 12114, stressors for Alternative 2 will not cause significant harm to sea turtles in non-territorial waters.

3.8.4 Unavoidable Significant Environmental Impacts

The Navy is working with the NMFS and USFWS 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.

3.8.5 Summary of Environmental Impacts

3.8.5.1 Endangered Species Act

Table 3.8-4, Table 3.8-5, and Table 3.8-6 provide summaries of the Navy's determination of effect on Federally listed sea turtles that occur in the MIRC Study Area associated with the No Action Alternative, Alternative 1, and Alternative 2. Administration of ESA obligations associated with sea turtles are shared between NMFS and USFWS, depending on life stage and specific location of the sea turtle. NMFS generally has jurisdiction over sea turtles in the marine environment, and USFWS jurisdiction is generally applied over nesting activities. The Navy is consulting with NMFS and USFWS regarding its determination of effect for Federally listed sea turtles.

Table 3.8-4: Determination of Effect for Federally Listed Sea Turtles that Occur in the Study Area – No Action Alternative

Stressor	Green Turtle	Hawksbill Turtle	Loggerhead Turtle	Olive Ridley Turtle	Leatherback Turtle
Vessel Movements					
Disturbance	May Affect	May Affect	May Affect	May Affect	May Affect
Collisions	May Affect	May Affect	May Affect	May Affect	May Affect
Amphibious Landings					
Nest Mortality	May Affect	May Affect	No Effect	No Effect	No Effect
Nest Attempt Failure	May Affect	May Affect	No Effect	No Effect	No Effect
Collisions	May Affect	May Affect	No Effect	No Effect	No Effect
Accelerated Beach Erosion from Vessel Wakes	May Affect	May Affect	No Effect	No Effect	No Effect
Aircraft Overflights					
Aircraft Disturbance	May Affect	May Affect	May Affect	May Affect	May Affect
Sonar					
MFA Sonar	May Affect	May Affect	May Affect	May Affect	May Affect
LFA Sonar	No Effect*	No Effect*	No Effect*	No Effect*	No Effect*
Weapons Firing/Nonexplosive Ordnance Use					
Weapons Firing Disturbance	May Effect	May Affect	May Affect	May Affect	May Affect
Ordnance Strikes	May Affect	May Affect	May Affect	May Affect	May Affect
Underwater Detonations and Explosive Ordnance					
Live Ordnance	May Affect	May Affect	May Affect	May Affect	May Affect
Underwater Detonation	May Affect	May Affect	May Affect	May Affect	May Affect
Expended Materials					
Ordnance-Related Materials	May Affect	May Affect	May Affect	May Effect	May Affect
Targets	May Affect	May Affect	May Affect	May Affect	May Affect
Chaff and End Caps	May Affect	May Affect	May Affect	May Affect	May Affect
Flares	May Affect	May Affect	May Affect	May Affect	May Affect
Marine Markers	May Affect	May Affect	May Affect	May Affect	May Affect

Note: LFA Sonar is not included as part of the No Action Alternative.

Table 3.8-5: Determination of Effect for Federally Listed Sea Turtles that Occur in the Study Area – Alternative 1 (Preferred Alternative) and Alternative 2

Stressor	Green Turtle	Hawksbill Turtle	Loggerhead Turtle	Olive Ridley Turtle	Leatherback Turtle
Vessel Movements					
Disturbance	May Affect	May Affect	May Affect	May Affect	May Affect
Collisions	May Affect	May Affect	May Affect	May Affect	May Affect
Amphibious Landings					
Nest Mortality	May Affect	May Affect	No Effect	No Effect	No Effect
Nest Attempt Failure	May Affect	May Affect	No Effect	No Effect	No Effect
Collisions	May Affect	May Affect	No Effect	No Effect	No Effect
Accelerated Beach Erosion from Vessel Wakes	May Affect	May Affect	No Effect	No Effect	No Effect
Aircraft Overflights					
Aircraft Disturbance	May Affect	May Affect	May Affect	May Affect	May Affect
Sonar					
MFA Sonar	May Affect	May Affect	May Affect	May Affect	May Affect
LFA Sonar	May Affect	May Affect	May Affect	May Affect	May Affect
Weapons Firing/Nonexplosive Ordnance Use					
Weapons Firing Disturbance	May Effect	May Affect	May Affect	May Affect	May Affect
Ordnance Strikes	May Affect	May Affect	May Affect	May Affect	May Affect
Underwater Detonations and Explosive Ordnance					
Live Ordnance	May Affect	May Affect	May Affect	May Affect	May Affect
Underwater Detonation	May Affect	May Affect	May Affect	May Affect	May Affect
Expended Materials					
Ordnance Related Materials	May Affect	May Affect	May Affect	May Effect	May Affect
Targets	May Affect	May Affect	May Affect	May Affect	May Affect
Chaff and End Caps	May Affect	May Affect	May Affect	May Affect	May Affect
Flares	May Affect	May Affect	May Affect	May Affect	May Affect
Marine Markers	May Affect	May Affect	May Affect	May Affect	May Affect

3.8.5.2 National Environmental Policy Act and Executive Order 12114

As summarized in Table 3.8-6, the No Action Alternative, Alternative 1, and Alternative 2 would have no significant impact on sea turtles in territorial waters. Furthermore, the No Action Alternative, Alternative 1, and Alternative 2 would not cause significant harm to sea turtles in non-territorial waters.

Table 3.8-6: Summary of Environmental Effects of the Alternatives on Sea Turtles in the MIRC Study Area

Alternative and Stressor	NEPA (Land and Territorial Waters, < 12 nm)	Executive Order 12114 (Non-Territorial Waters, >12 nm)
No Action Alternative, Alternative 1, and Alternative 2		
Vessel Movements	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
Amphibious Landings	Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. Vehicle activity and personnel movements may cause nest failures (false crawls of nesting females, or sand compaction/nest mortality). Long-term effects of accelerated beach erosion from vehicle tracks on the beach and craft wakes in the water.	Not Applicable. Amphibious landings exclusively occur within territorial waters.
Aircraft Overflights	Potential for short-term behavioral responses to overflights. No long-term population-level effects.	Potential for short-term behavioral responses to overflights. No long-term population-level effects.
Sonar	Low probability for masking effects, although MFA and HFA sonar frequencies do not overlap with sea turtle sensitive hearing ranges.	Low probability for masking effects, although MFA and HFA sonar frequencies do not overlap with sea turtle sensitive hearing ranges. For Alternative 1 and Alternative 2 there is a low probability for LFA sonar masking effects or other behavioral changes.
Weapons Firing/ Nonexplosive Ordnance Use	Low probability of direct strikes, but potential for short term temporary disturbance associated with gunnery noise transmitted to the ocean surface and/or transmitted through a ship's hull.	Low probability of direct strikes, but potential for short term temporary disturbance associated with gunnery noise transmitted to the ocean surface and/or transmitted through a ship's hull.
Underwater Detonations and Explosive Ordnance	Potential for short-term behavioral responses. Potential for injury or mortality within limited ZOI. SINKEX will not occur in territorial waters.	Potential for short-term behavioral responses. Potential for injury or mortality within limited ZOI.
Expended Materials	Low potential for ingestion of chaff and/or flares, plastic end caps, parachutes, marine markers, or pistons. Low potential for entanglement of sea turtles with expended materials, such as parachutes, flex hoses, or guide wires.	Low potential for ingestion of chaff and/or flares, plastic end caps, parachutes, marine markers, or pistons. Low potential for entanglement of sea turtles with expended materials, such as parachutes, flex hoses, or guide wires.
Impact Conclusion	No significant impact to sea turtles.	No significant harm to sea turtles.

3.9 FISH AND ESSENTIAL FISH HABITAT

3.9.1 Introduction and Methods

3.9.1.1 Regulatory Framework

3.9.1.1.1 Federal Laws and Regulations

The primary Federal laws that make up the regulatory framework for fish and essential fish habitat (EFH) include the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), EO 12962, and the Endangered Species Act (ESA).

Magnuson-Stevens Fishery Conservation and Management Act and Sustainable Fisheries Act. The MSFCMA established a 200 nm (370 km) fishery conservation zone in U.S. waters, established national standards (*e.g.*, optimum yield, scientific information, allocations, efficiency, and costs/benefits) for fishery conservation and management, and created a network of regional Fishery Management Councils (FMCs). The FMCs are composed of Federal and state officials, including National Marine Fisheries Service (NMFS), which oversee fishing activities within the fishery management zone.

In 1996, the MSFCMA was reauthorized and amended by the Sustainable Fisheries Act. The MSFCMA provided a new habitat conservation tool in the form of the EFH mandate. The EFH mandate required that the regional FMCs, through Federal Fishery Management Plans (FMPs), describe and identify EFH for each Federally managed species, minimize to the extent practicable adverse effects on such habitat caused by fishing, and integrate MSFCMA EFH consultations with ESA Section 7 consultations with NMFS. Congress defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (16 U.S. Code [U.S.C.] 1802[10]). The term “fish” is defined in the MSFCMA as “finfish, mollusks, crustaceans, and all other forms of marine animals and plant life other than marine mammals and birds.” The regulations for implementing EFH clarify that “waters” include all aquatic areas and their biological, chemical, and physical properties, while “substrate” includes the associated biological communities that make these areas suitable fish habitats (50 C.F.R. 600.10).

Authority to implement the MSFCMA is given to the Secretary of Commerce and has been delegated to NMFS. The MSFCMA requires that the EFH be identified and described for each Federally managed species. The identification must include descriptive information on the geographic range of the EFH for all life stages, along with maps of the EFH for life stages over appropriate time and space scales. Habitat requirements must also be identified, described, and mapped for all life stages of each species. The NMFS and regional FMCs determine the species distributions by life stage and characterize associated habitats, including Habitat Areas of Particular Concern (HAPC). The MSFCMA requires Federal agencies to consult with NMFS on activities that may adversely affect EFH. For actions that affect a threatened or endangered species, its critical habitat, and/or EFH, Federal agencies must initiate both ESA and EFH consultations.

In 2002, the EFH Final Rule was authorized, which simplified EFH regulations (NMFS, 2002). Significant changes delineated in the EFH Final Rule are (1) clearer standards for identifying and describing EFH, including the inclusion of the geographic boundaries and a map of the EFH, as well as guidance for the FMCs to distinguish EFH from other habitats; (2) more guidance for the FMCs on evaluating the impact of fishing activities on EFH and clearer standards for deciding when FMCs should act to minimize the adverse impacts; and (3) clarification and reinforcement of the EFH consultation procedures (NMFS, 2002).

Executive Order (EO) 12962 on Recreational Fisheries. EO 12962 on Recreational Fisheries (60 Federal Register [FR] 30769) was enacted in 1995 to ensure that Federal agencies strive to improve other actions to encourage the conservation and enhancement of recreational fishing. The overarching 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 (NRFCC), co-chaired by the Secretaries of the Interior and Commerce, is charged with overseeing Federal actions and programs that are mandated by this order. The specific duties of the NRFCC include: (1) ensuring that the social and economic values of healthy aquatic systems, which support recreational fisheries, are fully considered by Federal agencies; (2) reducing duplicative efforts among Federal agencies; and (3) disseminating the latest information and technologies to assist in the conservation and management of recreational fisheries. In June 1996, the NRFCC developed a comprehensive Recreational Fishery Resources Conservation Plan (RFRCP) specifying what member agencies would do to achieve the order's goals (NMFS, 1999). In addition to defining Federal agency actions, the plan also ensures agency accountability and provides a comprehensive mechanism to evaluate achievements. A major outcome of the RFRCP has been the increased utilization of artificial reefs to better manage recreational fishing stocks in U.S. waters (USFWS, 2003c).

Endangered Species Act. As described in Section 3.7 (Marine Mammals) and Section 3.8 (Sea Turtles), the ESA of 1973 (16 U.S.C. §§ 1531 et seq.) 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. All Federal agencies are required to implement protection programs for threatened and endangered species and to use their authority to further the purposes of the ESA. NMFS and USFWS jointly administer the ESA and are also responsible for the listing (*i.e.*, the labeling of a species as either threatened or endangered) of all "candidate" species. A "candidate" species is one that is the subject of either a petition to list or status review, and for which the NMFS or USFWS has determined that listing may be or is warranted (NMFS, 2004). The NMFS is further charged with the listing of all Species of Concern that fall under its jurisdiction. A Species of Concern is one about which the NMFS has some concerns regarding status and threats, but for which insufficient information is available to indicate a need to list the species under the ESA (NMFS, 2004).

As discussed in Section 3.9.2 (Affected Environment), fish classified as Species of Concern and EFH have been designated in the Study Area. Fish classified as Species of Concern in the Study Area are the humphead wrasse (*Cheilinus undulatus*) and the bumphead parrotfish (*Bolbometopon muricatum*). Accordingly, the Navy is consulting with the NMFS on activities that may adversely affect EFH, and has prepared an EFH Assessment to support the consultation process.

3.9.1.1.2 Territory and Commonwealth Laws and Regulations

Guam. Pursuant to the Territorial Submerged Lands Act of 1960, the Territory of Guam owns and has management responsibility over the marine resources out to 3 nm (5.6 km). In general, the authority of the MSFCMA begins at the 3 nm (5.6 km) limit; however, there are exceptions to the management authority on Guam. Federal government administration covers waters off Ritidian Point as a National Wildlife Refuge (Guam NWR, Ritidian Unit), and the Air Force and Navy control entry to certain marine waters surrounding Andersen AFB and Apra Harbor.

The Guam Division of Aquatic and Wildlife Resources (DAWR) Fisheries Section has management responsibility of marine resources within the Territory of Guam. Fisheries are managed through education and conservation initiatives to foster health of the reefs on which the fish depend, which include installation of moorings to prevent reef damage and setting aside marine protected areas to help restock fishing areas (WPRFMC, 2005). Regulations governing fishing activities and harvest of marine resources in Guam can be found in Guam Code, Title 5, Division 6, Chapter 63.

Commonwealth of the Northern Mariana Islands. Similar to Guam, CNMI owns and has management over the marine resources out to 3 nm (5.6 km). A recent U.S. Supreme Court decision (*Commonwealth of the Northern Mariana Islands* v. *United States*) in 2005 affirmed the Federal authority over waters within the Exclusive Economic Zone (EEZ) from 3 nm (5.6 km) to 200 nm (370 km); therefore, MSFCMA jurisdiction covers the EEZ surrounding CNMI.

The CNMI Division of Fish and Wildlife (DFW) manages the fisheries within CNMI waters through research and implementing regulations governing fishing and conservation areas (WPRFMC, 2005). Regulations governing fishing activities and harvesting of marine resources in the CNMI can be found in the CNMI Register Volumes 22, 23, and 25.

3.9.1.2 Assessment Methods and Data Used

3.9.1.2.1 General Approach to Analysis

The general approach to analysis for fish and EFH is the same as the approach described for marine mammals in Section 3.7.1.2.

3.9.1.2.2 Study Area

The Study Area for fish and EFH is described in Section 1.1 and is shown in Figure 1.1-1. The Study Area is analogous to the "action area," for the purposes of analysis under Section 7 of the ESA.

3.9.1.2.3 Data Sources

A comprehensive and systematic review of relevant literature and data has been conducted to complete this analysis of fish and EFH. The primary source of information used to describe the affected environment for fish and EFH was the Navy's Marine Resources Assessment (MRA) report for the Marianas Operating Area (DoN, 2005), which included additional sources on the affected environment. The MRA report provides compilations of the most recent data and information on the occurrence of marine resources in the Study Area. 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 (DoD) training reports, theses, dissertations, endangered species recovery plans, species management plans, stock assessment reports, EISs, Range Complex 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.

Information was collected from the following sources to summarize the occurrence patterns of, and to evaluate the impacts to, protected species in the Study Area and vicinity:

- Academic and educational /research institutions: Biosis, Cambridge Abstract's Aquatic Sciences, University of California Melvyl, and Zoological Record Plus
- Internet searches: National Oceanic and Atmospheric Adminsitration (NOAA)-Coastal Services Center, NMFS, Ocean Biogeographic Information System, U.S. Geological Survey (USGS), Western Pacific Fishery Management Council, Blackwell-Science, FishBase, and Federal Register

- Federal, GovGuam, and CNMI agencies: the Navy, Western Pacific Fishery Management Council, NMFS Office of Habitat Protection, NMFS Office of Protected Resources, USGS, Guam DAWR, and CNMI DFW

3.9.1.2.4 Factors Used to Assess the Significance of Effects

This EIS/OEIS analyzes potential effects to fish and EFH in the context of the MSFCMA (Federally managed species and EFH), EO 12962 (Recreational Fisheries), ESA (Species of Concern), NEPA, and EO 12114. The factors used to assess the significance of effects vary under these Acts.

Pursuant to 50 CFR 600.910(a), an “adverse effect” on EFH is defined as any impact that reduces the quality and/or quantity of EFH. To help identify Navy activities falling within the adverse effect definition, the Navy has determined that temporary or minimal impacts are not considered to “adversely affect” EFH. 50 CFR 600.815(a)(2)(ii) and the EFH Final Rule (67 FR 2354) 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. Temporary effects are those that are limited in duration and allow the particular environment to recover without measurable impact (67 FR 2354). Minimal effects are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions (67 FR 2354). 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)
- 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 and NMFS, 1998) and are provided in Section 3.7.1.2.

3.9.1.3 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 training 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. As shown in Table 3.9-1, potential stressors to fish and EFH include vessel movements (disturbance or collisions), aircraft overflights (disturbance), sonar (harassment), weapons firing/ordnance use (disturbance and strikes), use of high explosive ordnance (disturbance, strike, habitat alteration), and expended materials (ordnance related materials, targets, chaff, self-protection flares, and marine markers). The potential effects of these stressors on fish and EFH are analyzed in detail in Section 3.9.3 (Environmental Consequences).

As discussed in Section 3.3 (Water Quality), some water pollutants would be released into the environment as a result of the Proposed Action. This analysis indicates that any increases in water pollutant concentrations resulting from Navy training in the Study Area would be negligible and localized, and impacts to water quality would be less than significant. Based on the analysis presented in Section 3.3, water quality changes would have no effect or negligible effects on fish and EFH. Accordingly, the effects of water quality changes on fish and EFH are not addressed further in this EIS/OEIS.

Table 3.9-1: Summary of Potential Stressors to Fish and Essential Fish Habitat

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Fish and Essential Fish Habitat
Army Training			
Surveillance and Reconnaissance (S & R) / Finegayan and Barrigada Housing, Tinian MLA		None	None
Field Training Exercise (FTX) / Polaris Point, Orote Point Airfield/Runway, NLNA, Northwest Field, Andersen South, Tinian EMUA		None	None
Live Fire / Pati Point CATM Range		None	None
Parachute Insertions and Air Assault / Orote Point Triple Spot, Polaris Point Field, Ordnance Annex Breacher House		None	None

Table 3.9-1: Summary of Potential Stressors to Fish and Essential Fish Habitat (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Fish and Essential Fish Habitat
Military Operations in Urban Terrain (MOUT) / OPCQC House, Ordnance Annex Breacher House, Barrigada Housing, Andersen South		None	None
Marine Corps Training			
Ship to Objective Maneuver (STOM) / Tinian EMUA		Vessel Movements	Short-term and localized disturbance to water column. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
Operational Maneuver / NLNA, SLNA		None	None
Non-Combatant Evacuation Order (NEO) / Tinian EMUA		None	None

Table 3.9-1: Summary of Potential Stressors to Fish and Essential Fish Habitat (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Fish and Essential Fish Habitat
Assault Support (AS) / Polaris Point Field, Orote Point KD Range, Tinian EMUA		None	None
Reconnaissance and Surveillance (R & S) / Tinian EMUA		None	None
MOUT / Ordnance Annex Breacher House, Orote Point CQC		None	None
Direct Fires / FDM, Orote Point KD Range, ATCAA 3A		Weapons Firing Expended Materials	Short-term and localized disturbance to water column and benthic habitats. Low potential for injury or mortality to fish. No long-term population-level effects or reduction in the quality and/or quantity of EFH. Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion. No long-term population-level effects or reduction in the quality and/or quantity of EFH. Low potential for ingestion of chaff and/or flare plastic end caps and pistons.
Exercise Command and Control (C2) / AAFB		None	None
Protect and Secure Area of Operations/ Northwest Field		None	None

Table 3.9-1: Summary of Potential Stressors to Fish and Essential Fish Habitat (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Fish and Essential Fish Habitat
Navy Training			
Anti-Submarine Warfare (ASW) / Open Ocean		Vessel Movements	Short-term and localized disturbance to water column. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Underwater explosions	Short-term and localized disturbance to water column and benthic habitats. Mortality to fish in immediate vicinity of explosions, with increased susceptibility by juvenile fish, small fish, and fish with swim bladders. Injury may include permanent or temporary hearing loss with effects diminishing further from the detonation. Behavioral effects include startle response and temporarily leaving an exercise area. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Sonar	Potential for increased mortality (swim bladder rupture) or injury (such as hearing loss). Potential for masking of sounds within frequency ranges of LFA, MFA, and HFA sonar systems that overlap with some fish species' hearing.
		Collision	Potential for injury or mortality from direct strikes of fish by inert torpedoes.

Table 3.9-1: Summary of Potential Stressors to Fish and Essential Fish Habitat (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Fish and Essential Fish Habitat
Mine Warfare (MIW) / Agat Bay, Inner Apra Harbor		Vessel Movements	Short-term behavioral responses to vessels and extremely low potential for injury/mortality from collisions which would more likely occur at night.
		Underwater explosions	Short-term and localized disturbance to water column and benthic habitats. Mortality to fish in immediate vicinity of explosions, with increased susceptibility by juvenile fish, small fish, and fish with swim bladders. Injury may include permanent or temporary hearing loss with effects diminishing further from the detonation. Behavioral effects include startle response and temporarily leaving an exercise area. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Sonar	Potential for injury or mortality from direct strikes of fish and potential for increased mortality (swim bladder rupture) or injury (such as hearing loss). Masking potential sonar sources that overlap with some species' hearing ranges.
		Expended Materials	Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion. No long-term population-level effects or reduction in the quality and/or quantity of EFH. Low potential for ingestion of chaff and/or flare plastic end caps and pistons.
Air Warfare (AW) / W-517, R-7201		Expended Materials	Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion. No long-term population-level effects or reduction in the quality and/or quantity of EFH. Low potential for ingestion of chaff and/or flare plastic end caps and pistons.
		Weapons Firing	Short-term and localized disturbance to water column and benthic habitats. Low potential for injury or mortality to fish. No long-term population-level effects or reduction in the quality and/or quantity of EFH.

Table 3.9-1: Summary of Potential Stressors to Fish and Essential Fish Habitat (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Fish and Essential Fish Habitat
Surface Warfare (SUW) / FDM, W-517	Surface to Surface Gunnery Exercise (GUNEX)	None	None
	Air to Surface Gunnery Exercise	Weapons Firing	Short-term and localized disturbance to water column and benthic habitats. Injury or mortality to fish in immediate vicinity of explosions. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Expended Materials	Potential for injury or mortality from direct strike of fish by inert torpedoes. Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion. No long-term population-level effects or reduction in the quality and/or quantity of EFH. Low potential for ingestion of chaff and/or flare plastic end caps and pistons.
	Visit Board Search and Seizure (VBSS)	Vessel Movements	Short-term and localized disturbance to water column. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
Strike Warfare (STW) / FDM	Air to Ground Bombing Exercises (Land)(BOMBEX-Land)	Expended Materials	Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion. No long-term population-level effects or reduction in the quality and/or quantity of EFH. Low potential for ingestion of chaff and/or flare plastic end caps and pistons.
		Explosive Ordnance	Short-term and localized disturbance to water column and benthic habitats. Mortality to fish in immediate vicinity of explosions, with increased susceptibility by juvenile fish, small fish, and fish with swim bladders. Injury may include permanent or temporary hearing loss with effects diminishing further from the detonation. Behavioral effects include startle response and temporarily leaving an exercise area. No long-term population-level effects or reduction in the quality and/or quantity of EFH.

Table 3.9-1: Summary of Potential Stressors to Fish and Essential Fish Habitat (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Fish and Essential Fish Habitat
	Air to Ground Missile Exercises (MISSILEX)	Expended Materials	Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion. No long-term population-level effects or reduction in the quality and/or quantity of EFH. Low potential for ingestion of chaff and/or flare plastic end caps and pistons.
Naval Special Warfare (NSW) / Orote Point Training Areas, Ordnance Annex Breacher House, Apra Harbor, Andersen South, Northwest Field, Reserve Craft Beach, Polaris Point Field, Dan Dan Drop Zone	Naval Special Warfare Operations (NSW OPS)	Vessel Movements	Short-term and localized disturbance to water column. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Expended Materials	Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion. No long-term population-level effects or reduction in the quality and/or quantity of EFH. Low potential for ingestion of chaff and/or flare plastic end caps and pistons.
		Amphibious Landings	Short-term behavioral responses from vessel approaches to shoreline in nearshore habitats. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Weapons Firing	Short-term and localized disturbance to water column and benthic habitats. Injury or mortality to fish in immediate vicinity of explosions. No long-term population-level effects or reduction in the quality and/or quantity of EFH.

Table 3.9-1: Summary of Potential Stressors to Fish and Essential Fish Habitat (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Fish and Essential Fish Habitat
	Insertion/Extraction	Vessel Movements	Short-term and localized disturbance to water column. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Expended Materials	Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion. No long-term population-level effects or reduction in the quality and/or quantity of EFH. Low potential for ingestion of chaff and/or flare plastic end caps and pistons.
		Amphibious Landings	Short-term behavioral responses from vessel approaches to shoreline in nearshore habitats. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Weapons Firing	Short-term and localized disturbance to water column and benthic habitats. Injury or mortality to fish in immediate vicinity of explosions. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
	Direct Action	Vessel Movements	Short-term and localized disturbance to water column. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Expended Materials	Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion. No long-term population-level effects or reduction in the quality and/or quantity of EFH. Low potential for ingestion of chaff and/or flare plastic end caps and pistons.
		Amphibious Landings	Short-term behavioral responses from vessel approaches to shoreline in nearshore habitats. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Weapons Firing	Short-term and localized disturbance to water column and benthic habitats. Injury or mortality to fish in immediate vicinity of explosions. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
	MOUT	None	None

Table 3.9-1: Summary of Potential Stressors to Fish and Essential Fish Habitat (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Fish and Essential Fish Habitat
	Airfield Seizure	None	None
	Over the Beach (OTB)	Vessel Movements	Short-term and localized disturbance to water column. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Expended Materials	Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion. No long-term population-level effects or reduction in the quality and/or quantity of EFH. Low potential for ingestion of chaff and/or flare plastic end caps and pistons.
		Amphibious Landings	Short-term behavioral responses from vessel approaches to shoreline in nearshore habitats. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Weapons Firing	Short-term and localized disturbance to water column and benthic habitats. Injury or mortality to fish in immediate vicinity of explosions. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
	Breaching	None	None

Table 3.9-1: Summary of Potential Stressors to Fish and Essential Fish Habitat (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Fish and Essential Fish Habitat
Amphibious Warfare (AMW) / FDM, Orote Point and Finegayan Small Arms Ranges, Orote Point KD Range, Reserve Craft Beach, Outer Apra Harbor, Tipalo Cove, Tinian EMUA	Naval Surface Fire Support (FIREX Land)	Vessel Movements	Short-term and localized disturbance to water column. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Expended Materials	Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion. No long-term population-level effects or reduction in the quality and/or quantity of EFH. Low potential for ingestion of chaff and/or flare plastic end caps and pistons.
		Amphibious Landings	Short-term behavioral responses from vessel approaches to shoreline in nearshore habitats. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Weapons Firing	Short-term and localized disturbance to water column and benthic habitats. Injury or mortality to fish in immediate vicinity of explosions. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
	Marksmanship	None	None
	Expeditionary Raid	Vessel Movements	Short-term and localized disturbance to water column. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Amphibious Landings	Short-term behavioral responses from vessel approaches to shoreline in nearshore habitats. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Expended Materials	Long-term, minor, and localized accumulation of expended materials in benthic habitat. No long-term population-level effects or reduction in the quality and/or quantity of EFH. Limited potential for ingestion of chaff and/or flare plastic end caps and pistons.
		Weapons Firing	Short-term and localized disturbance to water column and benthic habitats. Injury or mortality to fish in immediate vicinity of explosions. No long-term population-level effects or reduction in the quality and/or quantity of EFH.

Table 3.9-1: Summary of Potential Stressors to Fish and Essential Fish Habitat (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Fish and Essential Fish Habitat
	Hydrographic Surveys	Vessel Movements	Short-term and localized disturbance to water column. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Amphibious Landings	Short-term behavioral responses from vessel approaches to shoreline in nearshore habitats. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
Explosive Ordnance Disposal (EOD) / Outer Apra Harbor, Piti and Agat Bay Floating Mine Neutralization areas	Land Demolition	None	None
	Underwater Demolition	Vessel Movements	Short-term and localized disturbance to water column. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Expended Materials	Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion. No long-term population-level effects or reduction in the quality and/or quantity of EFH. Potential for injury or mortality within limited ZOI.
		Explosive Ordnance	Short-term and localized disturbance to water column and benthic habitats. Mortality to fish in immediate vicinity of explosions, with increased susceptibility by juvenile fish, small fish, and fish with swim bladders. Injury may include permanent or temporary hearing loss with effects diminishing further from the detonation. Behavioral effects include startle response and temporarily leaving an exercise area. No long-term population-level effects or reduction in the quality and/or quantity of EFH.

Table 3.9-1: Summary of Potential Stressors to Fish and Essential Fish Habitat (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Fish and Essential Fish Habitat
Logistics and Combat Services Support/ Orote Point Airfield/ Runway, Reserve Craft Beach	Combat Mission Area	Vessel Movements	Short-term and localized disturbance to water column. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Expended Materials	Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion. No long-term population-level effects or reduction in the quality and/or quantity of EFH. Low potential for ingestion of chaff and/or flare plastic end caps and pistons.
		Weapons Firing	Short-term and localized disturbance to water column and benthic habitats. Injury or mortality to fish in immediate vicinity of explosions. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
		Amphibious Landings	Short-term behavioral responses from vessel approaches to shoreline in nearshore habitats. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
	Command and Control (C2)	None	None
Combat Search and Rescue (CSAR) / North Field (Tinian)	Embassy Reinforcement	None	None
	Anti-Terrorism (AT)	None	None
Air Force Training			
Counter Land / FDM, ATCAA 3		None	None
Counter Air (Chaff) / W-517, ATCAAs 1 and 2		Expended Materials	Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion. No long-term population-level effects or reduction in the quality and/or quantity of EFH.

Table 3.9-1: Summary of Potential Stressors to Fish and Essential Fish Habitat (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Fish and Essential Fish Habitat
Airlift/ Northwest Field		None	None
Air Expeditionary/ Northwest Field		None	None
Force Protection / Northwest Field, Tarague Beach Small Arms Range, Andersen Main		None	None
Intelligence, Surveillance, Reconnaissance (ISR) and Strike Capacity/ R-7201, FDM, Andersen AFB	Air-to-Air Training	None	None
	Air-to-Ground Training	None	None
Rapid Engineer Deployable Heavy Operational Repair Squadron Engineer (RED HORSE) / Northwest Field	Silver Flag Training	None	None
	Commando Warrior Training	None	None
	Combat Communications	None	None

3.9.2 Affected Environment

3.9.2.1 Regional Overview

Distribution and abundance of fishery species depends greatly on the physical and biological factors associated with the ecosystem, as well as the individual species. Physical parameters include habitat quality variables such as salinity, temperature, dissolved oxygen, and large-scale environmental perturbations (*e.g.*, El Niño/Southern Oscillation [ENSO]). Biological factors affecting distribution are complex and include variables such as population dynamics, predator/prey oscillations, seasonal movements, reproductive/life cycles, and recruitment success (Helfman *et al.*, 1999). Rarely is one factor responsible for the distribution of fishery species; a combination of factors likely contributes to the distribution. For example, pelagic (open ocean) species optimize their growth, reproduction, and survival by tracking gradients of temperature, oxygen, or salinity (Helfman *et al.*, 1999). Additionally, the spatial distribution of food resources is variable and changes with prevailing physical habitat parameters. Another major component in understanding species distribution is the location of highly productive regions such as frontal zones. These areas concentrate higher trophic-level predators such as tuna and provide visual clues for the location of target species for commercial fisheries (NMFS-PIR, 2001). Ocean zonation is described in Section 3.6.2.1 of this EIS/OEIS.

Environmental variations, such as ENSO events, change the normal characteristics of water temperature, thereby changing the patterns of water flow. The Northern Equatorial Current (NEC) (westward) and the Subtropical Countercurrent (eastward) are major influences on distribution of fish and invertebrates in the Study Area and vicinity (Eldredge, 1983). ENSO events alter normal current patterns, alter productivity, and have dramatic effects on distribution, habitat range and movement of pelagic species (NMFS, 2003a). In the northern hemisphere, El Niño events typically result in tropical, warm-water species moving north (extending species range), and cold-water species moving north or into deeper water (restricting their range). Surface-oriented, schooling fish often disperse and move into deeper waters. Fish that remain in an affected region experience reduced growth, reproduction, and survival (NOAA, 2002). El Niño events have caused fisheries such as the skipjack tuna fishery to shift over 621 mi (1,000 km) (NMFS-PIR, 2001).

Coral reef communities surrounding the Study Area are known to have year-round uniformity and stability (Amesbury *et al.*, 1986). While this is true for most species in the area, there are exceptions. Seasonal variations in pelagic species distributions in the area are understood. Several of the reef fish species (juvenile rabbitfish [*Siganus* spp.], juvenile jacks [*Seriola* spp.], juvenile goatfish [family Mullidae], and bigeye scad [*Selar crumenophthalmus*]) in the Study Area show strong seasonal fluctuation, usually related to juvenile recruitment (Amesbury *et al.*, 1986).

Fish species composition within the Study Area is typical of most Indo-Pacific insular, coral reef-bordered coastal areas. Seventy-three percent of the total number of species found belongs to 20 families (Myers and Donaldson, 2003). The geographic location of the Study Area suggests a more diverse ichthyofauna than areas such as the Hawaiian Islands. Recorded species diversity in the Guam/Marianas island chain is lower than that of the Hawaiian archipelago. Actual diversity may be higher in the Mariana Archipelago, and the recorded diversity may be an artifact of insufficient sampling (Paulay, 2003). However, many other factors such as larval recruitment and frequent natural disturbances have dramatic impacts on species diversity (Randall, 1995). Myers and Donaldson (2003) noted the occurrence of 1,019 fish species (epipelagic and demersal species found to 656 ft [200 m]) within the Study Area. Inshore species are composed primarily of widespread Indo-Pacific species (58 percent) with the remainder consisting of circumtropical species (3.6 percent) and nearly equal numbers of species with widespread distributions primarily to the west, south, and east of the islands (Myers and Donaldson, 2003). Ten species of inshore and epipelagic fish are currently considered endemic to the Marianas. However, this number is probably too high due to the observations of transient species in the area (Myers and Donaldson, 2003). Additionally, Myers and Donaldson (2003) identified 1,106 species of fish known from the Mariana Islands and adjacent territorial waters. Extensive studies have been done on the biogeography of inshore and epipelagic fauna found in the Marianas from 0 to 328 ft (0 to 100 m). Currently, occurrence and distribution of benthic and mesopelagic species from 328 ft (100 m) to greater than 656 ft (200 m) are incomplete and poorly understood (Myers and Donaldson, 2003). Lack of adequate data has made it difficult to identify and interpret other sources of variation in the distribution and/or decline of the fisheries resources of these islands. Declining fisheries resources is a major problem facing Guam; however, CNMI has adopted some of the strictest fishing regulations in the Pacific banning gears such as SCUBA/hookah spear fishing, gill nets, drag nets, and surround nets.

According to the Guam DAWR, fish populations have declined 70 percent over the past 15 years. Finfish harvest dropped from 334,441 lb (151,700 kg) in 1985 to 138,206 lb (62,689 kg) in 1999 (Richmond and Davis, 2002). Catch-per unit-effort has dropped over 50 percent since 1985, and landings of large reef fish are rare (Richmond and Davis, 2002). Seasonal harvest of juvenile rabbitfish has also declined in recent years. Currently, there are little data assessing the health of fish resources in the Study Area but it is believed that populations increase with increasing distance northward, due to decreased fishing pressure (Starmer *et al.*, 2002). Regulations such as the ban of spear fishing with SCUBA and gill netting have been proposed to aid in the relief of fishing pressure in the area (Richmond and Davis, 2002).

3.9.2.2 Essential Fish Habitat Designations

The Western Pacific Regional Fisheries Management Council (WPRFMC) manages major fisheries within the EEZ around Hawai'i and the territories and possessions of the U.S. in the Pacific Ocean (WPRFMC, 1998; 2001). The WPRFMC (3 to 200 nm [5.6 to 370 km]), in conjunction with the Guam DAWR (0 to 3 nm [0 to 5.6 km]) and the CNMI DFW, manages the fishery resources in the Study Area. The WPRFMC has also proposed to defer fisheries management from 0 to 3 nm (0 to 5.6 km) to the CNMI DFW (WPRFMC, 2001). The WPRFMC focuses on the major fisheries in the Study Area that require regional management. The WPRFMC currently oversees four major FMPs for (1) bottomfish, (2) pelagics, (3) crustaceans, and (4) coral reef ecosystems. Each Management Unit is described below. There is no FMP for precious corals within the Study Area.

3.9.2.2.1 Bottomfish Management Unit

Status. Seventeen species are currently managed within the Bottomfish Management Unit by the WPRFMC through the *Bottomfish and Seamount Groundfish Fishery Management Plan* (WPRFMC, 1986a) and subsequent amendments (WPRFMC, 1998; 2004a). In the Northern Marianas, Guam, and American Samoa, the species are grouped into a shallow-water complex and a deep-water complex based on habitat preferences. All 17 species have viable recreational, subsistence, and commercial fisheries (WPRFMC, 2004b) with none of the species within the Bottomfish Management Unit approaching an overfished condition (NMFS, 2004a). The species within the Bottomfish Management Unit found in the Study Area are not listed on the International Union for the Conservation of Nature (IUCN) Red List of threatened species (IUCN, 2004).

Distribution. The shallow-water (0 to 328 ft [0 to 100 m]) and the deep-water (328 to 1,312 ft [100 to 400 m]) complexes are distributed throughout the tropical and subtropical waters of the insular and coral reef-bordered coastal areas of Pacific islands (Myers and Donaldson, 2003).

Habitat Preferences. Bottomfish comprising the shallow-water and deep-water complexes concentrate around the 600 ft (183 m) contour (index of bottomfish habitat) that surrounds Guam and the Northern Mariana Islands (WPRFMC, 1998). Juvenile and adult bottomfish are usually found in habitats characterized by a mosaic of sandy bottoms and rocky areas of high structural complexity (WPRFMC, 1998). Habitats encompassing the shallow-water complex consist of shelf and slope areas (Spalding *et al.*, 2001). The shelf area includes various habitats such as mangrove swamps; seagrass beds; shallow lagoons; hard, flat, and coarse sandy bottoms; coral and rocky substrate; sandy inshore reef flats; and deep channels. Seaward reefs, outer deep reef slopes, banks, and deeper waters of coral reefs comprise the slope areas (Heemstra and Randall, 1993; Allen, 1985; Myers, 1999; Amesbury and Myers, 2001; Allen and Adrim, 2003). The deep-water complex inhabits areas of high relief with hard rocky bottoms such as steep slopes, pinnacles, headlands, rocky outcrops, and coral reefs (Allen, 1985; Parrish, 1987; Haight *et al.*, 1993).

Life History. Very little is known about the ecology (life history, habitat, feeding, and spawning) of the bottomfish species managed in the Study Area (WPRFMC, 1998). However, limited information is available for various larval, juvenile, and adult bottomfish genera of the shallow-water and deep-water complexes. Within the shallow-water complex, snappers form large aggregations and groupers/jacks occur in pairs within large aggregations near areas of prominent relief. Spawning coincides with lunar periodicity corresponding with new/full moon events (Grimes, 1987; Myers, 1999; Amesbury and Myers, 2001). Groupers have been shown to undergo small, localized migrations of several kilometers to spawn (Heemstra and Randall, 1993). Large jacks are highly mobile, wide-ranging predators that inhabit the open waters above the reef or swim in upper levels of the open sea (Sudekum *et al.*, 1991) and spawn at temperatures of 18°C to 30°C (Miller *et al.*, 1979). Within the deep-water complex, snappers aggregate near areas of bottom relief as individuals or in small groups (Allen, 1985). Snappers may be batch or serial spawners, spawning multiple times over the course of the spawning season (spring and summer peaking in November and December), exhibit a shorter, more well-defined spawning period (July to September), or have a protracted spawning period (June through December peaking in August) (Allen, 1985; Parrish, 1987; Moffitt, 1993). Some snappers display a crepuscular periodicity (active during twilight hours) and migrate diurnally from areas of high relief during the day at depths of 328 to 656 ft (100 to 200 m) to shallow (98 to 262 ft [30 to 80 m]), flat shelf areas at night (Moffitt and Parrish, 1996). Other snapper species exhibit higher densities on up-current side islands, banks, and atolls (Moffitt, 1993).

Bottomfish EFH and HAPC Designations. EFH has been designated for bottomfish in the egg and larval stages in the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 1,312 ft (400) m for all 17 species within this management unit. EFH for juvenile and adult bottomfish encompasses the water column and all bottom habitats extending from the shoreline to a depth of 1,312 ft (400 m). No HAPC has been designated for bottomfish in this Management Unit within the Study Area.

3.9.2.2.2 Pelagic Management Unit

Status. Thirty-three species are currently managed within the Pelagic Management Unit by the WPRFMC through the *Fishery Ecosystem Plan for the Pelagic Fisheries of the Western Pacific Region* (WPRFMC, 2005). These species are divided into the following species complex designations: temperate species, tropical species, and sharks. The designation of these complexes is based on the ecological relationships among the species and their preferred habitat (WPRFMC, 2005). The temperate species complex includes those pelagic species that are found in greater abundance outside tropical waters at higher latitudes (*e.g.*, broadbill swordfish [*Xiphias gladius*], bigeye tuna [*Thunnus obesus*], northern bluefin tuna [*T. thynnus*], and albacore tuna [*T. alalunga*]).

Currently, no data are available to determine if the species within the Pelagic Management Unit are approaching an overfished condition except for the bigeye tuna (NMFS, 2004a). NMFS (2004b) determined that overfishing was occurring Pacific-wide on this species. In addition, the shark species are afforded protection under the Shark Finning Prohibition Act (NMFS, 2002).

The broadbill swordfish, albacore tuna, common thresher shark (*Alopias vulpinus*), and salmon shark (*Lamna ditropis*) have been listed as data deficient on the IUCN Red List of threatened species (Safina, 1996; Uozumi 1996a; Goldman and Human, 2000; Goldman *et al.*, 2001). The shortfin mako shark (*Isurus oxyrinchus*), oceanic whitetip shark (*Caracharhinus longimanus*), and the blue shark (*Prionace glauca*) have been listed as near threatened (Smale, 2000a; Stevens, 2000a; 2000b). The bigeye tuna is listed as vulnerable (Uozumi, 1996b).

Distribution. Pelagic fish occur in tropical and temperate waters of the Western Pacific Ocean. Geographical distribution among the pelagic species is governed by seasonal changes in ocean temperature. These species range from as far north as Japan, to as far south as New Zealand. Albacore tuna, striped marlin (*Tetrapurus audax*), and broadbill swordfish have broader ranges and occur from 50°N to 50°S (WPRFMC, 1998).

Habitat Preferences. The pelagic species are typically found in epipelagic to pelagic waters; however, shark species can be found in inshore benthic (bottom habitats), neritic (nearshore) to epipelagic (open ocean shallow zone), and mesopelagic waters (open ocean zone with reduced light penetration). Oceanic zonation is discussed in Section 3.6 (Marine Communities). Gradients in temperature, oxygen, or salinity can affect the suitability of a habitat for pelagic fish. Skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*T. albacares*), and Indo-Pacific blue marlin (*Makaira nigricans*) prefer warm surface layers, where the water is well mixed and relatively uniform in temperature. Species such as albacore tuna, bigeye tuna, striped marlin, and broadbill swordfish prefer cooler temperate waters associated with higher latitudes and greater depths. Certain species are known to aggregate near the surface at night. However, during the day, broadbill swordfish can be found at depths of 2,624 ft (800 m), while bigeye tuna can be found around 902 to 1,804 ft (275 to 550 m). Juvenile albacore tuna generally concentrate above 295 ft (90 m) with adults found in deeper waters (295 to 902 ft [90 to 275 m]) (WPRFMC, 1998).

Life History. Migration and life history patterns of most pelagic fish are poorly understood in the Pacific Ocean. Additionally, very little is known about the distribution and habitat requirements of the juvenile life stages of tuna and billfish prior to recruitment into fisheries. Seasonal movements of cooler-water tunas such as the northern blue fin and albacore are more predictable and better defined than billfish migrations. Tuna and related species tend to move toward the poles during the warmer months and return to the equator during cooler months. Most pelagic species make daily vertical migrations, inhabiting surface waters at night and deeper waters during the day. Spawning for pelagic species generally occurs in tropical waters but may include temperate waters during warmer months. Very little is known about the life history stages of species that are not targeted by fisheries in the Pacific such as gempylids, sharks, and pomfrets (WPRFMC, 1998).

Pelagic Fish EFH and HAPC Designations. EFH has been designated for pelagic fish in the egg and larval stages in the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 656 ft (200 m) for all 33 fish within this management unit. EFH for juvenile and adult bottomfish encompasses the water column extending from the shoreline to a depth of 3,281 ft (1,000 m). HAPC designated for pelagic fish includes the entire water column to a depth of 3,281 ft (1,000 m) above all seamounts and banks with summits shallower than 6,562 ft (2,000 m) within the EEZ.

3.9.2.2.3 Crustacean Management Unit

Status. Five crustacean species are currently included in this Management Unit by the WPRFMC through the *Fishery Management Plan of the Spiny Lobster Fisheries of the Western Pacific Region* and the *Final*

Combined Fishery Management Plan, Environmental Impact Statement, Regulatory Analysis, and Draft Regulations for the Spiny Lobster Fisheries of the Western Pacific Region (WPRFMC, 1981; 1982) and subsequent amendments (WPRFMC, 1998). The spiny lobster (*Panulirus* spp.) is a main component of the inshore lobster catch (Hensley and Sherwood, 1993) and it is overfished on Guam (Paulay personal communication, as cited in DoN, 2005). None of the species found in the Study Area are listed on the IUCN Red List of threatened species (IUCN, 2004). The ridgeback slipper lobster (*Scyllarides haanii*) and the Kona crab (*Ranina ranina*) have not been recorded in the Marianas (Paulay personal communication, as cited in DoN, 2005).

Distribution. There are 839 species of crustaceans in the Marianas (Paulay *et al.*, 2003). Thirteen species of spiny lobster occur in the tropical and subtropical Pacific between 35°N and 35°S (Holthuis, 1991; WPRFMC, 1998). Five species of spiny lobsters occur in the Marianas and *P. penicillatus* is the most common species (WPRFMC, 2001; Paulay *et al.*, 2003).

Habitat Preferences. In general, adults of the crustacean species included in this Management Unit favor sheltered areas with rocky substrates and/or sandy bottoms. There are a lack of published data pertaining to the preferred depth distribution of decapod larvae and juveniles in this region (WPRFMC, 2001). The spiny lobster is mainly found in windward surf zones of oceanic reefs but some are also found on sheltered reefs (Pitcher, 1993). Adult spiny lobsters are typically found on rocky substrate in well-protected areas, such as crevices and under rocks (Holthuis, 1991; Pitcher, 1993). Some spiny lobsters prefer depths less than 33 ft (10 m), while others are found to depths of around 361 ft (110 m) (Holthuis, 1991; Pitcher, 1993; WPRFMC, 2001). Small juvenile spiny lobsters prefer the same habitat as larger individuals (Pitcher, 1993). The ridgeback spiny lobster likely inhabits rocky bottoms; it is known to occur from depths between 3 and 41 ft (10 and 135 m) (Holthuis, 1991). The depth distribution of the Chinese slipper lobster (*Parribacus antarcticus*) is 0 to 33 ft (0 to 10 m) and some are taken as incidental catch in the spiny lobster fishery (Polovina, 1993). The Chinese slipper lobster prefers to live in coral or stone reefs with a sandy bottom (Holthuis, 1991). The Kona crab is found in a number of environments, from sheltered bays and lagoons to surf zones, but prefers sandy habitat in depths of 79 to 377 ft (24 to 115 m) (Smith, 1993; Poupin, 1996; WPRFMC, 1998).

Life History. Decapods exhibit a wide range of feeding behaviors, but most combine nocturnal predation with scavenging; large invertebrates are the typical prey items (WPRFMC, 2001). Both lobsters and crabs are ovigerous (females carry fertilized eggs on the outside of the body). The relationships between egg production, larval settlement, and stock recruitments are poorly understood (WPRFMC, 1998; 2001). Spiny lobsters produce eggs in summer and fall. The larvae have a pelagic distribution of about one year and can be transported up to 2,302 mi (3,704 km) by prevailing ocean currents (WPRFMC, 1998). This species is nocturnal, hiding during the daytime in crevices in rocks and coral reefs. At night, this lobster moves up through the surge channels to forage on the reef crest and reef flat (Pitcher, 1993). The Kona crab spawns at least twice during the spawning season; there are insufficient data to define the exact spawning season in the Study Area (WPRFMC, 1998). This species remains buried in the substratum during the day, emerging only at night to search for food (Bellwood, 2002).

Crustacean EFH and HAPC Designations. EFH has been designated for crustaceans in the egg and larval stages in the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 492 ft (150 m) for all five species within this management unit. EFH for juvenile and adult crustaceans includes all bottom habitats from the shoreline to a depth of 328 ft (100 m). No HAPC has been designated for crustaceans in this Management Unit within the Study Area.

3.9.2.2.4 Coral Reef Ecosystem Management Unit

The Coral Reef Ecosystem Fishery Management Plan (CRE FMP) manages coral reef ecosystems surrounding the following U.S. Pacific Island areas: the State of Hawai'i, the Territories of American Samoa and Guam, the CNMI, and the Pacific remote island areas of Johnston Atoll, Kingman Reef, Palmyra and Midway Atolls, and Jarvis, Howland, Baker and Wake Islands (WPRFMC, 2001). Under this plan, 80 coral reef species are managed (WPRFMC, 2005).

In addition to EFH, WPRFMC also identified HAPC which are specific areas within EFH that are essential to the life cycle of important coral reef species. HAPC for all life stages of these species within this Management Unit includes all hardbottom substrate between 0 and 328 ft (0 and 100 m) depth in the Study Area. Five individual HAPC sites have been identified for the island of Guam, one of which, Jade Shoals, occurs within Apra Harbor. Orote Point Ecological Reserve Area lies immediately outside of Apra Harbor. The remaining three occur in the northern (Ritidian Point), northwest (Haputo Ecological Preserve), and southern (Cocos Lagoon) areas of the island (Research Planning Inc., 1994; WPRFMC, 2001). Within the CNMI, Saipan Lagoon off Saipan has been designated HAPC because it represents rare habitats, ecological function, susceptibility to human impact, and may be subject to future development impacts. The HAPC designations apply to all 80 species managed within this unit.

3.9.2.3 Sensitivity of Fish to Acoustic Energy

Fish, like other vertebrates, have a variety of different sensory systems that enable them to glean information from the world around them (see volumes by Atema *et al.* [1988] and by Collin and Marshall [2003] for thorough reviews of fish sensory systems). While each of the sensory systems may have some overlap in providing a fish with information about a particular stimulus (*e.g.*, an animal might see and hear a predator), different sensory systems may be most appropriate to serve an animal in a particular situation. Thus, vision is often most useful when a fish is close to the source of the signal, in daylight, and when the water is clear. However, vision does not work well at night, or in deep waters. Chemical signals can be highly specific (*e.g.*, a particular pheromone used to indicate danger). However, chemical signals travel slowly in still water, and diffusion of the chemicals depends upon currents and so chemical signals are not directional and, in many cases, they may diffuse quickly to a nondetectable level. As a consequence, chemical signals may not be effective over long distances.

In contrast, acoustic signals in water travel very rapidly, travel great distances without substantially attenuating (declining in level) in open water, and they are highly directional. Thus, acoustic signals provide the potential for two animals that are some distance apart to communicate quickly (reviewed in Zelick *et al.,* 1999; Popper *et al.,* 2003).

Since sound is potentially such a good source of information, fish have evolved two sensory systems to detect acoustic signals, and many species use sound for communication (*e.g.*, mating, territorial behavior – see Zelick *et al.* [1999] for review). The two systems are the ear, for detection of sound above perhaps 20 hertz (Hz) to 1 kilohertz (kHz) or more, and the lateral line for detection of hydrodynamic signals (water motion) from less than 1 Hz to perhaps 100 or 200 Hz. The inner ear in fish functions very much like the ear found in all other vertebrates, including mammals. The lateral line, in contrast, is only found in fish and a few amphibian (frogs) species. It consists of a series of receptors along the body of the fish. Together, the ear and lateral line are often referred to as the octavolateralis system.

3.9.2.3.1 Sound in Water

The basic physical principles of sound in water are the same as sound in air (see Rogers and Cox, 1988; Kalmijn, 1988, Kalmijn, 1989). Any sound source produces both pressure waves and actual motion of the medium particles. However, whereas in air the actual particle motion attenuates very rapidly and is often inconsequential even a few centimeters from a sound source, particle motion travels (propagates) much further in water due to the much greater density of water than air. One, therefore, often sees reference to the “acoustic near field” and the “acoustic far field” in the literature on fish hearing, with the former referring to the particle motion component of the sound and the latter the pressure. There is often the misconception that the near field component is only present close to the source. Indeed, all propagating sound in water has both pressure and particle motion components, but after some distance, often defined as the point at a distance of wavelength of the sound divided by 2 pi ($\lambda/2\pi$), the pressure component of the signal dominates, though particle motion is still present and potentially important for fish (*e.g.*, Rogers and Cox, 1988; Kalmijn, 1988; Kalmijn, 1989). For a 500 Hz signal, this point is about 1.5 ft (0.5 m) from the source.

The critical point to note is that some fish detect both pressure and particle motion, whereas terrestrial vertebrates generally only detect pressure. Fish directly detect particle motion using the inner ear (see below). Pressure signals, however, are initially detected by the gas-filled swim bladder or other bubble of air in the body. The air bubble then vibrates and therefore serves as a small sound source which “reradiates” (or resends) the signal to the inner ear as a near field particle motion. Note, the ear can only detect particle motion directly, and it needs the air bubble to produce particle motion from the pressure component of the signal.

If a fish is able to only detect particle motion, it is most sensitive to sounds when the source is nearby due to the substantial attenuation of the particle motion signal as it propagates away from the sound source. As the signal level gets lower (further from the source), the signal ultimately gets below the minimum level detectable by the ear (the threshold). Fish that detect both particle motion and pressure generally are more sensitive to sound than are fish that only detect particle motion. This is the case since the pressure component of the signal attenuates much less over distance than does the particle motion, although both particle motion and pressure are always present in the signal as it propagates from the source.

One very critical difference between particle motion and pressure is that fish pressure signals are not directional. Thus, for fish, as to any observer with a single pressure detector, pressure does not appear to come from any direction (*e.g.*, Popper *et al.*, 2003; Fay, 2005). In contrast, particle motion is highly directional and this is detectable by the ear itself. Accordingly, fish appear to use the particle motion component of a sound field to glean information about sound source direction. This makes particle motion an extremely important signal to fish.

Since both pressure and particle motion are important to fish, it becomes critical that in design of experiments to test the effects of sound on fish (and fish hearing in general), the signal must be understood not only in terms of its pressure levels, but also in terms of the particle motion component. This has not been done in most experiments on effects of human-generated sound to date, with the exception of one study on effects of seismic airguns on fish (Popper *et al.*, 2005).

3.9.2.3.2 What Do Fish Hear?

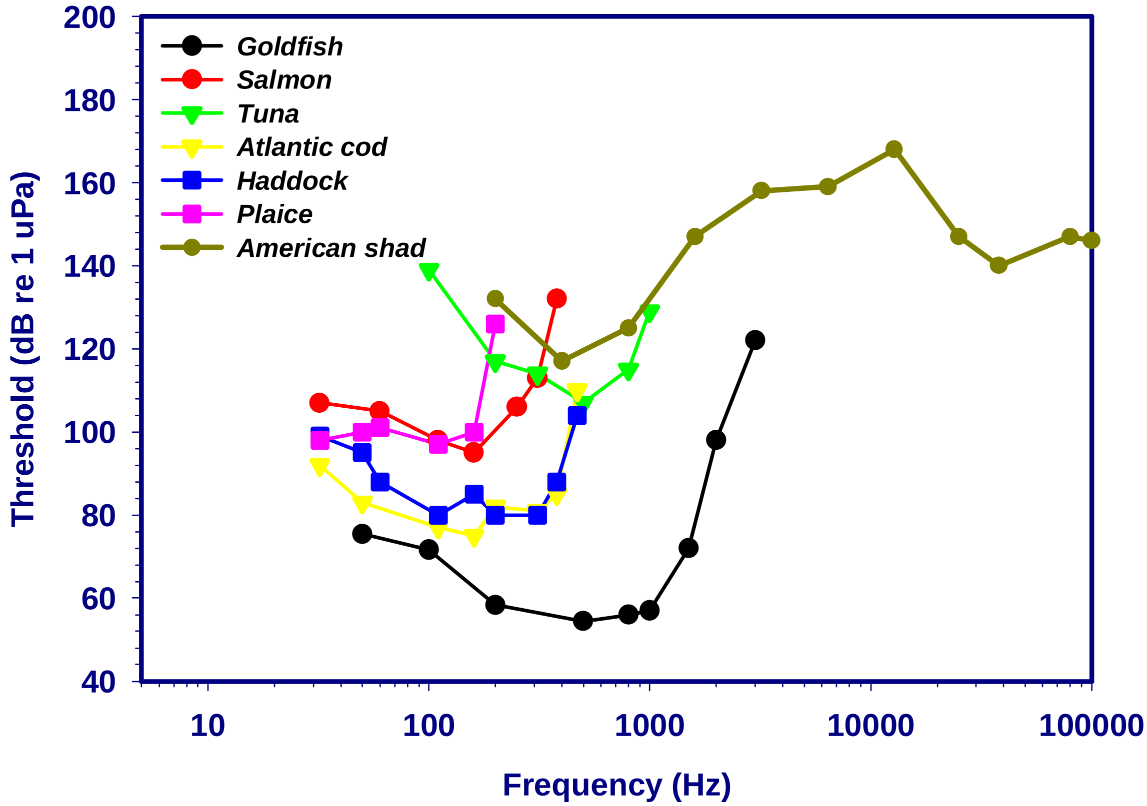
Basic data on hearing provides information about the range of frequencies that a fish can detect, and the lowest sound level that an animal is able to detect at a particular frequency; this level is often called the “threshold.” Sounds that are above threshold are detectable by fish. It therefore follows that if a fish can hear a biologically irrelevant human-generated sound (*e.g.*, sonar, ship noise), such sound might interfere with the ability of fish to detect other biologically relevant signals. In effect, anthropogenic sounds and explosions may affect behavior, and result in short- and long-term tissue damage, but only at significantly high levels. Importantly, to date there has not been any experimental determination of an association of such effects from military mid- and high-frequency active sonars.

Hearing thresholds have been determined for perhaps 100 of the more than 29,000 living fish species (Figure 3.9-1) (see Fay, 1988; Popper *et al.*, 2003; Ladich and Popper, 2004; Nedwell *et al.*, 2004 for data on hearing thresholds). These studies show that, with few exceptions, fish cannot hear sounds above about 3 to 4 kHz, and that the majority of species are only able to detect sounds to 1 kHz or even below. In contrast, a healthy young human can detect sounds to about 20 kHz, and dolphins and bats can detect sounds to well over 100 kHz. There have also been studies on a few species of cartilaginous fish, with results suggesting that they detect sounds to no more than 600 or 800 Hz (*e.g.*, Fay 1988; Casper *et al.*, 2003).

Besides being able to detect sounds, a critical role for hearing is to be able to discriminate between different sounds (*e.g.*, frequency and intensity), detect biologically relevant sounds in the presence of background noises, and determine the direction and location of a sound source in the space around the animal. While data are available on these tasks for only a few fish species, all species studied appear to be able to discriminate sounds of different intensities and frequencies (reviewed in Fay and Megela-Simmons, 1999; Popper *et al.*, 2003) and perform sound source localization (reviewed in Popper *et al.*, 2003; Fay, 2005).

Fish are also able to detect signals in the presence of background noise (reviewed in Fay and Megela-Simmons, 1999; Popper *et al.*, 2003). The results of these studies show that fish hearing is affected by the presence of background noise that is in the same general frequency band as the biologically relevant signal. In other words, if a fish has a particular threshold for a biologically relevant sound in a quiet environment, and a background noise that contains energy in the same frequency range is introduced, this will decrease the ability of the fish to detect the biologically relevant signal. In effect, the threshold for the biologically relevant signal will become poorer.

The significance of this finding is that if background noise is increased, such as a result of human-generated sources, it may be harder for a fish to detect the biologically relevant sounds that it needs to survive.



Note: Goldfish and American shad are species with specializations (hearing specialists) that enhance hearing sensitivity and/or increase the range of sounds detectable by the animal. The other species are hearing generalists. Most of these data were obtained using methods where fish were conditioned to respond to a sound when it was present. Each data point represents the lowest sound level (threshold) the species could detect at a particular frequency. Data for American shad are truncated at 100 kHz so as to keep the size of the graph reasonable, but it should be noted that this species can hear sounds to at least 180 kHz (Mann *et al.*, 1997). Note that these data represent pressure thresholds, despite the fact that some of the species (*e.g.*, salmon, tuna) are primarily sensitive to the particle motion component of a sound field, something that was not generally measured at the time of the studies.

Figure 3.9-1: Hearing Curves (audiograms) for Select Teleost Fish

(refer to Fay, 1988 and Nedwell et al., 2004 for data).

Sound Detection Mechanisms. While bony and cartilaginous fish have no external structures for hearing, such as the human pinna (outer ear), they do have an inner ear which is similar in structure and function to the inner ear of terrestrial vertebrates (i.e., inner ear with sensory hair cells). The outer and middle ears of terrestrial vertebrates serve to change the impedance of sound traveling in air to that of the fluids of the inner ear. However, since fish already live in a fluid environment, there is no need for impedance matching to stimulate the inner ear. At the same time, since the fish ear and body are the same density as water, they will move along with the sound field. While this might result in the fish not detecting the sound, the ear also contains very dense calcareous structures, the otoliths, which move at a different amplitude and phase from the rest of the body. This provides the mechanism by which fish hear.

The ear of a fish has three semicircular canals that are involved in determining the angular movements of the fish. The ear also has three otolith organs, the saccule, lagena, and utricle, that are involved in both determining the position of the fish relative to gravity and detection of sound and information about such sounds. Each of the otolith organs contains an otolith that lies in close proximity to a sensory epithelium.

The sensory epithelium (or macula) in each otolith organ of fish contains mechanoreceptive sensory hair cells that are virtually the same as found in the mechanoreceptive cells of the lateral line and in the inner ear of terrestrial vertebrates. All parts of the ear have the same kind of cell to detect movement, whether it be movement caused by sound or movements of the head relative to gravity.

Hearing Generalists and Specialists. Very often, fish are referred to as “hearing generalists” (or nonspecialists) or “hearing specialists” (e.g., Fay, 1988; Popper et al., 2003; Ladich and Popper, 2004). Hearing generalists generally detect sound to no more than 1 to 1.5 kHz, whereas specialists are generally able to detect sounds to above 1.5 kHz (see Figure 3.9-1). And, in the frequency range of hearing that the specialists and generalists overlap, the specialists generally have lower thresholds than generalists, meaning that they can detect quieter (lower intensity) sounds. Furthermore, it has often been suggested that generalists only detect the particle motion component of the sound field, whereas the specialists detect both particle motion and pressure (see Popper et al., 2003).

However, while the terms hearing generalist and specialist have been useful, it is now becoming clear that the dichotomy between generalists and specialists is not very distinct. Instead, investigators are now coming to the realization that many species that do not hear particularly well still detect pressure as well as particle motion and pressure. However, these species often have poorer pressure detection than those fish that have a wider hearing bandwidth and greater sensitivity (see Popper and Schilt, 2008).

It is important to note that hearing specialization is not limited to just a few fish taxa. Instead, there are hearing specialists that have evolved in many very diverse fish groups. Moreover, there are instances where one species hears very well while a very closely related species does not hear well. The only “generalizations” that one can make is that all cartilaginous fish are likely to be hearing generalists, while all otophysan fish (goldfish, catfish, and relatives) are hearing specialists. It is also likely that bony fish without an air bubble such as a swim bladder (see below) are, like cartilaginous fish, hearing generalists. These fish include all flatfish, some tuna, and a variety of other taxonomically diverse species.

Ancillary Structures for Hearing Specializations. All species of fish respond to sound by detecting relative motion between the otoliths and the sensory hair cells. However, many species, and most effectively the hearing specialists, also detect sounds using the air-filled swim bladder in the abdominal cavity. The swim bladder is used for a variety of different functions in fish. It probably evolved as a mechanism to maintain buoyancy in the water column, but later evolved to have multiple functions.

The other two roles of the swim bladder are in sound production and hearing (*e.g.*, Zelick *et al.*, 1999; Popper *et al.*, 2003). In sound production, the air in the swim bladder is vibrated by the sound producing structures (often muscles that are integral to the swim bladder wall) and serves as a radiator of the sound into the water (see Zelick *et al.*, 1999).

For hearing, the swim bladder serves to re-radiate sound energy to the ear. This happens since the air in the swim bladder is of a very different density than the rest of the fish body. Thus, in the presence of sound the air starts to vibrate. The vibrating gas re-radiates energy which then stimulates the inner ear by moving the otolith relative to the sensory epithelium. However, in species that have the swim bladder some distance from the ear, any re-radiated sound attenuates a great deal before it reaches the ear. Thus, these species probably do not detect the pressure component of the sound field as well as fish where the swim bladder comes closer to the ear.

In contrast, hearing specialists always have some kind of acoustic coupling between the swim bladder and the inner ear to reduce attenuation and assure that the signal from the swim bladder gets to the ear. In the goldfish and its relatives, the otophysan fish, there is a series of bones, the Weberian ossicles, which connect the swim bladder to the ear. When the walls of the swim bladder vibrate in a sound field, the ossicles move and carry the sound directly to the inner ear. Removal of the swim bladder in these fish results in a drastic loss of hearing range and sensitivity (reviewed in Popper *et al.*, 2003).

Besides species with Weberian ossicles, other fish have evolved a number of different strategies to enhance hearing. For example, the swim bladder may have one or two anterior projections that actually contact one of the otolith organs. In this way, the motion of the swim bladder walls directly couples to the inner ear of these species (see discussion in Popper *et al.*, 2003).

Lateral Line. The lateral line system is a specialized sensory receptor found on the body that enables detection of the hydrodynamic component of a sound field or other water motions relative to the fish (reviewed in Coombs and Montgomery, 1999; Webb et al., 2008). The lateral line is most sensitive to stimuli that occur within a few body lengths of the animal and to signals that are from below 1 Hz to a few hundred Hz (Coombs and Montgomery, 1999; Webb et al., 2008). The lateral line is involved with schooling behavior, where fish swim in a cohesive formation with many other fish and it is also involved with detecting the presence of nearby moving objects, such as food. Finally, the lateral line is an important determinant of current speed and direction, providing useful information to fish that live in streams or where tidal flows dominate.

The only study on the effect of exposure to sound on the lateral line system suggests no effect on these sensory cells by very intense pure tone signals (Hastings *et al.*, 1996). However, since this study was limited to one (freshwater) species and only to pure tones, extrapolation to other sounds is not warranted and further work needs to be done on any potential lateral line effects on other species and with other types of sounds.

Overview of Fish Hearing Capabilities. Determination of hearing capability has only been done for fewer than 100 of the more than 29,000 fish species (Fay, 1988; Popper et al., 2003; Ladich and Popper, 2004; Nedwell et al., 2004). Much of these data is summarized in Table 3.9-2 for species of marine fish that have been studied and that could potentially be in areas where sonar or other Navy sound sources might be used. The data provided in Table 3.9-2 are hearing thresholds in terms of pressure, not particle velocity. This data set, while very limited, suggests that the majority of marine species are hearing generalists, although it must be kept in mind that there are virtually no data for species that live at great ocean depths and it is possible that such species, living in a lightless environment, may have evolved excellent hearing to help them get an auditory “image” of their environment (e.g., Popper, 1980).

Table 3.9-2: Hearing Ranges of Fish

Family	Description of Family	Common Name	Scientific Name	Hearing Range (Hz) Low	Hearing Range (Hz) High	Best Sensitivity (Hz)	Reference
Albulidae	Bonefish	Bonefish	*Albula vulpes*	100	700	300	Tavolga, 1974a
Anguillidae	Eels	European eel	*Anguilla anguilla*	10	300	40-100	Jerkø *et al.*, 1989
Ariidae	Catfish	Hardhead sea catfish	*Ariopsis felis* [1]	50	1,000	100	Popper and Tavolga, 1981
Batrachoididae	Toadfish	Midshipman[2]	*Porichthys notatus*	65	385		Sisneros, 2007
		Oyster toadfish	*Opsanus tau*	100	800	200	Fish and Offutt, 1972
		Gulf toadfish	*Opsanus beta*			<1,000	Remage-Healy *et al.*, 2006
Clupeidae	Herrings, shads, menhaden, sardines	Alewife	*Alosa pseudoharengus*		120+		Dunning *et al.*, 1992
		Blueback herring	*Alosa aestivalis*		120+		Dunning *et al.*, 1992
		American shad	*Alosa sapidissima*	0.1	180	200-800 and 25-150	Mann *et al.*, 1997
		Gulf menhaden	*Brevoortia patronus*		100+		Mann *et al.*, 2001
		Bay anchovy	*Anchoa mitchilli*		4,000		Mann *et al.*, 2001
		Scaled sardine	*Harengula jaguana*		4,000		Mann *et al.*, 2001
		Spanish sardine	*Sardinella aurita*		4,000		Mann *et al.*, 2001
		Pacific herring	*Clupea pallasii*	100	5,000		Mann *et al.*, 2005
Chondrichthyes [Class]	Rays, sharks, skates	Data are for several different species		200	1,000		See Fay, 1988; Casper *et al.*, 2003
Cottidae	Sculpins	Long-spined bullhead	*Taurulus bubalis*	*Hearing generalists*			Lovell *et al.*, 2005
Gadidae	Cods, gadiforms, grenadiers, hakes	Atlantic Cod	*Gadus morhua*	2	500	20	Chapman and Hawkins, 1973; Sand and Karlsen, 1986
		Ling	*Molva molva*	60	550	200	Chapman, 1973
		Pollack	*Pollachius pollachius*	40	470	60	Chapman, 1973

[1] Formerly *Arius felis*

[2] Data obtained using saccular potentials, a method that does not necessarily reveal the full bandwidth of hearing.

Table 3.9-2: Hearing Ranges of Fish (Continued)

Family	Description of Family	Common Name	Scientific Name	Hearing Range (Hz) Low	Hearing Range (Hz) High	Best Sensitivity (Hz)	Reference
		Haddock	*Melanogrammus aeglefinus*	40	470	110-300	Chapman, 1973
Gobidae	Gobies	Black goby	*Gobius niger*	100	800		Dijkgraaf, 1952
Holocentridae	Squirrelfish and soldierfish	Shoulderbar soldierfish	*Myripristis kuntee*	100	3,000	400-500	Coombs and Popper 1979
		Hawaiian squirrelfish	*Sargocentron xantherythrum**	100	800		Coombs and Popper, 1979
		Squirrelfish	*Holocentrus adscensionis**	100	2,800	600-1,000	Tavolga and Wodinsky, 1963
		Dusky squirrelfish	*Sargocentron vexillarium**	100	1,200	600	Tavolga and Wodinsky, 1963
Labridae	Wrasses	Tautog	*Tautoga onitis*	10	500	37 - 50	Offutt, 1971
		Blue-head wrasse	*Thalassoma bifasciatum*	100	1,300	300 – 600	Tavolga and Wodinksy, 1963
Lutjanidae	Snappers	Schoolmaster snapper	*Lutjanus apodus*	100	1,000	300	Tavolga and Wodinksy, 1963
Myctophidae[3]	Lanternfish	Warming's lanternfish	*Ceratoscopelus warmingii*	*Specialist*			Popper, 1977
Pleuronectidae	Flatfish[4]	Dab	*Limanda limanda*	30	270	100	Chapman and Sand, 1974
		European plaice	*Pleuronectes platessa*	30	200	110	
Pomadasyidae	Grunts	Blue striped grunt	*Haemulon sciurus*	100	1,000	-	Tavolga and Wodinsky, 1963
Pomacentridae	Damselfish[5]	Sergeant major damselfish	*Abudefduf saxatilis*	100	1,600	100-400	Egner and Mann, 2005
		Bicolor damselfish	*Stegastes partitus*	100	1,000	500	Myrberg and Spires, 1980
		Nagasaki damselfish	*Pomacentrus nagasakiensis*	100	2,000	<300	Wright *et al.,* 2005, 2007

[3] Several other species in this family also showed saccular specializations suggesting that the fish would be a hearing specialist. However, no behavioral or physiological data are available.

[4] Note: Data for these species should be expressed in particle motion since it has no swim bladder. See Chapman and Sand, 1974 for discussion.

[5] Formerly all members of this group were *Eupomocentrus*. Some have now been changed to *Stegatus* and are so indicated in this table (as per www.fishbase.org).

Table 3.9-2: Hearing Ranges of Fish (Continued)

Family	Description of Family	Common Name	Scientific Name	Hearing Range (Hz) Low	Hearing Range (Hz) High	Best Sensitivity (Hz)	Reference
		Threespot damselfish	*Stegatus planifrons**	100	1,200	500-600	Myrberg and Spires, 1980
		Longfish damselfish	*Stegatus diencaeus**	100	1,200	500-600	Myrberg and Spires, 1980
		Honey gregory	*Stegatus diencaeus**	100	1,200	500-600	Myrberg and Spires, 1980
		Cocoa damselfish	*Stegatus variabilis**	100	1,200	500	Myrberg and Spires, 1980
		Beaugregory[6]	*Stegatus leucostictus**	100	1,200	500-600	Myrberg and Spires, 1980
		Dusky damselfish	*Stegastes adustus**, [7]	100	1,200	400-600	Myrberg and Spires, 1980
Salmonidae	Salmons	Atlantic salmon	*Salmo salar*	<100	580	-	Hawkins and Johnstone, 1978; Knudsen *et al.,* 1994
Sciaenidae	Drums, weakfish, croakers	Atlantic croaker	*Micropogonias undulatus*	100	1,000	300	Ramcharitar and Popper, 2004
		Spotted seatrout	*Cynoscion nebulosus*	*Generalist*			Ramcharitar *et al.,* 2001
		Southern kingcroaker	*Menticirrhus americanus*	*Generalist*			Ramcharitar *et al.,* 2001
		Spot	*Leiostomus xanthurus*	200	700	400	Ramcharitar *et al.,* 2006a
		Black drum	*Pogonias cromis*	100	800	100-500	Ramcharitar and Popper, 2004
		Weakfish	*Cynoscion regalis*	200	2,000	500	Ramcharitar *et al.,* 2006a
		Silver perch	*Bairdiella chrysoura*	100	4,000	600-800	Ramcharitar *et al.,* 2004
		Cubbyu	*Pareques acuminatus*	100	2,000	400-1,000	Tavolga and Wodinsky, 1963
Scombridae	Albacores, bonitos, mackerels, tunas	Bluefin tuna	*Thunnus thynnus*	*Generalist*			Song *et al.,* 2006
		Yellowfin tuna	*Thunnus albacares*	500	1,100		Iversen, 1967
		Kawakawa	*Euthynnus affinis*	100	1,100	500	Iversen, 1969

[6] Similar results in Tavolga and Wodinsky, 1963.

[7] Formerly *Eupomacentrus dorsopunicans*.

Table 3.9-2: Hearing Ranges of Fish (Continued)

Family	Description of Family	Common Name	Scientific Name	Hearing Range (Hz) Low	High	Best Sensitivity (Hz)	Reference
		Skipjack tuna	*Katsuwonus pelamis*	*Generalist*			Popper, 1977
Serranidae	Seabasses, groupers	Red hind	*Epinephelus guttatus*	100	1,100	200	Tavolga and Wodinsky, 1963
Sparidae	Porgies	Pinfish	*Lagodon rhomboides*	100	1,000	300	Tavolga, 1974b
Triglidae	Scorpionfish, searobins, sculpins	Leopard searobin	*Prionotus scitulus*	100	~800	390	Tavolga and Wodinsky, 1963

Data were compiled from reviews in Fay (1988) and Nedwell *et al.* (2004). See the very important caveats about the data in the text. For a number of additional species, we can only surmise about hearing capabilities from morphological data. These data are shown in gray, with a suggestion as to hearing capabilities based only on morphology. Scientific names marked with an asterisk have a different name in the literature. The updated names come from www.fishbase.org.

While it is hard to generalize as to which fish taxa are hearing generalists or specialists since specialists have evolved in a wide range of fish taxa (see, for example, Holocentridae and Sciaenidae in Table 3.9-2), there may be some broad generalizations as to hearing capabilities of different groups. For example, it is likely that all, or the vast majority of species, in the following groups would have hearing capabilities that would include them as hearing generalists. These include cartilaginous fish (Casper *et al.*, 2003; Casper and Mann, 2006; Myrberg, 2001), scorpaeniforms (*i.e*., scorpionfish, searobins, sculpins) (Tavolga and Wodinsky, 1963), scombrids (*i.e*., albacores, bonitos, mackerels, tunas) (Iversen, 1967; Iversen, 1969; Song *et al.*, 2006), and more specifically, midshipman fish (*Porichthys notatus*) (Sisneros and Bass, 2003), Atlantic salmon (*Salmo salar*) (Hawkins and Johnstone, 1978) and other salmonids (*e.g*., Popper *et al.*, 2007), and all toadfish in the family Batrachoididae (see Table 3.9-2 for species).

Marine hearing specialists include some Holocentridae ("soldierfish" and "squirrelfish") (Coombs and Popper, 1979) and some Sciaenidae (drums and croakers) (reviewed in Ramcharitar *et al.*, 2006b) (see Table 3.9-2). In addition, all of the clupeids (herrings, shads, alewives, anchovies) are able to detect sounds to over 3 kHz. And, more specifically, members of the clupeid family Alosinae, which includes menhaden and shad, are able to detect sounds to well over 100 kHz (*e.g.*, Enger, 1967; Mann *et al.,* 2001; Mann *et al.,* 2005).

Variability in Hearing Among Groups of Fish. Hearing capabilities vary considerably between different fish species (Figure 3.9-1), and there is no clear correlation between hearing capability and environment, even though some investigators (e.g., Amoser and Ladich, 2005) have argued that the level of ambient noise in a particular environment might have some impact on hearing capabilities of a species. However, the evidence for this suggestion is very limited, and there are species that live in close proximity to one another, and which are closely related taxonomically, that have different hearing capabilities. This is widely seen within the family Sciaenidae, where there is broad diversity in hearing capabilities and hearing structures (data reviewed in Ramcharitar et al., 2006b). This is also seen in the family Holocentridae. In this group, the shoulderbar soldierfish (Myripristis kuntee) and the Hawaiian squirrelfish (Sargocentron xantherythrum) live near one another on the same reefs, yet Sargocentron detects sounds from below 100 Hz to about 800 Hz, whereas Myripristis is able to detect sounds from 100 Hz to over 3 kHz, and it can hear much lower intensity sounds than can Sargocentron (Coombs and Popper, 1979, see also Tavolga and Wodinsky, 1963).

Among all fish studied to date, perhaps the greatest variability has been found within the economically important 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 (all data on hearing and sound production in Sciaenidae is reviewed in Ramcharitar *et al.*, 2006b) (see Table 3.9-2). Specifically, the Atlantic croaker's (*Micropogonias undulatus*) swim bladder comes near the ear but does 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 (Ramcharitar *et al.*, 2006b). Ramcharitar and Popper (2004) found that the black drum detects sounds from 0.1 to 0.8 kHz and was most sensitive between 0.1 and 0.5 kHz, while the Atlantic croaker detects sounds from 0.1 to 1.0 kHz and was most sensitive at 0.3 kHz. Additionally, Ramcharitar *et al.* (2006a) found that weakfish (*Cynoscion regalis*) is able to detect frequencies up to 2.0 kHz, while spot can hear only up to 0.7 kHz.

The sciaenid with the greatest hearing sensitivity discovered thus far is the silver perch (*Bairdiella chrysoura*), a species which has auditory thresholds similar to goldfish and which is able to respond to sounds up to 4.0 kHz (Ramcharitar *et al.*, 2004). Silver perch swim bladders have anterior horns that terminate close to the ear.

Marine Hearing Specialists. The majority of marine fish studied to date are hearing generalists. However, a few species have been shown to have a broad hearing range suggesting that they are specialists. These include some holocentrids and sciaenids, as discussed above. There is also evidence, based on structure of the ear and the relationship between the ear and the swim bladder that at least some deep-sea species, including myctophids, may be hearing specialists (Popper, 1977; Popper, 1980), although it has not been possible to do actual measurements of hearing on these fish from great depths.

The most significant studies have shown that all herring-like fish (order Clupeiformes) are hearing specialists and able to detect sounds to at least 3 to 4 kHz, and that some members of this order, in the sub-family Alosinae, are able to detect sounds to over 180 kHz (Figure 3.9-1) (Mann *et al.*, 1997, 1998, 2001, 2005; Gregory and Clabburn, 2003). Significantly, there is evidence that detection of ultrasound (defined by the investigators as sounds over 20 kHz) in these species is mediated through one of the otolithic organs of the inner ear, the utricle (Higgs *et al.*, 2004; Plachta *et al.*, 2004). While there is no evidence from field studies, laboratory data leads to the suggestion that detection of ultrasound probably arose to enable these fish to hear the echolocation sounds of odontocete predators and avoid capture (Mann *et al.*, 1998; Plachta and Popper, 2003). This is supported by field studies showing that several Alosinae clupeids avoid ultrasonic sources. These include the 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*) (Mann *et al.*, 1997, 1998, 2001). Thus, masking of ultrasound by mid- or high-frequency sonar could potentially affect the ability of these species to avoid predation.

Although few non-clupeid species have been tested for ultrasound (Mann *et al.*, 2001), the only non-clupeid species shown to possibly be able to detect ultrasound is the cod (*Gadus morhua*) (Astrup and Møhl, 1993). However, in Astrup and Møhl'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 Møhl (1993) indicated that cod have ultrasound thresholds of up to 38 kHz at 185 to 200 dB re 1 µPa-m, which likely only allows for detection of odontocete's clicks at distances no greater than 33 to 98 ft (10 to 30 m) (Astrup, 1999).

Finally, while most otophysan species are freshwater, a few species inhabit marine waters. In the one study of such species, Popper and Tavolga (1981) determined that the hardhead sea catfish (*Ariopsis felis*) was able to detect sounds from 0.05 to 1.0 kHz, which is a narrower frequency range than that common to freshwater otophysans (*i.e.*, above 3.0 kHz) (Popper *et al.*, 2003). However, hearing sensitivity below about 500 Hz was much better in the hardhead sea catfish than in virtually all other hearing specialists studied to date (Table 3.9-2, Fay, 1988; Popper *et al.*, 2003).

Marine Hearing Generalists. As mentioned above, investigations into the hearing ability of marine bony fish have most often yielded results exhibiting a narrower hearing range and less sensitive hearing than specialists. This was first demonstrated in a variety of marine fish by Tavolga and Wodinsky (1963), and later demonstrated in taxonomically and ecologically diverse marine species (reviews in Fay, 1988; Popper et al., 2003; Ladich and Popper, 2004).

By examining the morphology of the inner ear of bluefin tuna (*Thunnus thynnus*), Song *et al.* (2006) hypothesized that this species probably does 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. albacares*) 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 affinis*) 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 non-existent (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 2 in. [50 mm]) 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 responses 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 below 0.3 kHz (Wright *et al.*, 2005, 2007). Thus, damselfish appear to be primarily generalists.

Female oyster toadfish (*Opsanus tau*) apparently use the auditory sense to detect and locate vocalizing males during the breeding season (*e.g.*, Winn, 1967). Interestingly, female midshipman fish (*Porichthys notatus*) (in the same family as the oyster toadfish) 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 (*Salmo salar*) indicates relatively poor sensitivity to sound (Hawkins and Johnstone, 1978). Laboratory experiments yielded responses only to 580 Hz and only at high sound levels. The Atlantic salmon is considered to be a hearing generalist, and this is probably the case for all other salmonids studied to date based on studies of hearing (*e.g.*, Popper *et al.*, 2007; Wysocki *et al.*, 2007) and inner ear morphology (*e.g.*, Popper, 1976, 1977).

Furthermore, investigations into the inner ear structure of the long-spined bullhead (*Taurulus bubalis*, order Scorpaeniformes) have suggested that these fish have generalist hearing abilities, and this is supported by their lack of a swim bladder (Lovell *et al.*, 2005). While it is impossible to extrapolate from this species to all members of this large group of taxonomically diverse fish, studies of hearing in another species in this group, the leopard sea robin (*Prionotus scitulus*), suggest that it is probably not able to detect sound to much above 800 Hz, indicating that it would be a hearing generalist (Tavolga and Wodinsky, 1963). However, since the leopard sea robin has a swim bladder, and the long-spined bullhead does not, this illustrates the diversity of species in this order and makes extrapolation on hearing from these two fish to all members of the group very difficult to do.

A number of hearing generalists can detect very low frequencies of sound. Detection of very low frequencies, or infrasound, was not investigated until fairly recently since most laboratory sound sources were unable to produce undistorted tones below 20 to 30 Hz. In addition, earlier measurements of fish hearing indicated a steadily declining sensitivity towards lower frequencies (Fay, 1988), suggesting that fish would not detect low frequencies. However, as has been pointed out in the literature, often the problem with measuring lower frequency hearing (*e.g.*, below 50 or 100 Hz) was simply that the sound sources available (underwater loud speakers) were not capable of producing lower frequency sounds, or the acoustics of the tanks in which the studies were conducted prevented lower frequency sounds from being effectively used.

Infrasound sensitivity in fish was first demonstrated in the Atlantic cod (*Gadus morhua*) (Sand and Karlsen, 1986). This species can detect sounds down to about 10 Hz and is sensitive to particle motion of the sound field and not to pressure. Other species shown to detect infrasound include the plaice flatfish (*Pleuronectes platessa*) (Karlsen, 1992), and the European eel (*Anguilla anguilla*) (Sand *et al.,* 2000).

The sensitivity of at least some species of fish to infrasound may theoretically provide the animals with a wide range of information about the environment than detection of somewhat higher frequencies. An obvious potential use for this sensitivity is detection of moving objects in the surroundings, where infrasound could be important in, for instance, courtship and prey-predator interactions. Juvenile salmonids display strong avoidance reactions to nearby infrasound (Knudsen *et al.*, 1992, 1994), and it is reasonable to suggest that such behavior has evolved as a protection against predators.

More recently, Sand and Karlsen (2000) proposed the hypothesis that fish may also use the ambient infrasounds in the ocean, which are produced by things like waves, tides, and other large-scale motions, for orientation during migration. This would be in the form of an inertial guidance system where the fish detect surface waves and other large scale infrasound motions as part of their system to detect linear acceleration, and in this way migrate long distances.

An important issue with respect to infrasound relates to the distance at which such signals are detected. It is clear that fish can detect such sounds. However, behavioral responses only seem to occur when fish are well within the acoustic near field of the sound source. Thus, it is likely that the responses are to the particle motion component of the infrasound.

Hearing Capabilities of Elasmobranchs and Other "Fish". Bony fish are not the only species that may be impacted by environmental sounds. The two other groups to consider are the jawless fish (Agnatha – lamprey) and the cartilaginous fish (i.e., elasmobranchs; the sharks and rays). While there is some lamprey in the marine environment, virtually nothing is known as to whether they hear or not. They do have ears, but these are relatively primitive compared to the ears of other vertebrates. No one has investigated whether the ear can detect sound (reviewed in Popper and Hoxter, 1987).

The cartilaginous fish are important parts of the marine ecosystem and many species are top predators. While there have been some studies on their hearing, these have not been extensive. However, available data suggests detection of sounds from 0.02 to 1 kHz, with best sensitivity at lower ranges (Myrberg, 2001; Casper *et al.,* 2003; Casper and Mann, 2006). Though fewer than 10 elasmobranch species have been tested for hearing thresholds (reviewed in Fay, 1988), it is likely that all elasmobranchs only detect low-frequency sounds because they lack a swim bladder or other pressure detector. At the same time, the ear in a number of elasmobranch species whose hearing has not been tested is very large with numerous sensory hair cells (*e.g.*, Corwin, 1981, 1989). Thus, it is possible that future studies will demonstrate somewhat better hearing in those species than is now known.

There is also evidence that elasmobranchs can detect and respond to human-generated sounds. Myrberg and colleagues did experiments in which they played back sounds and attracted a number of different shark species to the sound source (*e.g.*, Myrberg *et al.*, 1969, 1972, 1976; Nelson and Johnson, 1972). The results of these studies showed that sharks were attracted to pulsed low-frequency sounds (below several hundred Hz), in the same frequency range of sounds that might be produced by struggling prey (or divers in the water). However, sharks are not known to be attracted by continuous signals or higher frequencies (which they cannot hear).

Hearing and Sensitivity in Invertebrates and Plankton. There are no extensive studies of hearing in marine invertebrates or plankton. In general, based on studies of the effects of seismic surveys, it is believed that there are generally few effects, behavioral or physiological, unless the organisms are within meters of a powerful source noise. Marine invertebrates possess sensory organs through which sound may be perceived: mechanoreceptors and statocyst organs (McCauley, 1994). Some planktonic species are early life cycle stages of marine invertebrates and fish. Hearing and sensitivity in planktonic fish is generally the same as that described for adult fish (Vella et al,. 2001).

Data on Fish Hearing. Table 3.9-2 provides data on the hearing capabilities of all of the marine fish species that have been studied to date. However, before examining the data in the table, a number of important points must be made.

- In order to conform to the most recent taxonomic studies of the species, the table uses current scientific names for a number of species rather than the scientific names used at the time that the research paper was written. Source for names is www.fishbase.org.
- The data in the table were primarily compiled by two sources, Fay (1988) and Nedwell *et al.* (2004). Since the Nedwell *et al.* (2004) study was not published, the data were checked, where possible, against Fay (1988) or original sources.
- The data in the table for "best sensitivity" is only provided to give a sense of where the best hearing was for that species. However, since thresholds are often variable, this information should be used with utmost caution.
- It may generally be said that fish with a hearing range that only extends to 1.5 kHz are more likely to be hearing generalists, whereas fish with higher frequency hearing would be considered specialists.
- It is critical to note that comparison of the data in the table between species must be done with considerable caution. Most importantly, data were obtained in very different ways for the various species, and it is highly likely that different experimental methods yield different results in terms of range of hearing and in hearing sensitivity. Thus, data obtained using behavioral measures, such as those done by Tavolga and Wodinksy (1963) for a variety of marine fish provide data in terms of what animals actually detected since the animals were required to do a behavioral task whenever they detected a sound.
- In contrast, studies performed using auditory evoked potentials (AEP), often called auditory brainstem response (ABR), a very effective general measure of hearing that is being widely used today, tends, in fish, to generally provide results that indicate a somewhat narrower hearing range and possibly different sensitivity (thresholds) than obtained using behavioral methods. The difference is that ABR is a measure that does not involve any response on the part of the fish. Instead, ABR is a measure of the brainstem response and does not measure the integrated output

of the auditory system (*e.g.* cortical process, decision making, etc.). Examples of data from ABR studies include the work of Casper *et al.* (2003) and Ramcharitar *et al.* (2004, 2006a).

- Many of the species, as shown, are hearing generalists and these species respond best primarily to particle motion rather than pressure, as discussed earlier. However, the vast majority of the species were tested with pressure signals and the particle motion signal was not calibrated. Thus, hearing sensitivity data, and hearing range, may be somewhat different if particle motion had been calibrated. Accordingly, while the table gives a general sense of hearing of different species, caution must be taken in extrapolation to other species, and in interpretation of the data.

As a consequence of these differences in techniques, as well as differences in sound fields used and differences in experimental paradigms, one must be extremely cautious in comparing data between different species when they were tested in different ways and/or in different laboratories. While general comparisons are possible (*e.g.*, which species are generalists and which are specialists), more detailed comparisons, such as of thresholds, should be done with utmost caution since one investigator may have been measuring pressure and another particle motion. At the same time, it should be noted that when different species were tested in the same lab, using the same experimental approach, it is possible to make comparative statements about hearing among the species used since all would have been subject to the same sound field.

3.9.2.4 ESA-Listings and Species of Concern

The only marine species in the Study Area that are listed as threatened or endangered by the ESA include marine mammals (five species) and sea turtles (five species). No fish or invertebrate species have ESA listing status; however, two fish are considered Species of Concern, humphead wrasse (*Cheilinus undulatus*) and the bumphead parrotfish (*Bolbometopon muricatum*). Species of Concern do not carry any procedural or substantive protections under the ESA and Section 7 consultation requirements do not apply; however, the Navy is including these fish species in the ESA consultation with ESA-listed marine mammals and sea turtles. Species of Concern status serves to promote conservation and research efforts for these species.

3.9.2.4.1 Humphead wrasse (*Cheilinus undulatus*)

Status – The humphead wrasse was once an economically important reef fish in Guam but is rarely seen around reefs or reported in inshore survey catch results (WPRFMC, 2001). Factors influencing the decline of this species include (1) intensive and species-specific removal in the live reef food-fish trade, (2) spear fishing at night using SCUBA gear, (3) lack of coordinated, consistent national and regional management; (4) illegal, unregulated, or unreported fisheries; and (5) loss of habitat (NMFS, 2004).

Distribution. The humphead wrasse can be found in shallow waters of the Indo-Pacific region from the Red Sea in the west to the Tuamotus in the east, and from the Ryukyus in the north, including China, Taiwan, east to Wake Island, south to New Caledonia, and throughout Micronesia (Myers, 1999).

Habitat Preferences. Wrasses prefer shallow waters closely associated with coral reefs (WPRFMC, 2001). Wrasses can be found in virtually every habitat on tropical reefs, including rubble, sand, algae, seaweeds, rocks, flats, tidepools, crevices, caves, fringing reefs, and patch reefs (Allen and Steene, 1987; WPRFMC, 2001). Most wrasses are found in relatively calm waters between about 10 and 66 ft (3 and 20 m); however, some species occur at depths greater than 656 ft (200 m) (Allen and Steene, 1987; WPRFMC, 2001). Adults roam the coral reefs during the day keeping close to coral or rocky cover (Froese and Pauly, 2004). At night, they may rest in caves or under coral ledges, bury themselves in the sand, or lie motionless on the bottom (WPRFMC, 2001; Froese and Pauly, 2004). Labrid eggs and larvae are pelagic and are routinely found in the open ocean (WPRFMC, 2001). Juveniles, like adults, inhabit a wide range of habitats from shallow lagoons to deep reef slopes (WPRFMC, 2001).

Humphead wrasses occur along steep outer reef slopes, channel slopes, and occasionally on lagoon reefs, at depths from 3 to 197 ft (1 to 60 m) (WPRFMC, 2001; Froese and Pauly, 2004). Adults are usually solitary and can be found roaming the coral reefs by day and resting in reef caves and under coral ledges at night (Froese and Pauly, 2004). Juveniles are associated with coral-rich areas of lagoon reefs, usually among thickets of *Acropora* corals (Froese and Pauly, 2004). The eggs and larvae of this species are pelagic (Sadovy *et al.,* 2003).

Life History. The humphead wrasse may spawn in small or large groupings and spawning coincides with certain phases of the tidal cycle. This species is a daily spawner that does not migrate far from its spawning area (resident spawner) (Sadovy *et al.,* 2003). Humphead wrasses may spawn during several or all months of the year associated with a range of different reef habitats (Sadovy *et al.,* 2003).

3.9.2.4.2 Bumphead parrotfish (*Bolbometopon muricatum*)

Status. The bumphead parrotfish was listed as a Species of Concern by the NOAA Fisheries Office of Protected Resources in 2004 (IUCN, 2004; NMFS, 2004). The bumphead parrotfish is one of the most desirable and most vulnerable nearshore reef fish in the U.S. Western Pacific Islands. Bumphead parrotfish are an important species in the live reef fish trade as well as the aquarium trade. This species has all but disappeared from Guam’s reefs and has shown significant declines throughout its range. Reasons attributing to the decline of this species include 1) overexploitation and destructive fishing techniques, 2) degradation and loss of coral reef habitats, and 3) a vulnerable life history (NMFS, 2004).

Distribution. Parrotfish are mainly a tropical species occurring in the Atlantic, Indian, and Pacific Oceans (Froese and Pauly, 2004). The majority of these species are found inhabiting the coral reefs of the Indian and Western Pacific Oceans.

The bumphead parrotfish can be found throughout the Indo-Pacific from the Red Sea and East Africa in the east to the Line Islands and Samoa in the west, north to Yaeyama, south to the Great Barrier Reef and New Caledonia. In Micronesia, this species can be found from Palau to the Caroline, Mariana, and Wake Islands (Froese and Pauly, 2004).

Habitat Preferences. Parrotfish are commonly found around coral reefs, and are usually most abundant in shallow waters to a depth of 98 ft (30 m) (Westneat, 2001). This species occupies a variety of coral reef habitats including seagrass beds, coral-rich areas, sand patches, rubble or pavement fields, lagoons, reef flats, and upper reef slopes (Myers, 1999). Parrotfish sleep under ledges or wedged against coral or rock at night (Myers, 1999). Adults are found in small groups in clear outer lagoons and around seaward reefs and are often located on reef crests or fronts (WPRFMC, 2001; Froese and Pauly, 2004). Adults may utilize a wide range of coral and shallow-water habitat types, but juveniles are usually found in lagoons (WPRFMC, 2001).

Life History. Parrotfish spawn in pairs and groups with group spawning frequently occurring on reef slopes associated with high current speeds. Paired spawning has been observed at the reef crest or reef slope during peak or falling tides. Parrotfish may migrate into lagoons or to the outer reef slope in order to spawn. Some parrotfish are diandric, forming schools and spawning groups often after migration to specific sites, while others are monandric and are strongly site specific and practice haremic, pair spawning. The eggs and larvae of these species are pelagic and subject to dispersal by ocean currents (WPRFMC, 2001). At this time, no reliable data are available on the spawning and migration of the bumphead parrotfish (Myers, 1999; WPRFMC, 2001; Froese and Pauly, 2004).

3.9.3 Environmental Consequences

The analysis of effects on fish concerns direct physical injury, *i.e.*, the potential for death, injury, or failure to reach (or an increase in the time needed to reach) the next developmental stage, and was used to evaluate potential effects on fish eggs, larvae, and adult fish. Data are available to enable some predictions about the likelihood and extent of these kinds of effects.

EFH is located within the region of influence and consists of four management units: (1) Bottomfish, (2) Pelagic, (3) Crustacean, and (4) Coral Reef Ecosystem. There are FMPs that identify and describe each EFH. For the purpose of the analysis, potential effects were considered to determine adverse ecosystem impacts to EFH and managed species.

Mitigation measures for activities involving underwater detonations, implemented for marine mammals and sea turtles, also offer protections to habitats associated with fish communities.

3.9.3.1 Assessment of Effects on Fish

In this section, the approach to the assessment of effects on fish is presented, as well as a review of the literature on potential effects common to most activities. These include noise, disturbance, and nonacoustic effects of contaminants, debris, and discarded expendable material.

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.

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, long-term behavioral reactions, and changes in distribution.

Whereas baseline conditions describe the relative abundance of fish as estimated from fisheries data, estimates of the absolute abundance of fish for the area of interest are not available. Thus, effects on fish are expressed in relative terms.

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 biology or catchability by fishers. Both types of sound can cause changes in fish distribution and/or behavior. This assessment focuses on potential effects on fish.

3.9.3.1.1 Effect of Human-Generated Sound on 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), 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). Most investigations, however, have been in the gray literature (non peer-reviewed reports – see Hastings and Popper, 2005 for an extensive critical review of this material). While some of these studies provide insight into effects of sound on fish, as mentioned earlier, 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 nonauditory 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 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. Such studies were directed at developing some understanding of how fish might be affected if they lived in an area with constant and increasing shipping or in the presence of a wind farm, or in areas where there are long-term acoustic tests. Other similar environments might be aquaculture facilities or large marine aquaria. In most of these studies examining long-term exposure, the sound intensity was well below any that might be expected to have immediate damage to fish (*e.g*., damage tissues such as the swim bladder or blood vessels).

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 airgun 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.

Effects of Long-Duration Increases in Background Sounds on Fish. Effects of long-duration, relatively low-intensity sounds (*e.g*., below 170 – 180 dB re 1 μPa received level ([RL]) indicate that there is little or no effect of long-term exposure on hearing generalists (*e.g*., Scholik and Yan, 2001; Amoser and Ladich, 2003; Smith *et al.*, 2004a,b; Wysocki *et al.*, 2007). The longest of these studies exposed young rainbow trout (*Oncorhynchus mykiss*) to a level of noise equivalent to one that fish would experience in an aquaculture facility (*e.g.*, on the order of 150 dB re 1 μPa RL) for about 9 months. The investigators found no effect on hearing or on any other measures including growth and effects on the immune system as compared to fish raised at 110 dB re 1 μPa RL. The sound level used in the study would be equivalent to ambient sound in the same environment without the presence of pumps and other noise sources of an aquaculture facility (Wysocki *et al.*, 2007).

Studies on hearing specialists have shown that there is some hearing loss after several days or weeks of exposure to increased background sounds, although the hearing loss seems to recover (*e.g.*, Scholik and Yan, 2002; Smith *et al.*, 2004b, 2006). Smith *et al.* (2004a, 2006) investigated the goldfish (*Carassius auratus*). They exposed fish to noise at 170 dB re 1 μPa and there was a clear relationship between the level of the exposure sound and the amount of hearing loss. There was also a direct correlation of level of hearing loss and the duration of exposure, up to 24 hours, after which time the maximum hearing loss was found.

Similarly, Wysocki and Ladich (2005) investigated the influence of noise exposure on the auditory sensitivity of two freshwater hearing specialists, the goldfish and the lined Raphael catfish (*Platydoras costatus*), and on a freshwater hearing generalist, a sunfish (*Lepomis gibbosus*). Baseline thresholds showed greatest hearing sensitivity around 0.5 kHz in the goldfish and catfish and at 0.1 kHz in the sunfish. For the hearing specialists (goldfish and catfish), continuous white noise of 130 dB re 1 μPa RL resulted in a significant threshold shift of 23 to 44 dB. In contrast, the auditory thresholds in the hearing generalist (sunfish) declined by 7 to 11 dB.

In summary, and 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. However, 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 – 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 fish and have the same specializations to enhance hearing).

Effects of High-Intensity Sounds on Fish. There is a small group of studies that discusses effects of high intensity sound on fish. However, as discussed in Hastings and Popper (2005), much of this literature has not been peer reviewed, and there are substantial issues with regard to the actual effects of these sounds on fish. More recently, however, there have been two studies of the effects of high intensity sound on fish that, using experimental approaches, provided insight into overall effects of these sounds on hearing and on auditory and nonauditory tissues. One study tested effects of seismic airguns, a highly impulsive and intense sound source, while the other study examined the effects of Surveillance Towed-Array Sensor System (SURTASS) LFA sonar. Since these studies are the first that examined effects on hearing and physiology, they will be discussed in some detail. These studies not only provide important data, but also suggest ways in which future experiments need to be conducted. This discussion will be followed by a brief overview of other studies that have been conducted, some of which may provide a small degree of insight into potential effects of human-generated sound on fish.

Effects of Seismic Airguns on Fish. Popper et al. (2005) examined the effects of exposure to a seismic airgun array on three species of fish found in the Mackenzie River Delta near Inuvik, Northwest Territories, Canada. The species included a hearing specialist, the lake chub (Couesius plumbeus), and two hearing generalists, the northern pike (Esox lucius), and the broad whitefish (Coregonus nasus) (a salmonid). In this study, fish in cages were exposed to 5 or 20 shots from a 730 cubic inch ($in.^3$) (12,000 cubic centimeters [cc]) calibrated airgun array. And, unlike earlier studies, the received exposure levels were not only determined for root mean square (rms) sound pressure level, but also for peak sound levels and for Sound Exposure Levels (SEL) (e.g., average mean peak Sound Pressure Level [SPL] 207 dB re 1 μPa RL; mean RMS sound level 197 dB re 1 μPa Received Level [RL]; mean SEL 177 dB re 1 $\mu Pa^2 s$).

The results showed a temporary hearing loss for both lake chub and northern pike, but not for the broad whitefish, to both 5 and 20 airgun shots. Hearing loss was on the order of 20 to 25 dB at some frequencies for both the northern pike and lake chub, and full recovery of hearing took place within 18 hours after sound exposure. While a full pathological study was not conducted, fish of all three species survived the sound exposure and were alive more than 24 hours after exposure. Those fish of all three species had intact swim bladders and there was no apparent external or internal damage to other body tissues (*e.g.*, no bleeding or grossly damaged tissues), although it is important to note that the observer in this case (unlike in the following LFA study) was not a trained pathologist. Recent examination of the ear tissues by an expert pathologist showed no damage to sensory hair cells in any of the fish exposed to sound (Song *et al.* submitted).

A critical result of this study was that it demonstrated differences in the effects of airguns 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.

Experiments conducted by Skalski *et al.* (1992), Dalen and Raknes (1985), Dalen and Knutsen (1986), and Engås *et al.* (1996) demonstrated that some fish were forced to the bottom and others driven from the area in response to low-frequency airgun noise. The authors speculated that catch per unit effort would return to normal quickly in their experimental area because behavior of the fish returned to normal minutes after the sounds ceased.

Effects of SURTASS LFA Sonar on Fish. Popper et al. (2005, 2007) studied the effect of SURTASS LFA on hearing, the structure of the ear, and select nonauditory systems in the rainbow trout (Oncorhynchus mykiss) and channel catfish (Ictalurus punctatus) (also Halvorsen et al. 2006).

The SURTASS LFA sonar study was conducted in an acoustic free-field environment that enabled the investigators to have a calibrated sound source and to monitor the sound field throughout the experiments. In brief, experimental fish were placed in a test tank, lowered to depth, and exposed to LFA sonar for 324 or 648 seconds, an exposure duration that is far greater than any fish in the wild would receive. In the wild, the sound source is on a vessel moving past the far slower swimming fish. For a single tone, the maximum RL was approximately 193 dB re 1 μPa at 196 Hz and the level was uniform within the test tank to within approximately ±3 dB. The signals were produced by a single SURTASS LFA sonar transmitter giving an approximate source level of 215 dB. Following exposure, hearing was measured in the test animals. Animals were also sacrificed for examination of auditory and nonauditory tissues to determine any nonhearing effects. All results from experimental animals were compared to results obtained from baseline control and control animals.

A number of results came from this study. Most importantly, no fish died as a result of exposure to the experimental source signals. Fish all appeared healthy and active until they were sacrificed (killed in order to analyze any internal physiological or anatomical effects) or returned to the fish farm from which they were purchased. In addition, the study employed the expertise of an expert fish pathologist who used double-blind methods to analyze the tissues of the fish exposed to the sonar source, and compared these to control animals. The results clearly showed that there were no pathological effects from sound exposure including no effects on all major body tissues (brain, swim bladder, heart, liver, gonads, blood, etc.). There was no damage to the swim bladder and no bleeding as a result of LFA sonar exposure. Furthermore, there were no short- or long-term effects on ear tissue (Popper *et al.,* 2007).

Moreover, behavior of caged fish after sound exposure was no different than that prior to tests. It is critical to note, however, that behavior of fish in a cage in no way suggests anything about how fish would respond to a comparable signal in the wild. Just as the behavior of humans exposed to a noxious stimulus might show different behavior if in a closed room as compared to being out-of-doors, it is likely that the behaviors shown by fish to stimuli will also differ, depending upon their environment.

The study also incorporated effects of sound exposure on hearing both immediately post exposure and for several days thereafter to determine if there were any long-term effects, or if hearing loss showed up at some point post exposure. Catfish and some specimens of rainbow trout showed 10 to 20 dB of hearing loss immediately after exposure to the LFA sonar when compared to baseline and control animals; however another group of rainbow trout showed no hearing loss. Recovery in trout took at least 48 hours, but studies could not be completed. The different results between rainbow trout groups is difficult to understand, but may be due to developmental or genetic differences in the various groups of fish. Catfish hearing returned to, or close to, normal within about 24 hours.

Effects of MFA and HFA on Fish. While there are no other data on the effects of sonar on fish, there are two recent unpublished reports of some relevance since it examined the effects on fish of a mid-frequency sonar (1.5 to 6.5 kHz) on larval and juvenile fish of several species (Jørgensen et al., 2005, Kvadsheim and Sevaldsen, 2005). In this study, larval and juvenile fish were exposed to simulated sonar signals in order to investigate potential effects on survival, development, and behavior. The study used herring (Clupea harengus) (standard lengths 0.75 to 2 in. [2 to 5 cm]), Atlantic cod (Gadus morhua) (standard length 0.75 and 2.5 in. [2 and 6 cm]), saithe (Pollachius virens) (1.5 in. [4 cm]), and spotted wolffish (Anarhichas minor) (1.5 in. [4 cm]) at different developmental stages.

Fish were placed in plastic bags 10 ft (3 m) from the sonar source and exposed to between 4 and 100 pulses of 1-second duration of pure tones at 1.5, 4, and 6.5 kHz. Sound levels at the location of the fish ranged from 150 to 189 dB. There were no effects on fish behavior during or after exposure to sound (other than some startle or panic movements by herring for sounds at 1.5 kHz) and there were no effects on behavior, growth (length and weight), or survival of fish kept as long as 34 days post exposure. All exposed animals were compared to controls that received similar treatment except for actual exposure to the sound. Pathology of internal organs showed no damage as a result of sound exposure. The only exception to almost full survival was exposure of two groups of herring tested with sound pressure levels (SPLs) of 189 dB, where there was a post-exposure mortality of 20 to 30 percent. While these were statistically significant losses, it is important to note that this sound level was only tested once and so it is not known if this increased mortality was due to the level of the test signal or to other unknown factors.

In a follow-up unpublished analysis of these data, Kvadsheim and Sevaldsen (2005) sought to understand whether the mid-frequency Continuous Wave (CW) signals used by Jørgensen *et al.* (2005) would have a significant impact on larvae and juveniles in the wild exposed to this sonar. The investigators concluded that the extent of damage/death induced by the sonar would be below the level of loss of larval and juvenile fish from natural causes, and so no concerns should be raised. The only issue they did suggest needs to be considered is when the CW signal is at the resonance frequency of the swim bladders of small clupeids. If this is the case, the investigators predict (based on minimal data that is in need of replication) that such sounds might increase the mortality of small clupeids that have swim bladders that would resonate.

Other High Intensity Sources. A number of other sources have been examined for potential effects on fish. These have been critically and thoroughly reviewed recently by Hastings and Popper (2005) and so only brief mention will be made of a number of such studies.

One of the sources of most concern is pile driving, as occurs during the building of bridges, piers, off-shore wind farms, and the like. There have been a number of studies that suggest that the sounds from pile driving, and particularly from driving of larger piles, kill fish that are very close to the source. The source levels in such cases often exceed 230 dB re 1 μPa (peak) and there is some evidence of tissue damage accompanying exposure (*e.g.*, Caltrans, 2001, 2004, reviewed in Hastings and Popper, 2005). However, there is reason for concern in analysis of such data since in many cases the only dead fish that were observed were those that came to the surface. It is not clear whether fish that did not come to the surface survived the exposure to the sounds, or died and were carried away by currents.

There are also a number of gray literature experimental studies that placed fish in cages at different distances from the pile driving operations and attempted to measure mortality and tissue damage as a result of sound exposure. However, in most cases the studies' (*e.g.*, Caltrans, 2001, 2004; Abbott *et al.*, 2002, 2005; Nedwell *et al.,* 2003) work was done with few or no controls, and the behavioral and histopathological observations were done very crudely (the exception being Abbott *et al.*, 2005). As a consequence of these limited and unpublished data, it is not possible to know the real effects of pile driving on fish.

In a widely cited unpublished report, Turnpenny *et al.* (1994) examined the behavior of three species of fish in a pool in response to different sounds. While this report has been cited repeatedly as being the basis for concern about the effects of human-generated sound on fish, there are substantial issues with the work that make the results unusable for helping understand the potential effects of any sound on fish, including mid- and high-frequency sounds. The problem with this study is that there was a complete lack of calibration of the sound field at different frequencies and depths in the test tank, as discussed in detail in Hastings and Popper (2005). The issue is that in enclosed chambers that have an interface with air, such as tanks and pools used by Turnpenny *et al.*, the sound field is known to be very complex and will change significantly with frequency and depth. Thus, it is impossible to know the stimulus that was actually received by the fish. Moreover, the work done by Turnpenny *et al.* was not replicated by the investigators even within the study, and so it is not known if the results were artifact, or were a consequence of some uncalibrated aspects of the sound field that cannot be related, in any way, to human-generated high intensity sounds in the field, at any frequency range.

Several additional studies have examined effects of high intensity sounds on the ear. While there was no effect on ear tissue in either the SURTASS LFA study (Popper *et al.,* 2007) or the study of effects of seismic airguns on hearing (Popper *et al.,* 2005, Song *et al.* in press), three earlier studies suggested that there may be some loss of sensory hair cells due to high intensity sources. However, none of these studies concurrently investigated effects on hearing or nonauditory tissues. Enger (1981) showed some loss of sensory cells after exposure to pure tones in the Atlantic cod (*Gadus morhua*). A similar result was shown for the lagena of the oscar (*Astronotus oscellatus*), a cichlid fish, after an hour of continuous exposure (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.

Most recently, McCauley *et al.* (2003) showed loss of a small percent of sensory hair cells in the saccule (the only end organ studied) of the pink snapper (*Pagrus auratus*), and this loss continued to increase (but never to become a major proportion of sensory cells) for up to at least 53 days post exposure. It is not known if this hair cell loss, or the ones in the Atlantic cod or oscar, would result in hearing loss since fish have tens or even hundreds of thousands of sensory hair cells in each otolithic organ (Popper and Hoxter, 1984; Lombarte and Popper, 1994) and only a small portion were affected by the sound. The question remains as to why McCauley *et al.* (2003) found damage to sensory hair cells while Popper *et al.* (2005) did not. The problem is that there are so many differences in the studies, including species, precise sound source, spectrum of the sound (the Popper *et al.* 2005 study was in relatively shallow water with poor low-frequency propagation), that it is hard to even speculate.

Beyond these studies, there have also been questions raised as to the effects of other sound sources such as shipping, wind farm operations, and the like. However, there are limited or no data on actual effects of the sounds produced by these sources on any aspect of fish biology.

Intraspecific Variation in Effects. One unexpected finding in several of the recent studies is that there appears to be variation in the effects of sound, and on hearing, that may be correlated with environment, developmental history, or even genetics.

During the aforementioned LFA sonar study on rainbow trout, Popper *et al.* (2007) found that some fish showed a hearing loss, but other animals, obtained a year later but from the same supplier and handled precisely as the fish used in the earlier part of the study, showed no hearing loss. The conclusion reached by Popper *et al.* (2007) was that the differences in responses may have been related to differences in genetic stock or some aspect of early development in the two groups of fish studied.

The idea of a developmental effect was strengthened by findings of Wysocki *et al.* (2007) who found differences in hearing sensitivity of rainbow trout that were from the same genetic stock, but that were treated slightly differently in the egg stage. This is further supported by studies on hatchery-reared Chinook salmon (*Oncorhynchus tshawytscha*) which showed that some animals from the same stock and age class had statistical differences in their hearing capabilities that was statistically correlated with differences in otolith structure (Oxman *et al.*, 2007). While a clear correlation could not be made between these differences in otolith structure and specific factors, there is strong reason to believe that the differences resulted from environmental effects during development.

The conclusion one must reach from these findings is that there is not only variation in effects of intense sound sources on different species, but that there may also be differences based on genetics or development. Further, there may ultimately be differences in effects of sound on fish (or lack of effects) that are related to fish age as well as development and genetics since it was shown by Popper *et al.* (2005) that identical seismic airgun exposures had very different effects on hearing in young-of-the-year northern pike and sexually mature animals.

Effects of Anthropogenic Sound on Behavior. There have been very few studies of the effects of anthropogenic sounds on the behavior of wild (unrestrained) fish. This includes not only immediate effects on fish that are close to the source but also effects on fish that are further from the source.

Several studies have demonstrated that human-generated sounds may affect the behavior of at least a few species of fish. Engås *et al.* (1996) and Engås and Løkkeborg (2002) examined movement of fish during and after a seismic airgun study although they were not able to actually observe the behavior of fish per se. Instead, they measured catch rate of haddock and Atlantic cod as an indicator of fish behavior. These investigators found that there was a significant decline in catch rate of haddock (*Melanogrammus aeglefinus*) and Atlantic cod (*Gadus morhua*) that lasted for several days after termination of airgun use. Catch rate subsequently returned to normal. The conclusion reached by the investigators was that the decline in catch rate resulted from the fish moving away from the fishing site as a result of the airgun sounds. However, the investigators did not actually observe behavior, and it is possible that the fish just changed depth. Another alternative explanation is that the airguns actually killed the fish in the area, and the return to normal catch rate occurred because of other fish entering the fishing areas.

More recent work from the same group (Slotte *et al.*, 2004) showed parallel results for several additional pelagic species including blue whiting and Norwegian spring spawning herring. However, unlike earlier studies from this group, Slotte *et al.* used fishing sonar to observe behavior of the local fish schools. They reported that fish in the area of the airguns appeared to go to greater depths after the airgun exposure compared to their vertical position prior to the airgun usage. Moreover, the abundance of animals 16 to 27 nm (30 to 50 km) away from the ensonification increased, suggesting that migrating fish would not enter the zone of seismic activity. It should be pointed out that the results of these studies have been refuted by Gausland (2003) who, in a non peer-reviewed study, suggested that catch decline was from factors other than exposure to airguns and that the data were not statistically different than the normal variation in catch rates over several seasons.

Similarly, Skalski *et al.*, (1992) showed a 52 percent decrease in rockfish (*Sebastes* sp.) catch when the area of catch was exposed to a single airgun emission at 186 to 191 dB re 1 µPa (mean peak level) (see also Pearson *et al.* 1987, 1992). They also demonstrated that fish would show a startle response to sounds as low as 160 dB, but this level of sound did not appear to elicit decline in catch.

Wardle *et al.* (2001) used a video system to examine the behaviors of fish and invertebrates on a coral reef in response to emissions from seismic airguns that were carefully calibrated and measured to have a peak level of 210 dB re 1 µPa at 51 ft (16 m) from the source and 195 dB re 1 µPa at 349 ft (109 m) from the source. They found no substantial or permanent changes in the behavior of the fish or invertebrates on the reef throughout the course of the study, and no animals appeared to leave the reef. There was no indication of any observed damage to the animals.

Culik *et al.* (2001) and Gearin *et al.* (2000) studied how noise may affect fish behavior by looking at the effects of mid-frequency sound produced by acoustic devices designed to deter marine mammals from gillnet fisheries. Gearin *et al.* (2000) studied responses of adult sockeye salmon (*Oncorhynchus nerka*) and sturgeon (*Acipenser* sp.) to pinger sounds. They found that fish did not exhibit any reaction or behavior change to the onset of the sounds of pingers that produced broadband energy with peaks at 2 kHz or 20 kHz. This demonstrated that the alarm was either inaudible to the salmon and sturgeon, or that neither species was disturbed by the mid-frequency sound (Gearin *et al.*, 2000). Based on hearing threshold data (Table 3.9-2), it is highly likely that the salmonids did not hear the sounds.

Culik *et al.* (2001) did a very limited number of experiments to determine catch rate of herring (*Clupea harengus*) in the presence of pingers producing sounds that overlapped the frequency range of hearing of herring (2.7 kHz to over 160 kHz). They found no change in catch rate in gill nets with or without the higher frequency (> 20 kHz) sounds present, although there was an increase in catch rate with the signals from 2.7 kHz to 19 kHz (a different source than the higher frequency source). The results could mean that the fish did not "pay attention" to the higher frequency sound or that they did not hear it, but that lower frequency sounds may be attractive to fish. At the same time, it should be noted that there were no behavioral observations on the fish, and so how the fish actually responded when they detected the sound is not known.

The low-frequency (< 2 kHz) sounds of large vessels or accelerating small vessels usually caused an initial avoidance response among the herring. The startle response was observed occasionally. Avoidance ended within 10 seconds of the "departure" of the vessel. After the initial response, 25 percent of the fish groups habituated to the sound of the large vessel and 75 percent of the responsive fish groups habituated to the sound of the small boat. Chapman and Hawkins (1969) also noted that fish adjust rapidly to high underwater sound levels, and Schwartz and Greer (1984) found no reactions to an echo sounder and playbacks of sonar signals which were much higher than that of the MFA sonar in the Proposed Action.

Masking. Any sound detectable by a fish can have an impact on behavior by preventing the fish from hearing biologically important sounds including those produced by prey or predators (Myrberg, 1980, Popper *et al.*, 2003). This inability to perceive biologically relevant sounds as a result of the presence of other sounds is called masking. Masking may take place whenever the received level of a signal heard by an animal exceeds ambient noise levels or the hearing threshold of the animal. Masking is found among all vertebrate groups, and the auditory system in all vertebrates, including fish, is capable of limiting the effects of masking signals, especially when they are in a different frequency range than the signal of biological relevance (Fay, 1988, Fay and Megela-Simmons, 1999).

One of the problems with existing fish masking data is that the bulk of the studies have been done with goldfish, a freshwater hearing specialist. The data on other species are much less extensive. As a result, less is known about masking in nonspecialist and marine species. Tavolga (1974a, b) studied the effects of noise on pure-tone detection in two nonspecialists and found that the masking effect was generally a linear function of masking level, independent of frequency. In addition, Buerkle (1968, 1969) studied five frequency bandwidths for Atlantic cod in the 20 to 340 Hz region and showed masking in all hearing ranges. Chapman and Hawkins (1973) found that ambient noise at higher sea states in the ocean have masking effects in cod, haddock, and Pollock, and similar results were suggested for several sciaenid species by Ramcharitar and Popper (2004). Thus, based on limited data, it appears that for fish, as for mammals, masking may be most problematic in the frequency region of the signal of the masker. Thus, for mid-frequency sonars, which are well outside the range of hearing of most all fish species, there is little likelihood of masking taking place for biologically relevant signals to fish since the fish will not hear the masking source.

There have been a few field studies which may suggest that masking could have an impact on wild fish. Gannon *et al.* (2005) showed that bottlenose dolphins (*Tursiops truncatus*) move toward acoustic playbacks of the vocalization of Gulf toadfish (*Opsanus beta*). Bottlenose dolphins employ a variety of vocalizations during social communication including low-frequency pops. Toadfish may be able to best detect the low-frequency pops since their hearing is best below 1 kHz, and there is some indication that toadfish have reduced levels of calling when bottlenose dolphins approach (Remage-Healey *et al.*, 2006). Silver perch have also been shown to decrease calls when exposed to playbacks of dolphin whistles mixed with other biological sounds (Luczkovich *et al.*, 2000). Results of the Luczkovich *et al.* (2000) study, however, must be viewed with caution because it is not clear what sound may have elicited the silver perch response (Ramcharitar *et al.*, 2006a).

Of considerable concern is that human-generated sounds could mask the ability of fish to use communication sounds, especially when the fish are communicating over some distance. In effect, the masking sound may limit the distance over which fish can communicate, thereby having an impact on important components of the behavior of fish. For example, the sciaenids, which are primarily inshore species, are probably the most active sound producers among fish, and the sounds produced by males are used to “call” females to breeding sights (Ramcharitar *et al.*, 2001; reviewed in Ramcharitar *et al.*, 2006a). If the females are not able to hear the reproductive sounds of the males, this could have a significant impact on the reproductive success of a population of sciaenids.

Also potentially vulnerable to masking is navigation by larval fish, although the data to support such an idea are still exceedingly limited. There is indication that larvae of some species may have the potential to navigate to juvenile and adult habitat by listening for sounds emitted from a reef (either due to animal sounds or non-biological sources such as surf action) (*e.g.*, Higgs, 2005). In a study of an Australian reef system, the sound signature emitted from fish choruses was between 0.8 and 1.6 kHz (Cato, 1978) and could be detected by hydrophones 3 to 4 nm (5 to 8 km) from the reef (McCauley and Cato, 2000). This bandwidth is within the detectable bandwidth of adults and larvae of the few species of reef fish that have been studied (Kenyon, 1996; Myrberg, 1980). At the same time, it has not been demonstrated conclusively that sound, or sound alone, is an attractant of larval fish to a reef, and the number of species tested has been very limited. Moreover, there is also evidence that larval fish may be using other kinds of sensory cues, such as chemical signals, instead of, or alongside of, sound (*e.g.*, Atema *et al.,* 2002; Higgs *et al.,* 2005).

Finally, it should be noted that even if a masker prevents a larval (or any) fish from hearing biologically relevant sounds for a short period of time (*e.g*., while a sonar-emitting ship is passing), this may have no biological effect on the fish since they would be able to detect the relevant sounds before and after the masking, and thus would likely be able to find the source of the sounds.

Stress. Although an increase in background sound may cause stress in humans, there have been few studies on fish (*e.g.*, Smith *et al.,* 2004a; Remage-Healey *et al.,* 2006; Wysocki *et al.,* 2006, 2007). There is some indication of physiological effects on fish such as a change in hormone levels and altered behavior in some (Pickering, 1981; Smith *et al.,* 2004a, b), but not all, species tested to date (*e.g*., Wysocki *et al.*, 2007). Sverdrup *et al.* (1994) found that Atlantic salmon subjected to up to 10 explosions to simulate seismic blasts released primary stress hormones, adrenaline and cortisol, as a biochemical response; there was no mortality. All experimental subjects returned to their normal physiological levels within 72 hours of exposure. Since stress affects human health, it seems reasonable that stress from loud sound may impact fish health, but available information is too limited to adequately address the issue.

Eggs and Larvae. One additional area of concern is whether high intensity sounds may have an impact on eggs and larvae of fish. Eggs and larvae do not move very much and so must be considered as a stationary object with regard to a moving navy sound source. Thus, the time for impact of sound is relatively small since there is no movement relative to the navy vessel.

There have been few studies on effects of sound on eggs and larvae (reviewed extensively in Hastings and Popper, 2005) and there are no definitive conclusions to be reached. At the same time, many of the studies have used nonacoustic mechanical signals such as dropping the eggs and larvae or subjecting them to explosions (*e.g*., Jensen and Alderice, 1983, 1989; Dwyer *et al.*, 1993). Other studies have placed the eggs and/or larvae in very small chambers (*e.g*., Banner and Hyatt, 1973) where the acoustics are not suitable for comparison with what might happen in a free sound field (and even in the small chambers, results are highly equivocal).

Several studies did examine effects of sounds on fish eggs and larvae. One non peer-reviewed study using sounds from 115-140 dB (re 1 µPa, peak) on eggs and embryos in Lake Pend Oreille (Idaho) reported normal survival or hatching, but few data were provided to evaluate the results (Bennett *et al.*, 1994). In another study, Kostyuchenko (1973) reported damage to eggs of several marine species at up to 66 ft (20 m) from a source designed to mimic seismic airguns, but few data were given as to effects. Similarly, Booman *et al.,* (1996) investigated the effects of seismic airguns on eggs, larvae, and fry and found significant mortality in several different marine species (Atlantic cod, saithe, herring) at a variety of ages, but only when the specimens were within about 17 ft (5 m) of the source. The most substantial effects were to fish that were within 5 ft (1.4 m) of the source. While the authors suggested damage to some cells such as those of the lateral line, few data were reported and the study is in need of replication. Moreover, it should be noted that the eggs and larvae were very close to the airgun array, and at such close distances the particle velocity of the signal would be exceedingly large. However, the received sound pressure and particle velocity were not measured in this study.

Conclusions—Effects. The data obtained to date on effects of sound on fish are very limited both in terms of number of well-controlled studies and in number of species tested. Moreover, there are significant limits in the range of data available for any particular type of sound source. And finally, most of the data currently available has little to do with actual behavior of fish in response to sound in their normal environment. There is little known about stress effects of any kind(s) of sound on fish.

Mortality and Damage to Nonauditory Tissues. Test results to date show only limited mortality when fish are very close to an intense sound source. Thus, whereas there is evidence that fish within a few meters of a pile driving operation will potentially be killed, very limited data (and data from poorly designed experiments) suggest that fish further from the source are not killed, and may not be harmed. It should be noted, however, that these and other studies showing mortality (to any sound source) need to be extended and replicated in order to understand the effects of the most intense sound on fish.

Limited studies also show that fish tested at a distance from the source (where the sound level is below source level) show no mortality and possibly no long-term effects. While it is difficult to extrapolate results from the available data (*e.g.*, Popper *et al.*, 2005, 2007) from testing of a limited number of sound types, and test results from a single sound type, the effects of multiple exposures and duration of exposure is not well understood. Test results indicate that exposure to many types of loud sounds may have little or no effect on fish. It is estimated that a relatively small percentage of animals in a large population will be killed or affected by underwater sound that has attenuated considerably from its source. This projection is based on two factors: (a) the immediate movement of fish away from the sudden presence of the foreign object prior to emitting of sound, and (b) the constant movement and dispersal of fish in the open ocean.

Effects on Fish Behavior. The more critical issue, however, is the effect of human-generated sound on the behavior of wild animals, and whether exposure to the sounds will alter the behavior of fish in a manner that will affect its way of living – such as where it tries to find food or how well it can find a mate. With the exception of just a few field studies, there are no data on behavioral effects, and most of these studies are very limited in scope and all are related to seismic airguns. Because of the limited ways in which behavior of fish in these studies were "observed" (often by doing catch rates, which tell nothing about how fish really react to a sound), there really are no data on the most critical questions regarding behavior.

Indeed, the fundamental questions are how fish behave during and after exposure to a sound as compared to their "normal" preexposure behavior. This requires observations of a large number of animals over a large area for a considerable period of time before, during, and after exposure to sound sources. Only with such data is it possible to tell how sounds affect overall behavior (including movement) of animals.

Increased Background Sound. In addition to questions about how fish movements change in response to sounds, there are also questions as to whether any increase in background sound has an effect on more subtle aspects of behavior, such as the ability of a fish to hear a potential mate or predator, or to glean information about its general environment. There is a body of literature that shows that the sound detection ability of fish can be "masked" by the presence of other sounds within the range of hearing of the fish. Just as a human has trouble hearing another person as the room they are in gets noisier, it is likely that the same effect occurs for fish (as well as all other animals). In effect, acoustic communication and orientation of fish may potentially be restricted by noise regimes in their environment that are within the hearing range of the fish.

While it is possible to suggest behavioral effects on fish, there have been few laboratory, and no field, studies to show the nature of any effects of increased background noise on fish behavior (Smith *et al.*, 2003). At the same time, it is clear from the literature on masking in fish, as for other vertebrates, that the major effect on hearing is when the added sound is within the hearing range of the animal. Moreover, the bulk of the masking effect is at frequencies around that of the masker. Thus, a 2 kHz masker will only mask detection of sounds around 2 kHz, and a 500 Hz masker will primarily impact hearing in a band around 500 Hz.

As a consequence, if there is a background sound of 2 kHz, as might be expected from some mid-frequency sonars, and the fish in question does not hear at that frequency, there will be no masking, and no effect on any kind of behavior. Moreover, since the bulk of fish communication sounds are well below 1 kHz (*e.g*., Zelick *et al.*, 1999), even if a fish is exposed to a 2 kHz masker which affects hearing at around 2 kHz, detection of biologically relevant sounds (*e.g*., of mates) will not be masked.

Indeed, many of the human-generated sounds in the marine environment are outside the detection range of most species of marine fish studied to date (see Figure 3.9-1 and Table 3.9-2). In particular, it appears that the majority of marine species have hearing ranges that are well below the frequencies of the mid- and high-frequency range of the operational sonars used in Navy exercises, and therefore, the sound sources do not have the potential to mask key environmental sounds. The few fish species that have been shown to be able to detect mid and high frequencies, such as the clupeids (herrings, shads, and relatives), do not have their best sensitivities in the range of the operational sonars. Additionally, vocal marine fish largely communicate below the range of mid- and high-frequency levels used in Navy exercises.

Implications of Temporary Hearing Loss (TTS). Another related issue is the impact of temporary hearing loss, referred to as temporary threshold shift (TTS), on fish. This effect has been demonstrated in several fish species where investigators used exposure to either long-term increased background levels (e.g., Smith et al., 2004a) or intense, but short-term, sounds (e.g., Popper et al., 2005), as discussed above. At the same time, there is no evidence of permanent hearing loss (e.g., deafness), often referred to in the mammalian literature as permanent threshold shift (PTS), in fish. Indeed, unlike in mammals where deafness often occurs as a result of the death and thus permanent loss of sensory hair cells, sensory hair cells of the ear in fish are replaced after they are damaged or killed (Lombarte et al., 1993; Smith et al., 2006). As a consequence, any hearing loss in fish may be as temporary as the time course needed to repair or replace the sensory cells that were damaged or destroyed (e.g., Smith et al., 2006).

TTS in fish, as in mammals, is defined as a recoverable hearing loss. Generally there is recovery to normal hearing levels, but the time-course for recovery depends on the intensity and duration of the TTS-evoking signal. There are no data that allows one to “model” expected TTS in fish for different signals, and developing such a model will require far more data than currently available. Moreover, the data would have to be from a large number of fish species since there is so much variability in hearing capabilities and in auditory structure.

A fundamentally critical question regarding TTS is how much the temporary loss of hearing would impact survival of fish. During a period of hearing loss, fish will potentially be less sensitive to sounds produced by predators or prey, or to other acoustic information about their environment. The question then becomes how much TTS is behaviorally significant for survival. However, there have yet to be any studies that examine this issue.

At the same time, the majority of marine fish species are hearing generalists and so cannot hear mid- and high-frequency sonar. Thus, there is little or no likelihood of there being TTS as a result of exposure to these sonars, or any other source above 1.5 kHz. It is possible that mid-frequency sonars are detectable by some hearing specialists such as a number of sciaenid species and clupeids. However, the likelihood of TTS in these species is small since the duration of exposure of animals to a moving source is probably very low; exposure to a maximum sound level (generally well below the source level) would only be for a few seconds as the Navy vessel with operating sonar moves by.

Stress. While the major questions on effects of sound relate to behavior of fish in the wild, a more subtle issue is whether the sounds potentially affect the animal through increased stress. In effect, even when there are no apparent direct effects on fish as manifest by hearing loss, tissue damage, or changes in behavior, it is possible that there are more subtle effects on the endocrine or immune systems that could, over a long period of time, decrease the survival or reproductive success of animals. While there have been a few studies that have looked at things such as cortisol levels in response to sound, these studies have been very limited in scope and in species studied.

Eggs and Larvae. Finally, while eggs and larvae must be of concern, the few studies of the effects of sounds on eggs and larvae do not lead to any conclusions on how sound impacts survival. And of the few potentially useful studies, most were done with sources that are very different than sonar. Instead, these studies employed seismic airguns or mechanical shock. While a few results suggest some potential effects on eggs and larvae, such studies need to be replicated and designed to ask direct questions about whether sounds, and particularly mid- and high-frequency sounds, would have any potential impact on eggs and larvae.

3.9.3.1.2 Explosives and Other Impulsive Signals

Effects of Impulsive Sounds. Few studies have been conducted on the effects of impulsive sounds on fish; the most comprehensive studies using impulsive sounds are from seismic airguns (*e.g.*, Popper *et al.*, 2005). Additional studies have included those on pile driving (reviewed in Hastings and Popper, 2005) and explosives (*e.g.*, Yelverton *et al.*, 1975; Keevin *et al.*, 1997; Govoni *et al.*, 2003 reviewed in Hastings and Popper, 2005).

As discussed earlier, the airgun 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 nonauditory tissues, including the swim bladder, showed no apparent damage (Popper *et al.*, 2005). One other study of effects of an airgun exposure showed some damage to the sensory cells of the ear (McCauley *et al.*, 2003), but it is difficult to understand the differences between the two studies. However, the two studies had different methods of exposing fish, and used different species. There are other studies that have demonstrated some behavioral effects on fish during airgun 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). One of the real problems with these studies is that they are highly variable and so extrapolation from one study to another, or to other sources, such as those used by the Navy, is not 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 fish 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 fish 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 msec). Yelverton *et al*, (1975) exposed eight different species of freshwater fish to blasts of 1-lb (0.45-kg) spheres of Pentolite (*i.e.*, an 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 appeared 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 potentially 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 fish 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 fish without a swim bladder are less than those on fish with a swim bladder (*e.g.*, Gaspin, 1975; Geortner *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, fish 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.

In more recently published reports, 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 12 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 25 ft (7.5 m), and more pinfish than spot were affected. Govoni et al. (2008) also evaluated the effects of underwater explosions on the larvae and small juveniles of two species of fish under experimental conditions, determining that the resultant fish mortality (approximately 3 percent in the experimental system) was unlikely to seriously affect fishes at the population level.

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 airguns 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.

As indicated for other sources, the evidence of short- and long-term behavioral effects, as defined by changes in fish movement, etc., is nonexistent. 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.

3.9.3.1.3 General Conclusions of Sound on Fish

As discussed, the extent of data, and particularly scientifically peer-reviewed data, on the effects of high intensity sounds on fish is exceedingly limited. Some of these limitations include:

- Types of sources tested;
- Effects of individual sources as they vary by such things as intensity, repetition rate, spectrum, distance to the animal, etc.;
- Number of species tested with any particular source;
- The ability to extrapolate between species that are anatomically, physiologically, and/or taxonomically different;
- Potential differences, even within a species, as related to fish size (and mass) and/or developmental history;
- Differences in the sound field at the fish, even when studies have used the same type of sound source (*e.g.*, seismic airgun);
- Poor quality experimental design and controls in many of the studies to date;
- Lack of behavioral studies that examine the effects on, and responses of, fish in their natural habitat to high intensity signals;
- Lack of studies on how sound may impact stress, and the short- and long-term effects of acoustic stress on fish; and
- Lack of studies on eggs and larvae that specifically use sounds of interest to the Navy.

At the same time, in considering potential sources that are in the mid- and high-frequency range, a number of potential effects are clearly eliminated. Most significantly, since the vast majority of fish species studied to date are hearing generalists and cannot hear sounds above 500 to 1,500 Hz (depending upon the species), there are not likely to be behavioral effects on these species from higher frequency sounds.

Moreover, even those marine species that may hear above 1,500 Hz, such as a few sciaenids and the clupeids (and relatives), have relatively poor hearing above 1,500 Hz as compared to their hearing sensitivity at lower frequencies. Thus, it is reasonable to suggest that even among the species that have hearing ranges that overlap with some mid- and high-frequency sounds, it is likely that the fish will only actually hear the sounds if the fish and source are very close to one another. And, finally, since the vast majority of sounds that are of biological relevance to fish are below 1 kHz (*e.g.*, Zelick *et al.*, 1999; Ladich and Popper, 2004), even if a fish detects a mid- or high-frequency sound, these sounds will not mask detection of lower frequency biologically relevant sounds.

At the same time, it is possible that very intense mid- and high-frequency signals, and particularly explosives, could have a physical impact on fish, resulting in damage to the swim bladder and other organ systems. However, even these kinds of effects have only been shown in a few cases in response to explosives, and only when the fish has been very close to the source. Such effects have never been shown from any Navy sonar. Moreover, at greater distances (the distance clearly would depend on the intensity of the signal from the source) there appears to be little or no impact on fish, and particularly no impact on fish that do not have a swim bladder or other air bubble that would be affected by rapid pressure changes. Thus, a reasonable conclusion, even without more data, is that there will be few, and more likely no, impacts on the behavior of fish.

3.9.3.1.4 Acoustic Effects of Common Activities

Aircraft, Missile and Target Overflights. There are aircraft, missile, and target overflights during training exercises; torpedo and aerial and submarine target recovery operations; air-to-air and surface-to-air missile firing exercises; electronic warfare exercises; air strikes and Close Air Support (CAS) exercises, and other exercises. Relatively few low-altitude (<1,000 ft [305 m]) flights of fixed-wing aircraft and missiles are conducted in the MIRC, and many are of short (minutes) duration. Helicopter overflights or hovering at altitudes of 100 to 1,000 ft (30 to 305 m) are also part of some activities.

Sound does not transmit well from air to water (refer to Section 3.5). 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. Effects of underwater noise attributable to aircraft, missile, and target overflights on fish are anticipated to be minimal.

Muzzle Blast. 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 328 ft (100 m) and 185 dB re 1 µPa at ~18 ft (5.5 m). The resulting ensonified areas (semi-circles with radius 328 and 18 ft (100 and 5.5 m) would be 0.004 nm^2 (0.015 km^2) and ~ 538 ft^2 (50 m^2).

Because fish apparently only react to impulsive sounds >160 dB, only those in the 0.004-nm^2 (0.015-km^2) area would be affected, and effects would be limited to short-term, transitory alarm, or startle responses.

Effects of Underwater Explosions. Underwater explosions occur during mine warfare training activities, live-fire and bombing of seaborne targets, use of the Improved Extended Echo Ranging (IEER) sonobuoy during ASW, and when firing weapons end up in the water. Concern about potential fish mortality associated with the use of underwater explosives led military researchers to develop mathematical and computer models that predict safe ranges for fish and other animals from explosions of various sizes (*e.g.*, Yelverton *et al.*, 1973; Goertner, 1994).

Young's (1991) equations for 90 percent survivability were used to estimate fish mortality in the *Seawolf Shipshock Trial EIS* (DoN, 1998). In that document, Yelverton's (1981) equations were used to predict survival of fish with swim bladders. Young's equations apply to simple explosives, and several of the explosives used in the MIRC have a more complicated configuration and blast parameters. Thus, impulse and effects were computed separately. The Seawolf Shipshock Trials were conducted in open water, where blast effects are predicted more easily. Explosives used in the MIRC are detonated in both shallow water and deep water.

The impulse levels that kill or damage fish with swim bladders have been determined empirically to be as follows (from Yelverton, 1981):

50 percent Mortality	$\ln(I)=3.6136 + 0.3201 \ln(M)$
1 percent Mortality	$\ln(I)=3.0158 + 0.3201 \ln(M)$
No Injuries	$\ln(I)=2.0042 + 0.3201 \ln(M)$

where I = impulse (in Pascal·seconds or Pa·s) and M = body mass of a fish (g) with a swim bladder. Yelverton (1981) cautioned against using these equations for fish weighing more than a few kg because fish used in the experiments from which these equations were derived did not weigh more than 2.2 lb (1 kg). Based on the Yelverton equations, it is estimated that small fish (0.5 lb or 0.2 kg) with swim bladders would not be injured by impulses up to 42 Pa·s, while larger fish (125 lb or 57 kg) with swim bladders would not be injured by impulses as large as 247 Pa·s.

Effects of Shock Waves from Mines, Inert Bombs, Missiles, and Targets Striking the Water's Surface. Mines, inert bombs, or intact missiles or targets fall into the waters of the MIRC during the following exercises:

- Mine Exercise (MCMEX)
- MISSILEX
- SINKEX
- BOMBEX
- GUNEX

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 sound 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 injure fish. The rise times of these shock waves are very short and the 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.

Sonar. This section presents an evaluation of the potential sonar effects on fish resulting from the implementation of the Proposed Action. There have been few directed studies on the impact of sonar on fish (Jørgensen *et al.,* 2005; Kvadsheim and Sevaldsen, 2005). Some marine fish may be able to detect mid-frequency sounds, but the most sensitive hearing range of most marine fish is generally below the mid-frequency bandwidth. Studies indicate that most marine fish are hearing generalists and have their best hearing sensitivity at or below 0.3 kHz (Popper, 2003). It has been demonstrated that a few marine specialist species can detect sounds to 4 kHz and some to even above 120 kHz; however, a gap in the sensitivity exists from 3.2 kHz to 12.5 kHz for at least one of these species, the American shad (Dunning *et al.,* 1992; Mann *et al.,* 1998; Mann *et al.,* 2001; Nestler *et al.,* 2002; Popper and Carlson, 1998; Popper *et al.,* 2004; Ross *et al.,* 1996). Marine species that can hear in the mid-frequency range do not hear best at the frequencies of the operational sonars. Fish can only hear a sound at the edge of their hearing frequency sensitivity range if the sound is very loud. Thus, it is expected that most marine hearing specialists will be able to detect the lowest frequencies of the loudest pings of operational sonars and some, such as some clupeids, will be able to detect the entire range only if in close proximity to the loudest pings (*i.e.* 184 ft [56 m]) of a frequency modulated [FM] signal at 225 dB re 1 µPa; see Kvadsheim and Sevaldsen, 2005).

Studies have shown that hearing generalists normally experience only minor or no hearing loss when exposed to continuous noise, but that hearing specialists may be affected by noise exposure. Exposure to loud sound can result in significant threshold shifts in hearing specialists. Studies thus far have shown these threshold shifts are temporary (Scholik and Yan, 2001; Smith *et al.,* 2004a; Smith *et al.,* 2004b), but it is not known that they lead to any long-term behavioral disruptions in fish that are biologically significant. The only experiments to have shown mortality in fish due to MFA sonar have been investigations into the effects on juvenile herring exposed to intense MFA sonar. This is not to say, however, that fish, no matter what their hearing sensitivity, are not prone to injury as a result of exposure to MFA sonar. Individual juvenile fish with a swim bladder resonance in the frequency range of the operational sonars, and especially hearing specialists such as some clupeid species, may experience injury or mortality. The resonance frequency will depend on fish species, size, and depth (McCartney and Stubbs, 1971; Løvik and Hovem, 1979). The swim bladder is a vital part of a system that amplifies the vibrations which reach the fish's hearing organs and at resonance the swim bladders may absorb much of the acoustic energy in the impinging sound wave (Sevaldsen and Kvadsheim, 2004). The resulting oscillations may cause mortality or harm the swim bladder itself or the auditory organs (Jørgensen *et al.*, 2005). Kvadsheim and Sevaldsen (2005) found the zone within which injury may be caused in Atlantic herring at high levels of CW-signal MFA sonar (225 dB re 1 µPa), would be to a radius of 584 ft (178 m) and to a depth of 748 ft (228 m) if the sonar is placed 164 ft (50 m) deep. Lowering the source level by 25 dB reduced the ranges by over 328 ft (100 m). For a FM-signal, injury was predicted to occur over a radius of 184 ft (56 m) and to a depth of 358 ft (106 m). Lowering of the source level of the FM-signal by 25 dB reduced the ranges by over 164 ft (50 m). Kvadsheim and Sevaldsen (2005) determined the effects to the Atlantic herring population are likely to be insignificant considering the natural mortality rate of juvenile fish and the limited exposure of the fish to the sound source (Jørgensen *et al.*, 2005). The physiological effect of sonars on adult fish is expected to be less than for juvenile fish because adult fish are in a more robust stage of development, the swim bladder frequencies will be outside the range of the frequency of MFA sonar, and adult fish have more ability to move from an unpleasant stimulus (Kvadsheim and Sevaldsen, 2005).

Popper *et al.* (2007) exposed rainbow trout to high intensity low-frequency sonar (maximum RL was approximately 193 dB re 1 µPa at 196 Hz) for 324 or 648 seconds. Fish exhibited a slight behavioral reaction, and one group exhibited a 20 dB auditory threshold shift at one frequency. No direct mortality, morphological changes, or physical trauma was noted as a result of these exposures. The authors point out, however, that the experimental conditions represented an extreme worst-case example with longer than typical exposures for LF sonar, use of a stationary source, and confined animals. These results, therefore, may not be reflective of expected real-world exposures from low-frequency sonar operations.

Studies have indicated that acoustic communication and orientation of fish may be restricted by noise regimes in their environment (Wysocki and Ladich, 2005). Although some species may be able to produce sound at higher frequencies (> 1 kHz), vocal marine fish largely communicate below the range of mid-frequency levels used in the Proposed Action. Further, most marine fish species are not expected to be able to detect sounds in the mid-frequency range of the operational sonars used in the Proposed Action. The few fish species that have been shown to be able to detect mid-frequencies do not have their best sensitivities in the range of the operational sonars. Thus, these fish can only hear mid-frequency sounds when they are very loud (*i.e.*, when sonars are operating at their highest energy levels and fish are within a few meters). Considering the low frequency detection of most marine species and the limited time of exposure due to the moving sound sources, the MFA sound sources used in the Proposed Action do not have the potential to significantly mask key environmental sounds.

Based on the evaluation presented herein, the likelihood of significant effects to individual fish from the proposed use of MFA sonar is low. While the consequences of MFA sonar may affect some individual fish (*e.g.*, herring), the overall effects to populations will be minimal when compared to their natural daily mortality rates. Overall, the effects of this action are likely to be minimal considering the few fish species that will be able to detect sound in the frequencies of the Proposed Action and the limited exposure of juvenile fish with swim bladder resonance in the frequencies of the sound sources.

3.9.3.1.5 Nonacoustic Effects of Common Activities

Munitions Constituents. Munitions constituents can be released from sonobuoys, submarine targets, torpedoes, missiles, aerial targets, bombs, flares, projectiles, 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, its fuel will be spread over a large area and dissipate quickly. In addition, fuel spills and material released from weapons and targets would occur at different locations and at different times. The water quality analysis of all current and proposed operations found that concentrations of all constituents of concern associated with the release of materials into the MIRC were well below water quality criteria established to protect aquatic life (refer to Section 3.3). Effects on marine fish associated with the release of munitions constituents, carbon, and Kevlar pieces and other materials are expected to be minimal.

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. Effects of falling debris and small arms rounds on fish are expected to be minimal.

Flares and Chaff. An extensive review of literature, combined with controlled experiments, revealed that chaff and self-defense flare use pose little risk to the environment or animals (USAF, 1997; Naval Oceanographic Office, 1999). The materials in chaff are generally nontoxic except in quantities significantly larger than those any marine fish could reasonably be exposed to from normal usage. Particulate tests and a screening health risk assessment concluded that the concern about chaff breaking down into respirable particle sizes is not a significant issue. Experiments have shown that animals should not suffer toxic or physical effects from chaff ingestion (USAF, 1997; Naval Oceanographic Office, 1999). There is no published evidence that chaff exposure has caused the death of a marine fish, and experiments have shown no direct effects of chaff on marine animals (USAF, 1997; Naval Oceanographic Office, 1999). Effects of chaff on fish are expected to be minimal.

Toxicity is not a concern with self-defense flares since the primary material in flares, magnesium, has low toxicity (USAF, 1997) and will normally combust before striking the land or sea surface. It is unlikely that marine fish would ingest flare material and flare end caps because they will sink rapidly. Although impulse cartridges and initiators used in some flares contain chromium and lead, a screening health risk assessment concluded that they do not present a significant health risk in the environment (USAF, 1997). Effects of flares on fish are expected to be minimal.

3.9.3.2 No Action Alternative

3.9.3.2.1 Vessel Movements

Many of the ongoing and proposed training 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 fish and fish species with designated EFH by directly striking or disturbing individual fish or schools of fish. Vessel movements associated with training in the Study Area occur mostly during the annual major exercise, which can last up to 2 or 3 weeks. Elements of this training are widely dispersed throughout the Study Area, which is a vast area encompassing 450,187 nm^2 (1,544,098 km^2). The probability of ship and fish interactions occurring in the Study Area is dependent on several factors including numbers, types, and speeds of vessels; the regularity, duration, and spatial extent of training activities within areas of relatively high productivity (increasing prey and forage availability for fish); and protective measures implemented by the Navy (as described in Section 3.7 [Marine Mammals]). Currently, the number of Navy ships operating in the Study Area varies based on training schedules and can range from 0 to about 10 ships at any given time. Ship sizes range from 362 ft (110 m) for a nuclear submarine (SSN) to 1,092 ft (333 m) for a nuclear aircraft carrier (CVN) and speeds range from 10 to 14 knots. Training activities involving vessel movements occur intermittently and are short in duration, ranging from a few hours up to a few weeks.

Vessel movements under the No Action Alternative would expose fish to general disturbance in the Study Area, which could result in short-term behavioral and/or physiological responses (*e.g.*, swimming away and 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 particular 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 where a vessel is operating, 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. Navy mitigation measures include avoidance of areas of high productivity, discussed in Section 3.6 (Marine Communities), where some fish species tend to concentrate, further reducing the probability of habitat disturbance and injury or mortality. Vessel movements under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. Therefore, in accordance with NEPA, vessel movements under the No Action Alternative would not significantly impact fish, fish populations, or EFH. In accordance with EO 12114, vessel movements would not significantly harm fish, fish populations, or EFH.

3.9.3.2.2 Amphibious Landings and Over-the-Beach Training

The effects of amphibious landings and OTB training on fish and fish populations would be most closely associated with increased vessel movements in nearshore habitats. Combat swimmer insertions would not affect fish beyond inducing short-term behavioral response (*e.g.*, swimming away),

Amphibious landings consist of a seaborne force from over the horizon assaulting across a beach in a combination of helicopters, aircraft, landing craft air cushion, light armored vehicle, small rubber boats, or other landing craft. Locations where amphibious landings occur in the MIRC include the Exclusive Military Use Area (EMUA), which is DoD-leased land covering the northern third of Tinian. The EMUA has two small sandy beaches (Unai Chulu and Unai Dankulo) that are capable of supporting amphibious landing training activities. Existing habitat data indicates that the nearshore waters of Unai Chulu and Unai Dankulo are predominantly ephemeral turf species, with relatively low coral densities. These training activities may have temporary and localized impacts to EFH. Another location includes Tipalao Cove, which provides access to a small beach area capable of supporting a shallow draft amphibious landing craft. Benthic biota are extremely uncommon in Tipalao Bay; living corals comprise less than one percent bottom cover, and benthic macrofauna are essentially absent.

Although amphibious landings are restricted to specific areas of designated beaches, amphibious landings in nearshore habitat can lead to a temporary and localized impact on FMP species due to death or injury, loss of benthic epifauna and infauna that may serve as prey items for managed species, and increased turbidity. Increases in turbidity could temporarily decrease the foraging efficiency of fishes. In sandy areas, given the dynamic nature of the habitat and the grain size of the material, turbidity is expected to be minimal and localized. Although coral is not common in these areas, recovery to coral that is affected by amphibious landings would be dependent upon the frequency of additional disturbances and other natural factors. Protective measures are in place to insure that impacts to sensitive habitat are avoided and include pre- and post-activity hydrographic surveys, landing at high tide, and monitoring.

The effects of amphibious landings and OTB training on fish, fish populations, and essential fish habitat would be temporary and localized, and would not result in a significant impact to fish, fish populations, or EFH, in accordance with NEPA. These amphibious landing activities only take place within territorial waters of the U.S.; therefore, EO 12114 does not apply.

3.9.3.2.3 Sonar

MFA and HFA Sonar. Tactical MFA sonar produces sounds at frequencies between 1 and 10 kHz. Some species of fish are able to detect these sounds with their auditory systems, and sound is thought to be important to fish communication and perception of their environments (*e.g.*, learning about the "auditory scene," including detection of prey and avoidance of predators).

Many species of fish are known to be able to detect and localize (*i.e.*, determine the distance and bearing of) sounds, and to discriminate between sounds. It is also known that exposure to human-generated (anthropogenic) sounds can affect hearing capabilities of at least some fish species, and can even cause temporary loss of the ability to detect sounds in the environment (either from damage to the ears or through interference "masking" of the desired signal), which may have an impact on short- or long-term survival. Thus, the intensity, duration, onset, and incidence of exposure to sounds, and how they impact the ability of fish to detect biologically relevant sounds, are important factors in considering potential impacts of mid-frequency sonar on fish within the Study Area.

For years, fisheries in various parts of the world have complained about declines in their catch after intense acoustic activities (including naval exercises) moved into the area, suggesting that noise is seriously altering the behavior of some commercial species. There is no information available that suggests exposure to nonimpulsive acoustic sources results in significant fish mortality on a population level. Mortality has been shown to occur in one species, a hearing specialist; however, the level of mortality was considered insignificant in light of natural daily mortality rates. Experiments have shown that exposure to loud sound can result in significant threshold shifts in certain fish that are classified as hearing specialists (but not those classified as hearing generalists). Threshold shifts are temporary, and considering the best available data, no data exist that demonstrate any long-term negative effects on marine fish from underwater sound associated with sonar activities. Further, while fish may respond behaviorally to mid-frequency sources, this behavioral modification is only expected to be brief and not biologically significant.

The duration (pings lasting 0.5 to 2.0 seconds) and frequency (1 to 10 kHz) of MFA sonar use associated with training activities within the Study Area are too short and relatively infrequent to cause long-term effects to fish or EFH. Therefore, in accordance with NEPA, MFA and HFA sonar use as part of the No Action Alternative will not significantly impact fish, fish populations, or EFH. In accordance with EO 12114, MFA and HFA sonar use as part of the No Action Alternative will not significantly harm fish, fish populations, or EFH in non-territorial waters.

LFA Sonar. During ASW training, air, surface, and submarine units will be used to locate and localize Opposition Forces (OPFOR) submarines. In addition to the Carrier Strike Group (CSG) forces conducting ASW, up to two SURTASS LFA sonar ships will conduct search procedures in support of the friendly forces. The SURTASS LFA system is described in Chapter 2 of this EIS/OEIS as part of ASW training.

If LFA sonar training exercises occur in proximity to fish stocks, members of some fish species could potentially be affected by low-frequency sounds. Even then, the impact of fish is likely to be minimal to negligible since only an inconsequential portion of any stock would be present within the 190-dB sound field at any time. Moreover, recent results from direct studies of the effects of LFA sounds on fish (Popper et al., 2007) provide evidence that LFA sonar sounds at high levels (up to 193 dB RL) have minimal impact on at least the species of fish that have been studied. Nevertheless, the 180-dB criterion is maintained for the analyses presented in the SURTASS LFA Supplemental EIS, which noted that this criterion was highly conservative and protective of fish (DoN, 2006).

The SURTASS LFA FEIS also quantified the potential effects of LFA on fish catches through an analysis of nominal SURTASS LFA sonar exercises in the region off the Pacific Coast of the U.S. (DoN, 2006, Subchapter 4.3.1, NMFS Fisheries Resource Region-Pacific Coast). This analysis for fish catches covered an area from the Canadian to Mexican borders, from the shoreline out to 500 nm (926 km). The results of this analysis showed that the percent of fish catch potentially affected would be negligible compared to fish harvested commercially and recreationally in the region. The SURTASS LFA Supplemental EIS further stated that the analysis was based on 180 d-B injury level and a 20 percent duty cycle; therefore, the results were highly conservative and protective of fish.

In conclusion, LFA use under the No Action Alternative would have no significant impact on fish, fish populations, or EFH in accordance with NEPA. Further, in accordance with EO 12114, LFA use under the No Action Alternative within non-territorial waters would not significantly harm fish, fish habitat, or EFH.

3.9.3.2.4 Explosive Ordnance and Underwater Detonations

Explosions that occur in the Study Area are associated with training exercises that use explosive ordnance, including bombs, missiles, and naval gunshells (5-inch high explosive projectiles), as well as underwater detonations associated with ASW training. Explosive ordnance use and underwater detonation is limited to a few specific training areas. The potential for fish to be exposed to explosions is difficult to quantify and depends on several factors including the following:

- The geographic location of the explosions within the Study Area and the marine community type where the explosions occur. Depending on where the munitions are detonated, fish and invertebrates at different life stages may be affected by the blast. Marine communities within the Study Area are discussed in Section 3.6 (Marine Communities).
- Position of the explosion within the water column. Explosions associated with bombs, missiles, and naval gunshells occur at or immediately below the sea surface, while underwater detonations occur on the bottom and at depths below the surface. Depending on where the detonation occurs and how the explosive energy is distributed vertically through the water column, different species at varying life stages may be affected by the blast.

- Magnitude of the explosion (*i.e.*, net explosive weight [NEW]) and the zone of influence (ZOI) associated with the explosion. While ZOIs cannot be calculated for fish based on available data, higher NEWs would produce larger ZOIs. Of the explosions that occur in the Study Area, bombs are expected to have the largest ZOIs, followed by naval gunshells, 20-lb (9-kg) NEW underwater detonations, 10-lb (4.5-kg) NEW underwater detonations, and Hellfire missiles.

Effects of underwater explosives on fish have been fairly well documented (see reviews by Hastings and Popper, 2005; Christian, 1973; Hill, 1978; Baxter *et al.*, 1982; Lewis, 1996; and Keevin and Hempen, 1997). The few generalities that have emerged from empirical studies suggest that underwater explosions are lethal to most fish species in the immediate vicinity of the explosion regardless of size, shape, or internal anatomy. At greater distances from the detonation, species with gas-filled swim bladders suffer higher mortality than those without swim bladders.

Mortality and Injury. Studies suggest that larger fish are generally less susceptible to death or injury than small fish at the same distance from the source (Yelverton *et al.*, 1975), elongated forms that are round in cross-section are less at risk than deep-bodied forms, and orientation of fish relative to the shock wave may affect the extent of injury. The results of most studies are dependent upon specific biological, environmental, explosive, and data recording factors. One of the real problems with these studies is that they are highly variable and so extrapolation from one study to another, or to other sources, such as those used by the Navy, is not really possible.

Several factors determine a fish's susceptibility to harm from underwater detonations. Most injuries in fish involve damage to air- or gas-containing organs (*i.e.*, the swim bladder). Fish with swim bladders are vulnerable to effects of explosives, while fish without swim bladders are much more resistant (Yelverton, 1981; Young, 1991). Research has focused on the effects on the swim bladder from underwater detonations but not the ears of fish (Edds-Walton and Finneran, 2006).

For underwater demolition training, the effects on fish from a given amount of explosive depend on location, season, and many other factors. O'Keeffe (1984) provides charts that allow estimation of the potential effect on swim bladder fish using a damage prediction method developed by Goertner (1982). O'Keeffe's parameters include the size of the fish and its location relative to the explosive source, but are independent of environmental conditions (*e.g.*, depth of fish, explosive shot, and frequency content).

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 airguns 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.

Behavioral Effects. The evidence of short- and long-term behavioral effects caused by detonations, as defined by changes in fish movement, etc., is nonexistent. Several studies, however, have suggested that human-generated sounds may affect the behavior of at least a few species of fish. For example, field studies by Engås *et al.* (1996) and Engås and Løkkeborg (2002) showed that there was a significant decline in catch rate of haddock (*Melanogrammus* spp.) and cod (*Gadus* spp.) that lasted for several days after termination of air gun use, after which time the catch rate returned to normal. The observations suggest that the catch decline resulted from the sound of the air guns, and that the sound probably caused the fish to leave the exposure area, although there was no direct data to support this conclusion. More recent work from the same group (Slotte *et al.*, 2004) showed similar results for several additional pelagic species including blue whiting (a species of cod) and herring (*Clupea* spp.). Slotte *et al.* found that fish in the area of the air guns appeared to go to greater depths after sound exposure compared to their vertical position prior to the air gun usage. Moreover, the abundance of animals 19 to 31 mi (30 to 50 km) away from the sound exposure increased, suggesting that migrating fish would not enter the zone of seismic activity.

The declines in catch rates may be explained by other factors in the marine environment and the catch rates are not statistically different than the normal variation in catch rates over several seasons (Gausland, 2003). Skalski *et al.,* (1992) demonstrated a startle response to sounds as low as 160 dB in fish, but this sound did not appear to elicit decline in catch. Wardle *et al.,* (2001) used a video system to examine the behaviors of fish and invertebrates on a coral reef in response to emissions from seismic air guns that were carefully calibrated and measured to have a peak level of 210 dB re 1 µPa at 52 ft (16 m) from the source and 195 dB re 1 µPa at 358 ft (109 m) from the source. They found no permanent changes in the behavior of the fish or invertebrates on the reef throughout the course of the study, and no animals appeared to leave the reef. Further, there was no indication of any observed damage to the animals. It is therefore unknown whether explosions, at some distance, while causing no physical harm, may alter fish behavior in any significant way.

Underwater detonations may occur during the No Action Alternative at the MIRC, and may include the following exercises: SINKEX, Air-to-Surface (A-S) MISSILEX, Surface-to-Surface (S-S) MISSILEX, BOMBEX, S-S GUNEX, and Naval Surface Fire Support (NSFS). A lead time for setup and clearance of the impact area occurs before any event using explosives takes place (at least 30 minutes to several hours); therefore, a long period of area monitoring will occur before any detonation or live-fire event begins. Ordnance cannot be released until the target area is determined clear of marine mammals or sea turtles. In Apra Harbor, explosive charges are limited to 10 lb (4.5 kg) charges or less. Although these avoidance and minimization measures are designed specifically to avoid impact to sea turtles and marine mammals, the monitoring period prior to an exercise should be sufficient for fish to swim away; low NEW of explosive charges within Apra Harbor will not cause significant behavioral responses.

Potential impacts on fish from underwater demolition detonations would be negligible. A small number of fish are expected to be injured by detonation of explosive, and some fish located in proximity to the initial detonations can be expected to die. However, the overall impacts on water column habitat would be localized and transient. As training begins, the natural reaction of fish in the vicinity would be to leave the area. When training events are completed, the fish stock would be expected to return to the area.

While serious injury and/or mortality to individual fish would be expected if they were present in the immediate vicinity of an explosion, explosions under the No Action Alternative would not result in significant 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. Habitat disturbance and fish injury and mortality from explosions are reduced by Navy mitigation measures. Large areas of relatively high primary productivity (Section 3.6 [Marine Communities]) where some fish species tend to concentrate are avoided and underwater explosive charges are not set within 1,093 yards (1,000 m) of live/hard bottom, artificial reefs, and shipwrecks. Underwater detonations and explosive ordnance use under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. Therefore, in accordance with NEPA, explosive ordnance and underwater detonations will have no significant impact on fish, fish populations, or EFH under the No Action Alternative. The explosive ordnance and underwater detonations under the No Action Alternative will not significantly harm fish, fish populations, or EFH in non-territorial waters in accordance with EO 12114.

3.9.3.2.5 Weapons Firing/Nonexplosive Ordnance Use

While it is possible that some individual fish at or near the surface in the target area may be impacted during ordnance delivery, ordnance strikes under the No Action Alternative would not result in significant impacts to fish populations. Disturbances to water column habitats from ordnance strikes would be short-term and localized. Ordnance strikes would cause little or no physical damage to benthic habitat, and any damage would be localized. Navy mitigation measures which include avoidance of areas of high productivity, discussed in Section 3.6 (Marine Communities), where some fish species tend to concentrate, further reduce the probability of habitat disturbance and injury or mortality. Although these avoidance measures were generally devised to minimize and avoid effects to sea turtles and marine mammals, the measures will also serve to reduce effects on fish species. Weapons firing/ordnance use under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. Therefore, in accordance with NEPA, weapons firing and nonexplosive ordnance use will have no significant impact on fish, fish populations, or EFH under the No Action Alternative. The weapons firing and nonexplosive ordnance use under the No Action Alternative will not significantly harm fish, fish populations, or EFH in non-territorial waters in accordance with EO 12114.

3.9.3.2.6 Expended Materials

Fish could be exposed to a variety of expended materials under the No Action Alternative through direct contact and ingestion. Impacts associated with expended materials would include an increased exposure to ingestion and entanglement. Ingestion of materials such as chaff and plastics may increase mortality risk by blocking digestive pathways. Entanglement of fish species in materials such as parachutes could render fish immobile or expose the fish to predation. However, the effects of expended materials on fish would be negligible to minor. Benthic habitats throughout the Study Area would be exposed to expended materials as they are widely dispersed and a majority of the materials rapidly sink to the sea floor. The analyses presented in Sections 3.2.3 and 3.3.3 indicate that expended 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. Some materials are the same as those often used in artificial reef construction (*e.g.,* concrete and metal associated with inert bombs) and would be colonized by benthic organisms that prefer hard substrate. This colonization could result in localized increases in species richness and abundance, but no significant changes in community structure or function would be anticipated based on the limited amount and dispersed nature of the materials. Artificial reefs are discussed in detail in Section 3.6 (Marine Communities). Expended materials under the No Action Alternative would not result in adverse effects to fish populations or EFH as defined under the MSFCMA. Therefore, in accordance with NEPA, expended materials will have no significant impact on fish, fish populations, or EFH under the No Action Alternative. The No Action Alternative will not significantly harm fish, fish populations, or EFH in non-territorial waters in accordance with EO 12114.

3.9.3.2.7 Species of Concern

The effects of the No Action Alternative on Species of Concern would be the same as those described above for other fish species. Further, because of the close association of the humphead wrasse and bumphead parrotfish with coralline communities and coralline fringes and the Navy's compliance with EO 13089, Coral Reef Protection, the No Action Alternative would not result in significant adverse effects to Species of Concern. Expected effects would be temporary, resulting from low yield (under 10 lb [4.5 kg] NEW) detonations within Apra Harbor that may cause these two species to leave the vicinity for a short duration.

3.9.3.3 Alternative 1

3.9.3.3.1 Vessel Movements

An additional major exercise involving vessel movements will be added under Alternative 1. Unlike the Multiple Strike Group exercise, the additional exercise will be an Amphibious Assault exercise, which will not involve as many vessel movements as a Multiple Strike Group exercise. These changes would result in increased potential for short-term behavioral reactions to vessels. Although vessel movements would increase, increased ship collisions with fish are not expected to occur. Avoidance of areas known for relatively higher primary productivity, along with other mitigation measures designed to reduce impacts to sea turtles and marine mammals will likewise reduce impacts to fish and EFH.

3.9.3.3.2 Amphibious Landings and Over-the-Beach Training

There will be no increases in amphibious landing activities or OTB under Alternative 1. Effects to fish, fish populations, and EFH from amphibious landings or OTB would be similar to those of the No Action Alternative. Since amphibious landings or OTB would not occur in non-territorial waters, EO 12114 does not apply.

3.9.3.3.3 Sonar

Training activities using sonar will increase under Alternative 1. The duration and frequency of MFA and HFA sonar use associated with training activities within the Study Area will increase by approximately 33 percent. However, because they are too short and relatively infrequent, long-term effects to fish, fish populations, or EFH are unlikely. Further, LFA sonar use associated with SURTASS LFA training will also be short in duration and relatively infrequent. Long term effects to fish, fish populations, or EFH are unlikely. Therefore, in accordance with NEPA, LFA, MFA, and HFA sonar will not significantly impact fish, fish populations, or EFH under Alternative 1. In accordance with EO12114, LFA, MFA, and HFA sonar will not significantly harm fish, fish populations, or EFH.

3.9.3.3.4 High Explosive Ordnance

Underwater detonations may occur under Alternative 1, and may include the following exercises: SINKEX, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS. There is a lead time for setup and clearance of the impact area before any event using explosives takes place (at least 30 minutes to several hours). There will, therefore, be a long period of area monitoring occurring before any detonation or live-fire event begins. Ordnance cannot be released until the target area is determined clear.

The effects to fish and fish populations would be the same as discussed under the No Action Alternative. Fish and fish populations would not be affected because of the low numbers of fish that would be exposed to detonations. The amount of benthic habitat affected by large explosions would continue to be small and the effects would be short-term and localized. Habitat disturbance and fish injury and mortality from explosions are reduced by Navy mitigation measures designed to reduce or avoid impacts to sea turtles and marine mammals. In accordance with NEPA, high explosive events under Alternative 1, submerged or on the surface within territorial waters, would have no significant impact on fish or fish populations. Furthermore, high explosive events in non-territorial waters would not cause significant harm to fish or fish populations in accordance with EO 12114.

3.9.3.3.5 Expended Materials

The amount of ordnance fired would increase in the Study Area under Alternative 1 (Tables 2-7 and 2-8). These changes would result in increased exposure of fish and EFH to expended materials (*e.g.*, chaff, parachutes, etc). However, the analysis presented in the EFH Assessment indicates that the effects of expended materials on fish and EFH would be negligible to minor. Under Alternative 1, expended materials 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 Alternative 1 would have no significant impact on fish populations or habitat. Furthermore, expended materials in non-territorial waters would not cause significant harm to fish populations or habitat in accordance with EO 12114.

3.9.3.3.6 Species of Concern

Despite the increase in training activities, the effects of Alternative 1 on Species of Concern would be the same as those described above for the No Action Alternative. Further, because of the close association of the humphead wrasse and bumphead parrotfish with coralline communities and coralline fringes, as well as the Navy's compliance with EO 13089, Coral Reef Protection, Alternative 1 would not result in significant adverse effects to Species of Concern.

3.9.3.4 Alternative 2

3.9.3.4.1 All Stressors

As detailed in Chapter 2 and Tables 2-6 and 2-7, implementation of Alternative 2 would include all the actions proposed for MIRC, including the No Action Alternative and Alternative 1, as well as additional major exercises. Beach landings are highly restricted and dependent on an array of training management measures described under the No Action Alternative. Although these measures are specifically designed to avoid impacts to nearshore fish, the increased presence and disturbance should encourage fish to swim away during exercises.

Fish and fish populations would be affected by the increases in exposure to the various stressors considered for analyses; however, mitigation measures reduce the likelihood of significant impacts.

3.9.3.4.2 Unavoidable Significant Environmental Impacts

The analysis presented above indicates that Alternatives 1 and 2 would not result in unavoidable significant adverse effects to fish or fish populations within EFH.

3.9.4 Summary of Environmental Impacts

3.9.4.1 Magnuson-Stevens Fishery Conservation and Management Act

The Study Area covers a vast area encompassing more than 450,187 nm^2 (1,544,098 km^2). The wide dispersion in time and space of Navy training activities superimposed on the variable temporal and seasonal distributions of the fish species present minimizes the potential for interaction with local populations. As described in Section 3.9.1.2, for managed species and EFH an adverse effect is 1) more than minimal, 2) not temporary, 3) causes significant changes in ecological function, and 4) does not allow the environment to recover without measurable impact. Given the limited extent, duration, and magnitude of potential impacts of Navy training, adverse effects on managed species and EFH are not expected under Alternatives 1 or 2 (Table 3.9-3). The Navy has completed an EFH Assessment and is initiating an EFH consultation with NMFS.

3.9.4.2 Endangered Species Act

Species are listed as Species of Concern by NMFS because of insufficient data on fish populations. These species may be petitioned for ESA protection in the future. Fish and marine invertebrates within the Study

Area are not listed under the ESA. The effects of the No Action Alternative, Alternative 1, and Alternative 2 are expected to be the same for nearshore fish. Accordingly, the No Action Alternative and Action Alternatives would not significantly impact the two Species of Concern (bumphead parrotfish and humphead wrasse). Likewise, no significant harm to Species of Concern will occur in non-territorial waters.

3.9.4.3 National Environmental Policy Act and Executive Order 12114

As summarized in Table 3.9-3, the environmental effects of the No Action Alternative, Alternative 1, and Alternative 2 on fish populations and EFH would not be significant.

Table 3.9-3: Summary of Environmental Effects of the Alternatives on Fish and Essential Fish Habitat in the MIRC Study Area

Alternative and Stressor	NEPA (Land and Territorial Waters, < 12 nm)	Executive Order 12114 (Non-Territorial Waters, >12 nm)
No Action Alternative, Alternative 1, and Alternative 2		
Vessel Movements	Short-term and localized disturbance to water column. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.	Short-term and localized disturbance to water column. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
Amphibious Landings	Short-term behavioral responses from vessel approaches to shoreline in nearshore habitats. Limited injury or mortality to fish eggs and larvae. No long-term population-level effects or reduction in the quality and/or quantity of EFH.	Not Applicable. Amphibious landings exclusively occur within territorial waters.
Weapons Firing/Nonexplosive Ordnance Use	Short-term and localized disturbance to water column and benthic habitats. Low potential for injury or mortality to fish from direct strikes. No long-term population-level effects or reduction in the quality and/or quantity of EFH.	Short-term and localized disturbance to water column and benthic habitats. Low potential for injury or mortality to fish from direct strikes. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
Sonar	None	Low potential for increased mortality (swim bladder rupture) or injury (such as hearing loss). Low potential for short-duration masking effects of MFA and LFA sonar.
Underwater Detonations and Explosive Ordnance	Short-term and localized disturbance to water column and benthic habitats. Injury or mortality to fish in immediate vicinity of explosions. No long-term population-level effects or reduction in the quality and/or quantity of EFH. Species of Concern may be subject to temporary behavioral changes (such as swimming away from detonations) within Apra Harbor.	Short-term and localized disturbance to water column and benthic habitats. Injury or mortality to fish in immediate vicinity of explosions. No long-term population-level effects or reduction in the quality and/or quantity of EFH. Species of Concern are not expected to occur in non-territorial waters.
Expended Materials	Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion. No long-term population-level effects or reduction in the quality and/or quantity of EFH.	Long-term, minor, and localized accumulation of expended materials in benthic habitat. Limited potential for ingestion. No long-term population-level effects or reduction in the quality and/or quantity of EFH.
Impact Conclusion	No significant impact to fish populations or habitat.	No significant harm to fish populations or habitat.

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3.10 SEABIRDS AND SHOREBIRDS

This section focuses on seabirds and shorebirds in the open waters, coastal, and wetland areas of the MIRC Study Area. Seabirds 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). Shorebirds are birds that primarily forage in coastal waters (including beaches, tidal areas, and estuaries) and inland palustrine (freshwater) marshes and riverine areas (Temple 2001). Some of these birds are year-round residents in the Mariana Islands, and some species are migratory.

One hundred fifteen species of seabirds and shorebirds are found within the MIRC. All of these species are protected by the Migratory Bird Treaty Act (MBTA). Two of these species, short-tailed albatross (*Phoebastria albatrus*) and Hawaiian petrel (*Pterodroma sandwichensis*), are listed as endangered under the ESA. Eighteen of the 115 seabird and shorebird species are known to breed in the MIRC Study Area; of these, 11 seabird and shorebird species are known to breed on military owned or leased lands.

The Mariana common moorhen, which is protected by the ESA, is not considered a shorebird. Although the moorhen is rarely found in brackish waters, moorhens primarily utilize inland palustrine areas. Moorhens are considered wetland birds and are the last remaining wetland bird species within the Mariana Islands (Stinson *et al.* 1991). Effects of the No Action Alternative and Alternatives 1 and 2 to ESA species are analyzed in Section 3.11 (Terrestrial Resources). Non-ESA listed terrestrial birds, such as the Tinian monarch, are also discussed in Section 3.11.

3.10.1 Introduction and Methods

3.10.1.1 Regulatory Framework

Federal Laws and Regulations

Migratory Bird Treaty Act. Although not all the seabirds and shorebirds known to occur within the MIRC Study Area are migratory (many are year-round residents), all of the seabirds and shorebirds considered in this EIS/OEIS are protected under the MBTA of 1918. The MBTA implements the United States' commitment to four bilateral treaties, or conventions, for the protection of a shared migratory bird resource. The MBTA prohibits the taking, killing, or possessing of migratory birds unless permitted by regulation. The species of birds protected by the MBTA is codified in 50 CFR 10.13. 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.

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 the proper operation and suitability for combat use. Congress further provided that military readiness activities do not include: (a) the routine installation of operating support functions, such as administrative offices, military exchanges, commissaries, water treatment facilities, storage facilities, schools, housing, motor pools, laundries, morale, welfare, and recreational activities, shops, and mess halls; (b) the operation of industrial activities; or (c) the construction or demolition of facilities used for a purpose described in (a) or (b).

The final rule authorizing the DoD to take migratory birds during military readiness activities was published in the Federal Register on February 28, 2007. The regulation can be found in 50 CFR 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 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, sufficiently 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." Assessment of impacts should take into account yearly variations and migratory movements of the impacted species.

Migratory bird conservation relative to non-military readiness activities is addressed separately in a Memorandum of Understanding developed in accordance with EO 13186, signed January 10, 2001, "Responsibilities of Federal Agencies to Protect Migratory Birds." The Memorandum of Understanding between DoD and 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 DoD 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; and,

(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.

Territory and Commonwealth Laws and Regulations. The Government of Guam has enacted the Guam Territorial Seashore Protection Act of 1974 (Chapter 63 of Title 21 of the GCA). This regulation provides protection of the natural, scenic, and historical resources of the seashore reserve including wildlife, marine life, and other ocean resources. This policy seeks to preserve the ecological balance of seashore reserve and prevent its deterioration and destruction. The management of fish and wildlife on Guam is administered by the Department of Agriculture under (Chapter 63 of Title 5 of the GCA [Fish, Game, Forestry and Conservation]). This regulation prohibits any person from taking, buying, selling, transporting or possessing any wild bird, or any part thereof, or wild bird eggs, except as authorized.

Article 2 of Chapter 63 in Title 5 of the GCA establishes the Guam Endangered Species Act, which authorizes protection and conservation of the ecosystem of resident endangered or threatened species. This act provides a program for the conservation and management of such endangered and/or threatened species as appropriate to achieve the purposes of the ESA.

The CNMI has enacted Public Law 2-51 (Fish, Game and Endangered Species Act) which establishes a conservation policy for fish, game and wildlife and the protection of endangered and threatened species. The Division of Fish & Wildlife is one of several agencies under the CNMI Department of Lands and Natural Resources and is responsible for conservation management, restoration of habitat, preserving habitat and species populations in protected areas, issuing licenses and permits, and regulating human use and interaction with our natural resources. To sustain marine sanctuaries, the CNMI has established Marine Protected Areas such as three areas on Saipan (Managaha Marine Conservation Area, Bird Island Sanctuary and Forbidden Island Sanctuary), each of which have No Take Zones.

3.10.1.2 General Approach to Analysis

Each alternative analyzed in this EIS/OEIS includes several warfare areas (e.g., Mine Warfare and Air Warfare) and most warfare areas include multiple types of training activities (e.g., Mine Neutralization, A-S MISSILEX). Likewise, several activities (e.g., vessel movements, aircraft overflights, weapons firing) are accomplished under each event, and those activities typically are not unique to that event. For example, many of the activities involve Navy vessel movements and aircraft overflights. Accordingly, the analysis for seabirds and shorebirds 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 seabirds and shorebirds:

- Identify those aspects of the Proposed Action that are likely to act as stressors to seabirds or shorebirds 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 resources that may occur in the action area.
- Identify locations of seabirds and shorebirds that are likely to co-occur with the stressors in space and time.
- Determine whether and how seabirds or shorebirds are likely to respond given their exposure and available scientific knowledge of their responses.
- Determine the risks those responses pose to seabirds and shorebirds and the significance of those risks.

MIRC Study Area. The MIRC Study Area for seabirds and shorebirds includes open ocean and near-shore areas within the MIRC, as well as DoD owned or leased lands on Guam and the CNMI. Most effects to seabirds are expected to occur at FDM and Hagoi, an atypical emergent marsh and shallow lake within the EMUA on Tinian. Other areas considered for seabirds on Guam include estuarine and riverine habitats within the Navy Main Base (described in Section 3.6.2 [Marine Communities]) and Fena Reservoir within the Ordnance Annex.

Data Sources. A comprehensive and systematic review of relevant literature and data has been conducted in order to complete this analysis for seabirds and shorebirds. Besides journal articles and technical articles that are relevant to seabirds and shorebirds within the Mariana Islands, the primary source of information used to describe the affected environment for seabirds and shorebirds was periodic surveys of FDM and Tinian conducted primarily by Commander, U.S. Naval Forces, Marianas (COMNAVMAR) natural resource personnel. Other sources used in the analysis included the Biological Opinions issued by USFWS for various training actions on Tinian (USFWS 1984a, 1984b, 1990a, 1990b, 1999) and FDM (USFWS 1997a, 1997b, 1997c, 1998, 1999), the Integrated Natural Resources Management Plan (INRMP) associated with Navy lands (and leased lands) in the CNMI (DoN 2003), as well as the USFWS Pacific Region Seabird Conservation Plan (2005a) and recovery plans for the endangered short-tailed albatross and the Hawaiian petrel (USFWS 1983, 2005b). Other site specific seabird and shorebird inventories were obtained from Lusk *et al.* (2000) for FDM and Pratt *et al.* (1987) for the Mariana Islands.

Factors Used to Assess the Significance of Effects. This EIS/OEIS analyzes potential effects to seabirds and shorebirds in the context of the MBTA, NEPA, and EO 12114. The factors used to assess the significance of effects vary under these acts. Factors considered under the MBTA, NEPA, and EO 12114 include the extent to which an alternative could 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 over a reasonable period of time (50 CFR Part 21).

3.10.1.3 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 seabirds and shorebirds. Navy subject matter experts de-constructed the warfare areas and training 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 subsections of this EIS/OEIS. As summarized in Table 3.10-1, potential stressors to seabirds include vessel movements (disturbance and strikes), aircraft overflights (disturbance and strikes), amphibious landings (disturbance and direct nest mortality), weapons firing/non-explosive ordnance use (disturbance and strikes at FDM), explosive ordnance (disturbance and strikes at FDM), and expended materials (targets, chaff, self-protection flares, marine markers, and materials that have the potential to entangle seabirds and shorebirds). The potential effects of these stressors on seabirds and shorebirds are analyzed in detail in Section 3.10.3.

As discussed in the Water Resources and Air Quality sections, some water and air pollutants would be released into the environment as a result of the Proposed Action. The analyses presented in these sections indicate that any increases in water or air pollutant concentrations resulting from Navy training in the MIRC Study Area would be negligible and localized, and impacts to water and air quality would be less than significant. Based on the analyses presented in those sections, water and air quality changes would have no effect or negligible effects on seabirds. Accordingly, the effects of water and air quality changes on seabirds and migratory birds are not addressed further in this EIS/OEIS.

Table 3.10-1: Summary of Potential Stressors to Seabirds and Shorebirds

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Seabirds and Shorebirds
Army Training			
Surveillance & Reconnaissance (S & R)		None	No Impact
Field Training Exercise (FTX)/ Polaris Point Field, Orote Point Airfield & Runway, NLNA, Northwest Field, Andersen South, Tinian EMUA		None	No Impact
Parachute Insertions and Air Assault/ Orote Point Triple Spot, Polaris Point Field, Ordnance Annex Breacher House		None	No Impact
Military Operations in Urban Terrain (MOUT) /Orote Point CQC House, Ordnance Annex Breacher House, Barrigada Housing, Andersen South		Aircraft Overflights	Potential for short-term behavioral responses to overflights, and increased potential for aircraft strikes at access insertion locations in the Main base.
Marine Corps Training			
Ship to Objective Maneuver (STOM)/ Tinian EMUA		Vessel Movements	Short-term behavioral responses to vessels and extremely low potential for collisions, primarily at night. Potential of mortality or death resulting from vessel collisions.
Operational Maneuver		None	No Impact
Non-Combatant Evacuation Order (NEO) /Tinian EMUA		None	No Impact

Table 3.10-1: Summary of Potential Stressors to Seabirds and Shorebirds (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Seabirds and Shorebirds
Marine Corps Training (Continued)			
Assault Support (AS) / Polaris Point Field, Orote Point KD Range, Tinian EMUA		Aircraft Overflights	Potential for short-term behavioral responses to overflights at access insertion locations in the Main base and within the EMUA on Tinian and increased aircraft strike potential.
Reconnaissance and Surveillance (R & S) / Tinian EMUA		None	No Impact
MOUT/ Ordnance Annex Breacher House, Orote Point CQC		None	No Impact
Direct Fires/ FDM, Orote Point KD Range, ATCAA 3A		Aircraft Overflights Weapons Firing Expended Materials	Potential for short-term behavioral responses to overflights to access firing sites at FDM and Orote Point KD Range, and increased bird – aircraft strike potential. Potential for mortality or injury resulting from direct strike of seabirds, eggs or chicks. Potential for ingestion of chaff and/or flare plastic end caps and pistons
Exercise Command and Control (C2)		None	No Impact
Protect and Secure Area		None	No Impact
Navy Training			
Anti-Submarine Warfare (ASW) / Open Ocean		Vessel Movements Aircraft Overflights Underwater explosions Expended Materials	Short-term behavioral responses to vessels and extremely low potential for injury/mortality from collisions, primarily at night. Potential for short-term behavioral responses to overflights, and increased potential for aircraft strikes. Potential for short-term behavioral responses from explosive noise and pressure changes if seabirds are submerged. Potential for injury or mortality within limited ZOI. Potential for direct strike of seabirds (inert torpedo strikes) Potential for ingestion of chaff and/or flare plastic end caps and pistons

Table 3.10-1: Summary of Potential Stressors to Seabirds and Shorebirds (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Seabirds and Shorebirds
Navy Training (Continued)			
Mine Warfare (MIW)/ Agat Bay, Inner Apra Harbor		Vessel Movements Underwater explosions Expended Materials	Short-term behavioral responses to vessels and extremely low potential for injury/mortality from collisions, primarily at night. Potential for short-term behavioral responses from explosive noise and pressure changes if seabirds are submerged. Potential for injury or mortality within limited ZOI. Potential for direct strike of seabirds (inert torpedo strikes) Potential for ingestion of chaff and/or flare plastic end caps and pistons
Air Warfare (AW)/ W-517, R-7201		Expended Materials Weapons Firing	Potential for ingestion of chaff and/or flare plastic end caps and pistons Potential for direct strike of seabirds.
Surface Warfare (SUW)/ FDM, W-517	Surface to Surface Gunnery Exercise (GUNEX)	None	No Impact
	Air to Surface Gunnery Exercise	Aircraft Overflights Weapons Firing Expended Materials	Potential for short-term behavioral responses to overflights, and increased potential for aircraft strikes in W-517 Potential for direct strike of seabirds, eggs or chicks. Potential for ingestion of chaff and/or flare plastic end caps and pistons
	Visit Board Search and Seizure (VBSS)	Aircraft Overflights Vessel Movements	Potential for short-term behavioral responses to overflights, and increased potential for aircraft strikes. Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions.
Strike Warfare (STW)/ FDM	Air to Ground Bombing Exercises (BOMBEX-Land)	Aircraft Overflights Expended Materials Explosive Ordnance	Potential for short-term behavioral responses to overflights to seabirds near FDM Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities and coralline systems surrounding FDM, increasing potential for ingestion. Increase in resident seabird exposure at FDM. Potential for direct strike of seabirds, eggs or chicks. Impacts to seabird breeding from wildland fires ignited by explosive ordnance.

Table 3.10-1: Summary of Potential Stressors to Seabirds and Shorebirds (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Seabirds and Shorebirds
Navy Training (Continued)			
Strike Warfare (STW)/ FDM (continued)	Air to Ground Missile Exercises (MISSILEX)	Aircraft Overflights Expended Materials Explosive Materials	Potential for short-term behavioral responses to overflights to seabirds near FDM. Long-term, minor, and localized accumulation of expended materials in soft bottom benthic communities and coralline systems surrounding FDM, increasing potential for ingestion. Increase in resident seabird exposure at FDM. Impacts to seabird breeding on FDM from wildland fires. Potential for direct strike of seabirds, eggs or chicks.
Naval Special Warfare (NSW) / Orote Point Training Areas, Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field, Reserve Craft Beach, Polaris Point Field, Dan Dan Drop Zone	Naval Special Warfare Operations (NSW OPS)	Aircraft Overflights Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Potential for short-term behavioral responses to overflights. Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions. Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. Potential for direct strike of seabirds, eggs or chicks. Potential for ingestion of chaff and/or flare plastic end caps and pistons
	Insertion/Extraction	Aircraft Overflights Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Potential for short-term behavioral responses to overflights. Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions. Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. Potential for direct strike of seabirds, eggs or chicks Potential for ingestion of chaff and/or flare plastic end caps and pistons
	Direct Action	Aircraft Overflights Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Potential for short-term behavioral responses to overflights, and increased potential for aircraft strikes. Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions. Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. Potential for direct strike of seabirds, eggs or chicks. Potential for ingestion of chaff and/or flare plastic end caps and pistons.

Table 3.10-1: Summary of Potential Stressors to Seabirds and Shorebirds (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Seabirds and Shorebirds
Navy Training (Continued)			
	MOUT	None	No Impact
	Airfield Seizure	None	No Impact
Naval Special Warfare (NSW) / Orote Point (Training Areas, Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field, Reserve Craft Beach, Polaris Point Field, Dan Dan Drop Zone	Over the Beach (OTB)	Aircraft Overflights Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Potential for short-term behavioral responses to overflights, and increased potential for aircraft strikes. Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions. Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. Potential for direct strike of seabirds and shorebirds, eggs or chicks Potential for loss of eggs or chicks as a result of flushing by the adults and other permutations Potential for ingestion of chaff and/or flare plastic end caps and pistons
	Breaching	None	No Impact
Amphibious Warfare (AMW))/ FDM, Orote Point and Finegayan Small Arms Ranges, Orote Point KD Range, Reserve Craft Beach, Outer Apra Harbor, Tipalao Cove, Tinian EMUA	Naval Surface Fire Support (FIREX Land)	Aircraft Overflights Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Potential for short-term behavioral responses to overflights, and increased potential for aircraft strikes. Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions. Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. Potential for direct strike of seabirds and shorebirds, eggs or chicks Potential for loss of eggs or chicks as a result of flushing by the adults and other permutations Potential for ingestion of chaff and/or flare plastic end caps and pistons
	Marksmanship	None	No Impact

Table 3.10-1: Summary of Potential Stressors to Seabirds and Shorebirds (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Seabirds and Shorebirds
Navy Training (Continued)			
	Expeditionary Raid	Aircraft overflights Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Potential for short-term behavioral responses to overflights, and increased potential for aircraft strikes. Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions. Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. Potential for direct strike of seabirds, eggs or chicks Potential for ingestion of chaff and/or flare plastic end caps and pistons
	Hydrographic Surveys	Vessel Movements Amphibious Landings	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions. Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches.
Explosive Ordnance Disposal (EOD) / (refer to specific operation)	Land Demolition	None	No Impact
	Underwater Demolition/ Outer Apra Harbor, Piti Floating Mine Neutralization Area, Agat Bay	Vessel Movements Explosive Ordnance Expended Materials	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions. Potential for short-term behavioral responses from explosive noise and pressure changes if seabirds are submerged. Potential for injury or mortality within limited ZOI. Potential for ingestion of chaff and/or flare plastic end caps and pistons.
Logistics and Combat Services Support/ Orote Point Airfield/ Runway, Reserve Craft Beach	Combat Mission Area	Vessel Movements Amphibious Landings Weapons Firing Expended Materials	Short-term behavioral responses from general vessel disturbance. Potential for injury or mortality from vessel collisions. Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. Potential for direct strike of seabirds, eggs or chicks. Potential for ingestion of chaff and/or flare plastic end caps and pistons
	Command and Control (C2)	None	No Impact

Table 3.10-1: Summary of Potential Stressors to Seabirds and Shorebirds (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Seabirds and Migratory Birds
Navy Training (Continued)			
Combat Search and Rescue (CSAR)	Embassy Reinforcement	None	No Impact
	Anti-Terrorism (AT)	None	No Impact
Air Force Training			
Counter Land		None	No Impact
Counter Air (Chaff)/ W-517, ATCAAs 1 and 2		Expended Materials	Potential for ingestion of floating chaff, endcaps and pistons that could result to injury or mortality.
		Aircraft Overflights	Potential for short-term behavioral responses to overflights within the warning areas; flight altitudes typically will be above bird flight heights.
Airlift/ Northwest Field		Aircraft Overflights	Potential for short-term behavioral responses to overflights, and increased potential for aircraft strikes.
Air Expeditionary/ Northwest Field		Aircraft Overflights	Potential for short-term behavioral responses to overflights, and increased potential for aircraft strikes.
Force Protection		None	No Impact
Intelligence, Surveillance, Reconnaissance (ISR) and Strike Capacity/ R-7201, FDM, Andersen AFB	Air-to-Air Training	Aircraft Overflights	Potential for short-term behavioral responses to overflights, and increased potential for aircraft strikes.
	Air-to-Ground Training	Aircraft Overflights	Potential for short-term behavioral responses to overflights, and increased potential for aircraft strikes.
Rapid Engineer Deployment Heavy Operational Repair Squadron Engineer (RED HORSE) / Northwest Field	Silver Flag Training	None	No Impact
	Commando Warrior Training	None	No Impact
	Combat Communications	None	No Impact

3.10.2 Affected Environment

3.10.2.1 Overview of Seabirds and Shorebirds in the Tropics

Non-resident migrant shorebirds, such as the Pacific golden plover, migrate to Guam and the CNMI during winter months along the Central Pacific Flyway. The Central Pacific Flyway includes various other Pacific archipelagos, such as New Zealand, Samoa, Line Islands, Phoenix Islands, Hawaii, and continental sub-arctic and arctic regions in Alaska.

Inhabited islands within the MIRC Study Area have been extensively altered by humans and support a wide array of introduced predators. The largest inhabited islands in the Marianas Archipelago (Guam, Rota, Saipan, and Tinian) support less than four percent of the estimated 265,000 seabirds estimated to occur within the MIRC Study Area (USFWS 2005). Areas free of predators (cats, rats, mice, dogs, monitor lizards, and brown tree-snake [BTS]) or with low predator densities are more favorable to nesting birds. In addition, access restrictions to military lands prevents seabird poaching, which is a major limiting factor for seabirds in the Mariana Islands (DoN 2007; USFWS 2005).

Ocean habitats are dynamic and often change in size, shape, magnitude, and location as water masses of varying temperature, salinity and velocity converge and diverge (USFWS 2005a). Dynamic habitats are also created when water interacts with ocean floor topography (such as islands, seamounts, and ocean trenches). Current convergences and eddy effects (created by islands) promote productivity and concentrate prey for seabirds (Oedekoven *et al 20*01; Mann and Lazier 1996). Generally, most fish are found in schools close to land, and consequently most distinctive seabirds of this region (tropicbirds, boobies, frigatebirds, and several species of terns) keep to inshore waters (McGowan 2001). Most seabirds feed by hovering and plunging quickly into the water after prey, or skimming the water's surface while hovering.

3.10.2.2 Seabirds and Shorebirds within the MIRC Study Area

Table 3.10-2 provides a list of seabirds and shorebirds that could potentially occur in the MIRC Study Area. Distribution and abundance varies considerably by species, with some species primarily occurring in nearshore habitats and others primarily occurring in offshore pelagic habitats. The area from the beach to about 10 nm (nm) (18.5 km) offshore provides foraging areas, a migration corridor and winter habitat for various breeding and transient pelagic seabirds and shorebirds such as the Pacific golden plover. Pelagic seabirds are widely distributed throughout the Marianas, but they tend to congregate in areas of high productivity and prey availability. . FDM is a known breeding location for ten seabird species (black noddies, brown noddies, brown boobies, masked boobies, red-footed boobies, white terns, sooty terns, great frigatebirds, red-tailed tropicbirds, and white-tailed tropicbirds). Lusk *et al.* (2000) identified the locations of the rookery locations for the great frigatebirds, masked boobies, red-footed boobies, and brown boobies. The other five species breeding locations are either dispersed or breeding activity is sporadic. Figure 3.10-1 shows the location of FDM's known rookery locations.

Table 3.10-2 Seabirds and Shorebirds within the MIRC Study Area

Family	Common Name	General Occurrence on Guam, Rota, Tinian, and FDM				Observations within DoD owned/leased lands or Open Ocean Observations
		Guam	Rota	Tinian	FDM	
Anatidae	American wigeon (*Anas Americana*)	V	-	-	-	-
	Common pochard (*Aythya ferina)*	V	-	-	-	-
	Spot-billed duck (*Anas poecilorhyncha*)	V	-	-	-	-
	Gadwall (*Anas strepera*)	V	-	-	-	-
	Surf scoter (*Melanitta perspicillata*)		-	-	-	-
	Eurasian wigeon (*Anas Penelope*)	V	-	V	-	-
	Garganey (Anas querquedula)	V	-	V	-	-
	Green-winged teal (*Anas carolinensis*)	-	-	V	-	-
	Mariana mallard (*Anas platyrhynchos oustaleti*)*	Extinct	Extinct	Extinct	-	Observed on Main Base (Guam), Fena Reservoir (Guam), Hagoi (Tinian) Last sighting in the Mariana Islands in 1979.
	Northern pintail (*Anas acuta*)	V	-	V	-	-
	Northern shoveler (*Anas clypeata*)	V	-	V	-	-
	Tufted duck (*Aythya fuligula*)	V	-	V	-	-
Ardeidae	Black-crowned night heron (*Nycticorax*	-	-	V	-	-
	Black bittern (*Dupetor flavicollis*)	V	-	-	-	-
	Cattle egret (*Bubulcus ibis*)	V	V	V	V	Observed on Tinian EMUA, Observed at FDM
	Chinese pond heron (*Ardeola bacchus*)	V	-	-	-	-
	Gray heron (*Ardea cinerea*)	-	-	V	-	-
	Great egret (*Area alba)*	V	-	-	-	-
	Intermediate egret (*Ardea intermedia*)	V	V	V	-	Observed on Tinian EMUA
	Little (green-backed) heron (*Butorides*	?	-	V	-	-
	Little egret (*Egretta garzetta*)	-	-	V	-	-
	Pacific Reef Heron (*Ardea sacra*)	R	R	R	R	Observed at Hagoi (Tinian) and FDM
	Rufous night heron (*Nycticorax caledonicus*)	-	-	?	-	-
	Yellow Bittern (*Ixobrychus sinensis*)	R	R	R	R	Observed at Hagoi (Tinian) and FDM
Charadriidae	Common ringed plover (*Charadrius*	V	-	-	-	-
	Gray (black-bellied) plover (*Pluvialis*	V	V	V	-	-
	Great sand plover (*Charadrius leschenaultia*)	V	-	V	-	-
	Little ringed plover (*Charadrius dubius*)	?	-	-	-	-
	Mongolian plover (*Charadrius mongolus*)	W	W	W	-	-
	Pacific golden plover (*Pluvialis fulva*)	W	W	W	W	Observed on 2007 MISTCS cruise, Main Base (Guam), Fena Reservoir (Guam), Hagoi (Tinian) and FDM.
	Snowy plover (*Charadrius alexandrinus*	-	-	V	-	-
Diomedeidae	Black-footed albatross *(Phoebastria*	-	-	-	-	Observed on 2007 MISTCS cruise
	Short-tailed albatross *(Phoebastria*	-	-	-	-	Observed on 2007 MISTCS cruise

Table 3.10-2 Seabirds and Shorebirds within the MIRC Study Area (Continued)

Family	Common Name	General Occurrence on Guam, Rota, Tinian, and FDM				Observations within DoD owned/leased lands or Open Ocean Observations
		Guam	Rota	Tinian	FDM	
Frigitae	Great frigatebird *(Fregata minor)*	V	V	V	R	Observed on 2007 MISTCS cruise and FDM (breeding)
	Lesser frigatebird (*Fregata ariel*)	?	-	V	-	-
Larinae	Common black-headed gull (*Larus*	V	-	V	-	-
	Slaty-backed gull (*Larus schistisagus)*	V	-	V	-	-
Haematopodid	Eurasian oystercatcher (*Haematopus*	V	-	-	-	-
Accipitridae	Osprey (*Pandion haliaetus*)	V	-	-	-	-
Phaethontidae	Red-tailed tropicbird *(Phaethon rubricauda)*	R	R	R	R	Observed on 2007 MISTCS cruise, Hagoi (Tinian), and FDM
	White-tailed tropicbird *(Phaethon lepturus)*	R	R	R	R	Observed on 2007 MISTCS cruise, Hagoi (Tinian), and FDM
Phalacrocoraci dae	Little pied cormorant (*Phalacrocorax*	-	-	V	-	-
	Great cormorant (*Phalacrocorax carbo)*	V	-	-	-	-
Procellariidae	Audubon's Shearwater *(Puffinus lherminieri)*	V	-	V	V	Observed on 2007 MISTCS cruise
	Black-winged petrel *(Pterodroma*	-	-	-	-	Observed on 2007 MISTCS cruise
	Bonin petrel *(Pterodroma hypoleuca)*	-	-	-	-	Observed on 2007 MISTCS cruise
	Bulwer's petrel *(Bulweria bulwerii)*	-	-	-	-	Observed on 2007 MISTCS cruise
	Christmas shearwater (*Puffinus nativitatis*)	-	-	V	-	-
	Flesh-footed S\shearwater (*Puffinus*	-	-	-	-	Observed on 2007 MISTCS cruise
	Hawaiian petrel *(Pterodroma*	-	-	-	-	Observed on 2007 MISTCS cruise
	Herald petrel *(Pterodroma arminioniana)*	-	-	-	-	Observed on 2007 MISTCS cruise
	Juan Fernandez petrel (*Pterodroma externa*)	V	-	-	-	-
	Kermadec petrel *(Pterodroma neglecta)*	-	-	-	-	Observed on 2007 MISTCS cruise
	Leach's storm petrel *(Oceanodroma*	V	-	V	-	Observed on 2007 MISTCS cruise
	Matsudaira's storm petrel *(Oceanodroma*	V	-	V	-	Observed on 2007 MISTCS cruise
	Mottled petrel *(Pterodroma inexpectata)*				-	Observed on 2007 MISTCS cruise
	Newell's (Townsend's) shearwater (*Puffinus*	V		V	-	-
	Short-tailed shearwater *(Puffinus*	V		V	-	Observed on 2007 MISTCS cruise
	Streaked shearwater *(Calonectris*	-	-	V	-	Observed on 2007 MISTCS cruise
	Tahiti petrel *(Pseudobulweria rostrata)*				-	Observed on 2007 MISTCS cruise
	Wedge-tailed shearwater *(Puffinus*	X	-	R	V	Observed on 2007 MISTCS cruise, FDM (uncommon visitor)
	White-necked petrel *(Pterodroma cervicalis)*				-	Observed on 2007 MISTCS cruise
	Wilson's storm petrel *(Oceanites oceanicus)*				-	Observed on 2007 MISTCS cruise
Rallidae	Eurasian coot (*Fulica atra*)	V	-	V	-	-
	Guam rail (*Gallirallus owstoni)**	Extirpat ed	-	-	-	Records reported from Andersen AFB, although Guam rails persist only in captivity.
	Mariana common moorhen (*Gallinula chloropus guami*)*	R	R	R	-	Observed within Main Base (Guam), Fena Reservoir (Guam), and Hagoi (Tinian)

Table 3.10-2 Seabirds and Shorebirds within the MIRC Study Area (Continued)

Family	Common Name	General Occurrence on Guam, Rota, Tinian, and FDM				Observations within DoD owned/leased lands or Open Ocean Observations
		Guam	Rota	Tinian	FDM	
Rallidae	White-browed crake (*Porzana cinerea*)	X	R	R	R	-
Recurvirostrida	Black-winged stilt (*Himantopus himantopus*	R	-	-	-	-
Scolopacidae	Bar-tailed godwit (*Limosa lapponica*)	V	-	V	-	-
	Black-tailed godwit (*Limosa limosa*)	V	-	-	-	-
	Bristle-thighed curlew (*Numenius tahitiensis*)	?	-	V	V	Observed on FDM
	Common sandpiper (*Actitis hypoleucos*)	W	W	W	-	Observed on 2007 MISTCS cruise
	Common snipe (*Gallinago gallinago*	-	-	V	-	-
	Common greenshank (*Tringa nebularia*)	W	-	V	-	-
	Dunlin (*Calidris alpine*)	V	-	V	-	-
	Eurasian curlew (*Numenius arquata*)	-	-	V	-	-
	Far eastern curlew (*Numenius*	?	-	-	-	Observed on 2007 MISTCS cruise
	Little stint (*Erolia minuta*)	-	-	?	-	-
	Long-toed stint (*Erolia subminuta*)	V	-	-	-	-
	Marsh sandpiper (*Tringa stagnatilis*)	V	-	V	-	-
	Nordmann's greenshank (*Tringa guttifer*)	V	-	-	-	-
	Pectoral sandpiper (*Calidris melanotos*)	V	-	V	-	-
	Pin-tailed snipe (*Gallinago stenura*)	-	?	?	-	-
	Ruddy turnstone (*Arenaria interpres*)	W	W	W	W	Observed on FDM
	Ruff (*Philomachus pugnax*)	V	-	V	-	-
	Rufous-necked stint (*Calidris ruficollis*)	W	-	W	-	-
	Sanderling (*Calidris alba*)	V	-	V	-	-
	Sharp-tailed sandpiper (*Calidris acuminate*)	W	V	V	-	-
	Siberian tattler (*Tringa brevipes*)	W	W	W	-	-
	Spotted redshank (*Tringa erythropus*)	V	-	-	-	-
	Swinhoe's snipe (*Gallinago megala*)	V	V	V	-	-
	Temminck's stint (*Calidris temmincki*)	-	-	V	-	-
	Terek sandpiper (*Xenus cinereus*)	V	-	V	-	-
	Wandering tattler (*Tringa incana*)	W	W	W	V	Observed on FDM
	Whimbrel (*Numenius phaeopus*)	W	W	W	V	Observed on FDM
	Wood sandpiper (*Tringa glareola*)	W	-	W	-	-
Stercorariidae	Long-tailed jaeger (*Stercorarius longicaudus)*	-	-	-	-	Observed on 2007 MISTCS cruise
	Parasitic jaeger *(Stercorarius parasiticus)*	-	-	-	-	Observed on 2007 MISTCS cruise
	Pomarine jaeger *(Stercorarius pomarinus)*	-	-	-	-	Observed on 2007 MISTCS cruise
Glareolidae	Oriental pratincole *(Glareola maldivarum)*	R	-	-	-	-

Table 3.10-2 Seabirds and Shorebirds within the MIRC Study Area (Continued)

Family	Common Name	General Occurrence on Guam, Rota, Tinian, and FDM				Observations within DoD owned/leased lands or Open Ocean Observations
		Guam	Rota	Tinian	FDM	
Sternidae	Black noddy *(Anous minutus)*	V	V	R	R	Observed on 2007 MISTCS cruise, Main Base (Guam), Hagoi (Tinian), FDM (breeding)
	Black-naped tern (*Sterna sumatrana*)	V	-	-	-	-
	Brown noddy *(Anous stolidus)*	R	R	R	R	Observed on 2007 MISTCS cruise, Main Base (Guam), Hagoi (Tinian), FDM (breeding)
	Common fairy tern (*Sterna nereis*)	R	R	R	-	-
	Common tern (*Sterna hirundo*)	V	-	V	-	-
	Gray-backed tern *(Sterna lunata)*	V	-	V	-	Observed on 2007 MISTCS cruise
	Little tern (*Sternula albifrons*)	V	-	-	-	-
	Sooty tern *(Sterna fuscata)*	V	V	R	V	Observed on 2007 MISTCS cruise, Main Base (Guam), Fena Reservoir (Guam), FDM (possible breeding)
	White tern *(Gygis alba)*	R	R	R	R	Observed on 2007 MISTCS cruise, Main Base (Guam), Fena Reservoir (Guam), FDM (breeding)
	White-winged tern (*Chlidonias leucopterus*)	V	-	V	-	-
Sulidae	Brown booby *(Sula leucogaster)*	V	V	V	R	Observed on 2007 MISTCS cruise, Hagoi (Tinian), FDM
	Masked booby *(Sula dactylatra)*	?	V	R	R	Observed on 2007 MISTCS cruise, Hagoi (Tinian), FDM
	Red-footed booby *(Sula sula)*	V	R	V	R	Observed on 2007 MISTCS cruise, FDM (breeding)
Motacillidae	Yellow wagtail (*Motacilla flava)*	V	-	-	-	-
	Gray wagtail (*Motacilla cinerea)*	V	-	-	-	-

R = Resident / breeding
V = Visitor (includes passing of migrants as well as vagrants)
W = Winter resident (visitor during non-breeding season)
? = Unconfirmed observations

Sources: Lusk *et al*. (2000); DoN (2007), NAVFACPAC 2008d, Pratt et al. (1987), Wiles (1998)
Astericks "*" denote ESA-listed species. In 2004, the Mariana mallard was removed from ESA lists due to extinction.
Asterisks Dashes ("-") denotes that there are no observation records.

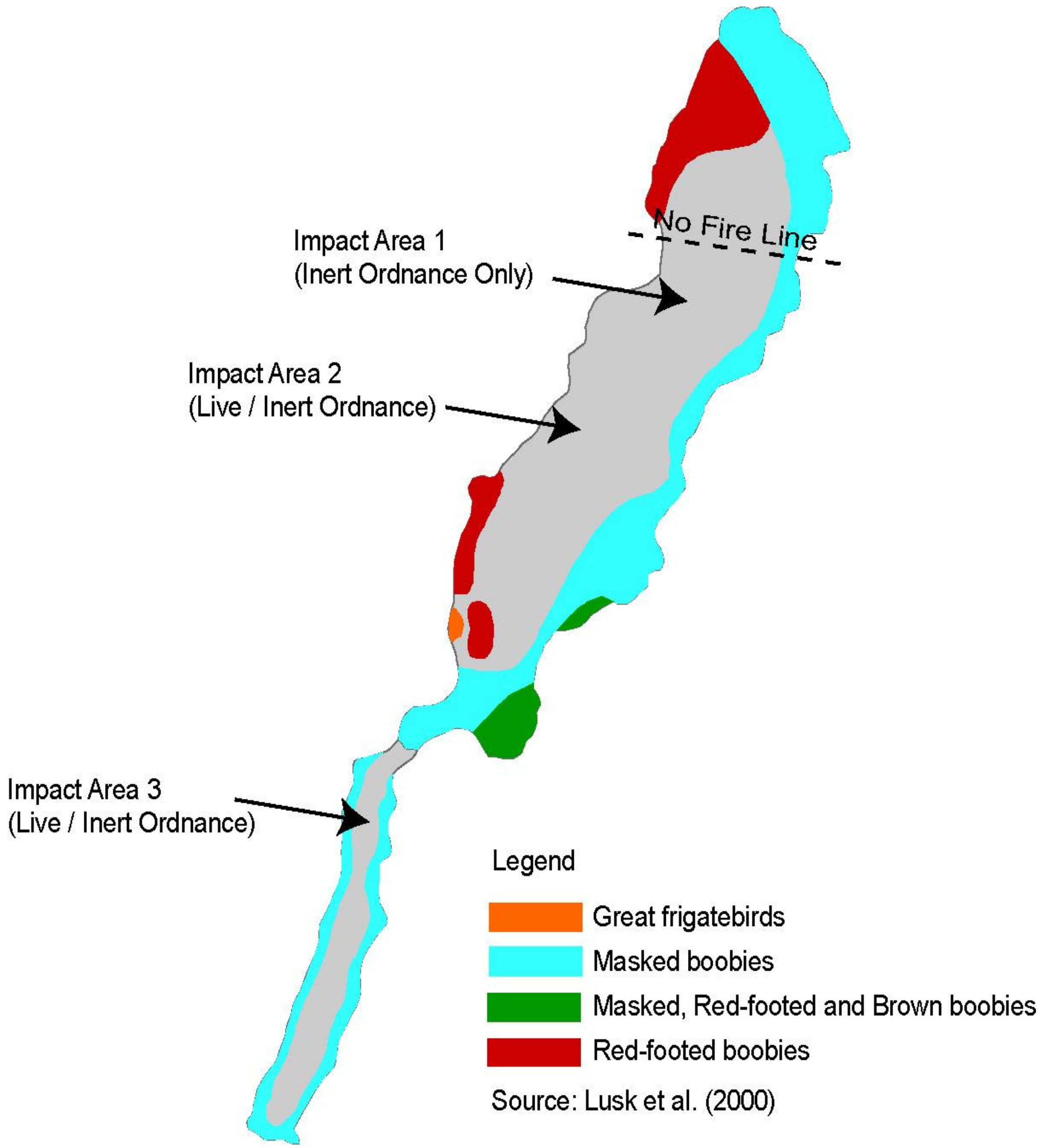

Figure 3.10-1 Seabird Rookery Locations on FDM for Masked, Red-Footed, and Brown Boobies, and Great Frigatebirds

Ecology and Status of Major Seabird and Shorebird Groups within the MIRC Study Area

Anatidae (Waterfowl birds-swans, ducks, geese)

Members of family Anatidae are considered waterbirds with webbed feet and broad flat bills. With the exception of the Mariana mallard (*Anas platyrhynchos oustaleti),* the Anatidae listed in Table 3.10-2 are considered rare visitors to the MIRC Study Area (Pratt *et al.* 1987), and most observations are associated with palustrine and brackish wetlands of Guam and Hagoi on Tinian. No members of this family currently extant listed in Table 3.10-2 have been recorded on Navy owned or leased lands on Guam and the CNMI or on Andersen AFB. The Mariana mallard was last observed in 1979 and is now considered extinct. Mallards are known to hybridize with other members of genus *Anas*, and the Mariana mallard was believed to be a stabilized hybrid population with both common mallard (*Anas platyrhynchos*) and gray duck (*Anas superciliosa*) ancestry (Pratt *et al.* 1987)

Ardeidae (Herons and Bitterns)

Birds in the Ardeidae family include herons and bitterns. Herons and bitterns resemble birds in some other families, such as storks, ibises and spoonbills, but differ by flying with their necks retracted, not outstretched. The members of this family are mostly associated with wetlands, and prey on fish, amphibians and other aquatic species. Some members of this group nest colonially in trees, while others, notably the bitterns, use reedbeds (Lusk *et al.* 2008).

The nine members of the Ardeidae family within the MIRC Study Area (listed in Table 3.10-2) are commonly associated with wetland areas on Guam and Hagoi on Tinian, with occasional sightings on Rota and FDM. Two members of this family (Pacific reef heron [*Ardea sacra*] and yellow bittern [*Ixobrychus sinensis*]) are known to breed on Guam and the CNMI, including FDM. These two species are considered resident species year-round in the Mariana Islands. The yellow bittern has short, yellow legs, with a chin marked by a narrow white stripe. They have brown beaks, gold-yellow colored eyes and the surrounding areas of their faces are normally greenish-yellow. Breeding habitats are closely associated with reedbeds, which are extensively found at Hagoi (composed primarily of *Phragmites karka*), though the yellow bittern has also been observed by Navy biologists nesting in tangan-tangan (*Leucaena leucocephala*) trees on Guam. Pacific reef heron predominantly feed on varieties of nearshore fish, crustaceans and mollusks. The species nests year-round in colonies in mesic wooded areas, including mangroves.

Charadriidae (Plovers)

Members of the Charadriidae family include plovers, which are generally considered shorebirds. Plovers are distributed through open country worldwide, mostly in habitats near water. Plovers hunt by sight, rather than by feel as longer-billed shorebirds do. Their diet includes insects, worms or other invertebrates, depending on habitat (Lusk *et al.* 2008).

Seven plovers are known to winter in or visit the MIRC Study Area and are listed in Table 3.10-2. No plovers are known to breed within the MIRC Study Area, and only two species are considered winter migrants. The Pacific golden plover (*Pluvialis fulva*) is known to occur on all islands within the MIRC Study Area, including Guam, Rota, Tinian, and FDM. The breeding habitat of the Pacific golden plover is arctic tundra from northernmost Asia into western Alaska. It nests on the ground in dry, open areas. Winter grounds are spread throughout the Pacific Basin, and migration routes follow the Central Pacific Flyway to reach the Mariana Islands (Pratt *et al.* 1987). Pacific golden plovers were observed in the open ocean on the 2007 MISTCS cruise (DoN 2007), and during the winter months are known to frequent open areas of the Navy owned and leased lands on Guam and the CNMI, as well as Andersen AFB.

Diomedeidae (Albatrosses)

Albatrosses range widely in the southern hemisphere and the North Pacific, although occasional vagrants are recorded in the North Atlantic (Pratt *et al*. 1987). Albatrosses are among the largest of flying birds, and great albatrosses (*Diomede*a spp.) have the largest wingspan of any extant birds.

Albatrosses are highly efficient in the air, using dynamic soaring and slope soaring to cover great distances with little exertion. They feed on squid, fish and krill by either scavenging, surface seizing or diving. Albatrosses are colonial, mostly nesting on remote oceanic islands, often with several species nesting together. Pair bonds between males and females form over several years with the use of 'ritualized dances', and will last for the life of the pair. A breeding season can take over a year from laying to fledging, with a single egg laid in each breeding attempt (Lusk *et al.* 2008).

Both albatross species (black-footed albatross and short-tailed albatross) occurring within the MIRC Study Area are considered vagrant migrants, are rarely documented more than once per year, and range throughout the North Pacific (Pratt *et al.* 2001). Neither species has been recorded on land within the MIRC Study Area and both species were observed during the 2007 MISCTS cruise survey (DoN 2007).

The black-footed albatross nest colonially on isolated islands of the Northwestern Hawaiian Islands (such as Laysan and Midway), and the Japanese islands of Torishima, Bonin, and Senkaku. Their range at sea varies during the seasons (straying farther from the breeding islands when the chicks are older) but they make use of great areas of the North Pacific, feeding from Alaska to California and Japan. The USFWS has initiated a status review to determine if listing the black-footed albatross under the ESA is warranted (50 CFR 17; FR October 9, 2007, Vol. 72, No. 194)

The short-tailed albatross breeds exclusively on Torishima, an island owned by Japan. The short-tailed albatross' range overlaps with the black-footed covering most of the northwestern and northeastern Pacific Ocean. The world population of short-tailed albatross is currently estimated at 2,000 birds (USFWS 2005b). The short-tailed albatross is described in more detail in the ESA-listed species discussion within this subsection.

Fregatidae (Frigatebirds)

Members of the Fregatidae family are large seabirds, with iridescent black feathers, a wingspan up to 7.5 ft (2.3 m) and deeply-forked tails. The males inflate red-colored throat pouches to attract females during the mating season. Frigatebirds are distributed globally in tropical oceans. These birds do not swim and cannot walk well, and cannot take off from a flat surface. Frigatebirds are able to stay aloft for more than a week, landing only to roost or breed on trees or cliffs (Lusk *et al*. 2008).

The great frigatebird (*Fregata minor*) nests on FDM, which is one of only two small breeding colonies known to exist within the Mariana Islands. The great frigatebird has a wide distribution throughout the tropical Pacific, with Hawaii as the northernmost extent of their range. Nesting pairs number over 10,000 in the Northwestern Hawaiian Islands (Harrison 1990). In the Central and South Pacific, colonies are found on most island groups from Wake Island to the Galapagos Islands to New Caledonia, with a few pairs nesting on Australian possessions in the Coral Sea. Colonies are also found on numerous Indian Ocean islands including Aldabra, Christmas Island and Mauritius. Great frigatebirds undertake regular migrations across their range, including both regular trips and more infrequent widespread dispersals.

Navy biologists conduct monthly aerial surveys (helicopter) over FDM for bird counts (NAVFACPAC 2008b). These index surveys began in 1999, and suggest that great frigatebird sightings are seasonally-dependent, with most sightings between December and March. Sightings for these birds have increased from 2005 through the present during the winter period (NAVFACPAC 2008b).

Larinae (Gulls)

Gulls are not common in the tropical Pacific (Pratt *et al.* 1987), preferring shallow water habitats in temperate and polar climates along coasts and inland rivers and lakes. Gulls that are observed in the Mariana Islands are generally associated with rare visitations are winter migrations. The common black-headed gull (*Larus ridibundus*) is the only gull species observed within the MIRC Study Area, with observations on Guam and Tinian (Pratt *et al.* 1987). Harrison (1983) notes that the occurrence of the common black-headed gull is associated with harbors and bays.

Haematopodidae (Oystercatchers)

Oystercatchers are large, stocky shorebirds with distinct patterns of black and white with bright red bills, and are generally associated with rare visitations in the tropical Pacific (Pratt *et al.* 1987). Maben and Wiles (1981) noted on Guam the Eurasian oystercatcher (*Haematopus ostralegus*). This oystercatcher was observed and photographed in 1980 and remained on the island for at least a year.

Accipitridae (Eagles, hawks and ospreys)

The only member of the Accipitridae family to occur in the Mariana Islands is the osprey (*Pandion haliaetus*). Pratt *et al.* (1987) noted “old observations” from Guam. No recent records have been found for the osprey, and as the largest bird of prey to visit the Pacific, it is unlikely that this bird could visit the MIRC Study Area without observation. Therefore, although occurrence of ospreys are possible on Guam and throughout the islands within the CNMI, the ospreys can only be considered extremely rare visitors to the MIRC Study Area.

Phaethontidae (Tropicbirds)

Tropicbirds are seabirds with predominantly white plumage and elongated central tail feathers. Their bills are large, powerful and slightly decurved, and they have large heads and short and thick necks. The three species within this family have a different combination of black markings on the face, back, and wings, distinctive to each species. Two of the three species of tropicbirds are known to occur within the MIRC Study Area (Lusk *et al.* 2008).

The red-tailed tropicbird (*Phaethon rubricauda*) and the white-tailed tropicbird (*Phaethon lepturus*) are known to occur on Tinian and FDM, as well as open waters of the MIRC Study Area (DoN 2007). The red-tailed tropicbird is the rarest of all tropicbird species, but is widely distributed with colonies on islands from Hawaii to Easter Island and Mauritius. This species breeds on Guam (DoN 2003), with other breeding records on Rota, Tinian, and FDM. The white-tailed tropicbird is the smallest of three species within the Phaethontidae family. It occurs in the tropical Atlantic, western Pacific and Indian Oceans. Breeding locations are recorded from Guam, Rota, Tinian, and FDM. Both species were observed during the MISTCS 2007 cruise survey (DoN 2007).

Phalacrocoracidae (Cormorants)

Cormorants are medium-sized divers with long hook-tipped bills (Pratt *et al.* 1987). Only one species of cormorants breed in the tropical Pacific, the pelagic cormorant, (*Phalacrocorax pelagicus*), which breeds around North Pacific coasts from Taiwan to California (Pratt *et al.* 1987). The only cormorant species noted within the MIRC Study Area is the little pied cormorant (*Phalacrocorax melanoleucos*), which is considered a rare visitor to the CNMI. No records are associated with Navy lease lands in the CNMI, including FDM.

Procellariidae (Shearwaters and Petrels)

Shearwaters are medium-sized, long-winged seabirds most common in temperate and cold waters. Shearwaters come to islands and coastal cliffs to breed. They are nocturnal at the colonial breeding sites, preferring moonless nights to minimize predation. Outside of the breeding season, they are pelagic (frequent the open waters) and most are long-distance migrants. They feed on fish, squid, and similar oceanic food. Numbers of shearwaters have been reduced due to predation by introduced species to islands, such as rats and cats. Some loss of birds also occurs from entanglement in fishing gear (Lusk *et al.* 2008).

Most species of this family observed within the MIRC Study Area are considered visitors (DoN 2007; Pratt *et al.* 1987). Shearwaters and petrels do not breed on DoD owned or leased lands within the MIRC, although wedge-tailed shearwaters are known to breed on Bird Island (an islet off Saipan's eastern coast). Shearwaters and petrels primarily utilize offshore and coastal waters for foraging and are typically concentrated along upwelling boundaries and other water mass convergence areas (USFWS 1983). The Hawaiian petrel, observed during the 2007 MISTCS cruise survey (DoN 2007), is protected under the ESA, and is described in more detail in the ESA-listed species discussion within this subsection.

Rallidae (Rails, moorhens, gallinules, and coots)

Rails include several types of birds associated with wetland and other aquatic habitats. Body types are chicken-like, and coots and gallinules demonstrate a relatively more proficient swimming ability than other members of this family (Ripley 1977).

Three members of the Rallidae family are associated with the MIRC Study Area. Before the 1970s, the Guam rail (*Gallirallus owstoni*) occurred island-wide and distributed in all habitats except wetlands. The population declined severely from 1969-1973, and the rail disappeared from southern Guam in the mid 1970s. The decline of the rail continued until in 1980, only 10 rails were recorded. The Guam rail is believed to be extirpated from Guam and the Guam rail population only persists in captive breeding programs. The Mariana common moorhen (*Gallinula chloropus guami*) occurs on various islands within the Mariana Islands, including Guam, Rota, Tinian, and FDM. Breeding is associated with wetland areas, within Main Base (Guam), Fena Reservoir (Guam), and Hagoi (on Tinian). The Eurasian coot, the third member of family Rallidae, is considered by Pratt *et al.* (1987) to be a rare visitor to Guam and Tinian.

Scolopacidae (Sandpipers and Curlews)

The majority of species within the Scolopacidae family eat small invertebrates picked out of mud or soil substrates. Different lengths of bills enable different species to feed in the same habitat, particularly on the coast, without direct competition for food. Sandpipers generally are found on shores and in wetlands around the world, breeding on the Arctic tundra to more temperate areas. Curlews foraging habits are similar to sandpipers, but are characterized by a long specialized bill (Lusk *et al.* 2008).

Twenty-eight species within the Scolopacidae family have been recorded as either winter migrants or rare visitors to Guam, Rota, Saipan, and Tinian (Pratt *et al.* 1987; DoN 2007), and are listed in Table 3.10-2. The common sandpiper (*Actitis hypoleucos*) breeds across most of Europe and Asia, and nests on the ground near fresh water. After breeding season, sandpipers migrate to Africa, southern Asia, Indonesia, and Australia. The common sandpiper forages by sight on the ground or in shallow water, picking up small food items such as insects, crustaceans and other invertebrates (Pratt *et al.* 1987). The far eastern curlew (*Numenius madagascariensis*) spends its breeding season in northeastern Asia, including Siberia to the Kamchatka Peninsula, as well as Mongolia. Its breeding habitat is comprised of marshy and swampy wetlands and lakeshores. Wintering habitat is mostly associated with coastal Australia; however, some migrate to South Korea, Thailand, and New Zealand, preferring estuaries, beaches, and salt marshes. The common sandpiper and the far-eastern curlew were observed during the 2007 MISTCS cruise surveys (DoN 2007); however, these birds have not been observed on islands within the MIRC Study Area. Birds within this family associated with FDM include the ruddy turnstone (*Arenaria interpes*), a winter migrant, and wandering tattler (*Tringa incana*) and whimbrel (*Numernius phaeopus*) noted as rare visitors to FDM (Lusk *et al.* 2000).

Stercorariidae (Skuas and Jaegers)

Members of the seabird family Stercorariidae are ground nesters in temperate and arctic regions and are long-distance migrants (Pratt *et al.* 1987). Outside the breeding season they feed on fish, offal and carrion. Many are partial kleptoparasites, chasing gulls, terns and other seabirds to steal their catches; the larger species also regularly kill and eat adult birds, up to the size of great black-backed gulls. On the breeding grounds they commonly eat lemmings, and the eggs and young of other birds.

The three species of family Stercorariidae that are known to occur within the MIRC Study Area include the long-tailed jaeger (*Stercorarius longicaudus*), the parasitic jaeger (*Stercorarius parasiticus*), and the pomarine jaeger (*Stercorarius pomarinus*). None are known to breed on islands within the MIRC Study Area, and no observations of these birds have been recorded on land in the Mariana Islands. The long-tailed jaeger breeds in the high Arctic of Eurasia and North America, with major populations in Russia, Alaska and Canada and smaller populations around the rest of the Arctic. It is a migrant, wintering in the south Atlantic and Pacific. The parasitic jaeger breeds on coasts of Alaska, as well as coastal and inland tundra regions of northern Canada. This species is also found in Greenland, Iceland, Scandinavia, and northern Russia. In the Pacific, parasitic jaegers winter at sea from southern California to southern Chile and Australia (Birdweb 2005). The pomarine jaeger is mostly a pelagic species occasionally observed inland. A large jaeger, the species is heavyset, having a thick-neck with broad-based wings and a wing span that can reach 48 in (1.2 m) (USGS 2008).

Sternidae (Terns and Noddies)

Terns and noddies are seabirds in the family Sternidae with worldwide distribution (Pratt *et al.* 1987). A recent taxonomic revision now separates terns and noddies out of the gull family Laridae (van Tuinen *et al.* 2004). Terns generally are medium to large birds, typically with gray or white plumage, often with black markings on the head. They have longish bills and webbed feet. Terns and noddies are lighter bodied and more streamlined than gulls, with long tails and long narrow wings. Terns and noddies hunt fish by diving, often hovering first for a few moments before a dive.

Ten species of this family are known to occur within the MIRC Study Area as resident birds or rare visitors, and are listed in Table 3.10-2. The brown noddy (*Anous stolidus*) and black noddy (*Anous minutus*) are known to occur at FDM (DoN 2007), Hagoi on Tinian, and the Navy Main Base on Guam (Brooke 2007); the black noddy also nests on Aguiguan, the small island next to Tinian (Pepi 2008). Both of these species were also observed in open waters during the MISTCS cruise survey (DoN 2007). The brown noddy is a tropical seabird with a worldwide distribution, ranging from Hawaii to the Tuamotu Archipelago and Australia in the Pacific Ocean, from the Red Sea to the Seychelles and Australia in the Indian Ocean and in the Caribbean to Tristan da Cunha in the Atlantic Ocean. The brown noddy is colonial, usually nesting on cliffs or in short trees or shrubs, and occasionally nests on the ground. The female lays a single egg each breeding season. Brown noddy breeds on Tinian, FDM, Rota and Guam (DoN 2003). Orote Point on Guam supports a large brown noddy nesting colony (~150 birds). Additional roosts for brown noddy are found on at least two small emergent rock islands off the north and south coast of Orote Peninsula (Lusk *et al.* 2008).

The black noddy is smaller than the brown noddy with darker plumage, a whiter cap, a longer, straighter beak and shorter tail. Black noddy nests consist of a level platform, often created in the branches of trees by a series of dried leaves covered with bird droppings. One egg is laid each season, and nests are re-used in subsequent years. The black noddy is distributed worldwide in tropical and subtropical seas, with colonies widespread in the Pacific Ocean and more scattered across the Caribbean, central Atlantic and in the northeast Indian Ocean. At sea, it is usually seen close to its breeding colonies within 50 mi (80 km) of shore. Birds return to colonies, or other islands, in order to roost at night. The black noddy nests on Aguiguan, a small island next to Tinian (Brooke 2007).

The gray-backed tern (*Sterna lunata*) has not been observed on land within the MIRC Study Area; however, this species was observed in open water during the 2007 MISTCS cruise survey (DoN 2007). The gray-backed tern breeds on islands of the tropical Pacific Ocean. At the northern end of its distribution it nests in the Northwestern Hawaiian Islands (with the largest population being Lisianski Island) and two small islets off Oahu, in the east as far as the Tuamotu Islands, with other colonies in the Society Islands, the Line Islands, Phoenix Islands, Mariana Islands and American Samoa. There are unconfirmed reports of breeding as far south as Fiji, and as far east as Easter Island. Outside of the breeding season the species is partly migratory, with birds from the Hawaiian Islands flying south. It is thought that birds in other parts of the Pacific are also migratory, and will disperse as far as Papua New Guinea, the Philippines, and Easter Island (Mostello *et al.* 2000).

The sooty tern (*Sterna fuscata*) utilizes areas of the Navy Main Base and Fena Reservoir on Guam (Brooke 2007), and this tern was observed in open waters during the MISTCS cruise surveys (DoN 2007); sooty terns have also been observed flocking over FDM (Pepi 2008). Sooty terns breed on FDM (DoN 2003). This tern is migratory and dispersive, wintering more widely through the tropical oceans. Compared to other terns, the sooty tern is more characteristically marine. Sooty terns breed in colonies on rocky or coral islands. It nests in a ground scrape or hole and lays one to three eggs. It feeds by picking fish from the surface in marine environments, often in large flocks, and rarely comes to land except to breed, and can stay out to sea (either soaring or floating on the water) for between 3 to 10 years (Pratt *et al.* 1987).

The white tern (*Gygis alba*) has been observed on the Main Base and Fena Reservoir on Guam, Hagoi on Tinian, and FDM, as well as open waters within the MIRC Study Area (Brooke 2007; DoN 2007). White terns nest throughout the CNMI and are considered common. This tern ranges widely across the Pacific and Indian Oceans, and also nests in some Atlantic islands. It nests on coral islands, usually on trees with thin branches but also on rocky ledges and on man-made structures. White tern breeds on Tinian, FDM and Rota (DoN 2003).

Sulidae (Gannets and Boobies)

Members of the seabird family Sulidae are medium-large coastal seabirds that plunge-dive for fish. Three species of booby are found within the MIRC Study Area. FDM is the location of the largest nesting location for the brown booby (*Sula leucogaster*) in the Mariana and Caroline Islands. The masked booby (*Sula dactylatra*) breeds on FDM, while red-footed booby (*Sula sula*) breeds on FDM and Rota (DoN 2003). Monthly aerial surveys via helicopter by Navy biologists over FDM for bird counts (NAVFACPAC 2008b) show distinct oscillations in the booby populations on this island. The period from 1999 to 2002 was a low period, followed by increasing numbers recorded from 2003 through 2005. Decreases in booby numbers continued from 2006 through 2007.

ESA-Listed Seabirds and Shorebirds within the MIRC Study Area. Three species of seabirds and shorebirds are listed as endangered under the ESA. The Mariana common moorhen, although a member of the Rallidae family, is discussed within Section 3.11 (Terrestrial Resources). As discussed in Section 3.11, the Navy has determined that activities described in the MIRC EIS/OEIS may affect the Mariana common moorhen and has initiated formal consultation for this species pursuant to Section 7 of the ESA. The other two ESA-listed seabird species considered for analysis are described below.

Short-tailed Albatross

*Listing Status and Description***.** The short-tailed albatross was originally listed in 1970, under the Endangered Species Conservation Act of 1969, prior to the passage of the ESA (35 FR 8495). The species was listed as endangered throughout its range except within the U.S. (50 CFR 17.11). On July 31, 2000, the USFWS published a final rule listing the short-tailed albatross as endangered throughout its range (65

FR 147:46643–46654). Critical habitat has not been designated for this species. In the 2000 final rule, USFWS determined that designation of critical habitat is not prudent due to the lack of habitat-related threats to the species within U.S. territory and the lack of specific areas in U.S. jurisdiction that could be identified as meeting the definition of critical habitat.

Population Status and Distribution. Prior to its exploitation, the short-tailed albatross was possibly the most abundant of the three North Pacific albatross species. By the 1950s, this species was nearly extirpated in the Pacific as populations were harvested by feather hunters. Presently, fewer than 2,000 short-tailed albatrosses are known to exist. The species is known to breed on only two remote islands in the western Pacific. Torishima, where 80 to 85 percent of short-tailed albatrosses breed, is an active volcano, and Tsubame-zaki, the natural colony site on the island, is susceptible to mud slides and erosion. An artificial colony has also been established in another area less prone to erosion on Torishima (Hatsune-zaki). As of the 2004–05 season, four pairs have nested and fledged chicks at the artificial colony site. The remainder of known short-tailed albatrosses breed at a site in the Senkaku Islands, to the southwest of Torishima, where volcanism is not a threat. The Japanese Government designated the short-tailed albatross as a Natural Monument in 1958 and as a Special Bird for Protection in 1972. Torishima is also a Japanese Natural Monument (USFWS 2005b).

Habitat and Breeding Biology. Short-tailed albatrosses require remote islands for breeding habitat. These birds nest in open, treeless areas with low, or absent vegetation. Short-tailed albatrosses spend much of their time feeding in shelf-break areas of the Bering Sea, the Aleutian island chain and in other Alaskan, Japanese and Russian waters, as they require nutrient-rich areas of ocean upwelling for their foraging habitat. The primary existing threat to the species' recovery is the possibility of an eruption of Torishima, their main breeding site. A minor eruption occurred there in August of 2002, after the end of the breeding season (USFWS 2005b).

Short-tailed albatrosses are monogamous for life and return to the same nesting areas to breed. Birds arrive at the Tsubame-zaki colony in October and nest building begins. Egg laying begins in October and lasts through late November. Females lay a single egg, which is incubated by both parents for up to 65 days. Eggs hatch in late December and January, and by May or early June, the young albatrosses are considered fledged. By mid-July, the colony is abandoned (USFWS 2005b).

Status within the MIRC Study Area. A short-tailed albatross was observed during the 2007 MISTCS cruise surveys (DoN 2007). Breeding does not occur within the Mariana Islands (USFWS 2005b). Although short-tailed albatrosses have been observed in less productive waters far from regions of upwelling, the extremely rare observations in these areas suggests that these birds may be simply moving between areas of favored habitat.

Hawaiian Petrel

Listing Status and Description. The Hawaiian petrel was originally listed in 1970, under the Endangered Species Conservation Act of 1969, prior to the passage of the ESA (35 FR 8495). The Hawaiian petrel is a fast-flying seabird that ranges thousands of miles over the central tropical Pacific. The Hawaiian petrel nests only on the Hawaiian Islands. The introduction of exotic predators to the Hawaiian Island breeding grounds poses a severe threat to the species, which is now endangered throughout its range.

Population Status and Distribution. The Hawaiian petrel formerly nested in very large numbers at multiple sites on all of the main islands in the Hawaiian chain except Niihau; however, hunting of nestlings, habitat modification and the introduction of predators and disease-carrying mosquitoes eliminated the nesting populations closer to sea level so that remaining colonies are restricted to a few remote high elevation sites. The Haleakala National Park on Maui Island houses the largest known breeding population of 450 to 650 pairs and Kauai is suspected of having as many as 1,600 pairs of breeding birds. Small numbers have bred on Hawaii Island on both Mauna Loa and Mauna Kea. Recent at-sea surveys estimate the population at approximately 20,000 individuals (BirdLife International 2007). These birds may range thousands of miles from their nesting colonies, even during the breeding season (USFWS 1983).

Habitat and Breeding Biology. Hawaiian petrels range far to find their widely dispersed food sources. They feed primarily on squid, but also fish, crustaceans and plankton found at the surface, and they are also known to scavenge. They do not seem to dive or swim underwater, and are seen more frequently when the wind is blowing at least 12.5 to 25.0 mi (20 to 40 km) per hour. They are long-lived and lay only a single egg per year, making them very susceptible to population declines. They are believed to be monogamous and show mate fidelity. During their March to October nesting season they return to the same nesting burrows year after year, entering and exiting their burrows only under the cover of night. Radar studies on Kauai indicate that birds come and go from breeding areas in greatest numbers two hours after dusk and two hours before dawn (BirdLife Internationa 2007). Currently threatened nesting habitat has forced them to adopt marginal, high-elevation sites, but historically they occupied low-elevation sites easily accessible to the ocean. They range up to approximately 930 mi (1,500 km) from the Hawaiian Islands during breeding season, with only rare sightings in these waters from January through March.

Status within the MIRC Study Area. The Hawaiian petrel was observed during the 2007 MISCTS cruise surveys (DoN 2007). There are no records of occurrence on any of the islands within the MIRC Study Area. Based on the rare sightings and range of the Hawaiian petrel, this bird species may be considered extremely rare within the MIRC Study Area.

3.10.3 Environmental Consequences

3.10.3.1 No Action Alternative

Vessel Movements. Many of the ongoing and proposed training activities within the MIRC 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 seabirds by directly striking or disturbing individual animals. Vessel movements associated with training in the MIRC Study Area occur mostly during a major exercise, which can last up to two or three weeks. Elements of this training are widely dispersed throughout the MIRC Study Area, which is a vast area encompassing 450,187 nm^2 (1,544,098 km^2). The probability of ship and seabird interactions occurring in the MIRC Study Area is dependent on several factors including numbers, types, and speeds of vessels; the regularity, duration, and spatial extent of training events within areas of relatively high productivity (increasing prey availability for seabirds); and protective measures implemented by the Navy. Currently, the number of Navy ships operating in the MIRC Study Area varies based on training schedules and can range from 0 to about 10 ships at any given time. Ship sizes range from 362 ft (110 m) for a nuclear submarine (SSN) to 1,092 ft (333 m) for a nuclear aircraft carrier (CVN) and speeds range from 10 to 14 knots. Training involving vessel movements occur intermittently and are short in duration, ranging from a few hours up to a few weeks.

Birds respond to moving vessels in various ways. Some species commonly follow vessels (Hamilton 1958; Hyrenbach 2001, 2006), while other species seem to avoid vessels (Borberg *et al*. 2005; Hyrenbach 2006). Albatross and gulls are known to follow vessels while cormorants and diving ducks are known to avoid vessels. Vessel movements could elicit short-term behavioral or physiological responses (e.g., alert response, startle response, fleeing the immediate area, and temporary increase in heart rate). However, the general health of individual birds would not be compromised (see additional discussion of these responses in the discussion of aircraft overflights). Direct collisions with vessels or a vessel’s rigging (i.e., 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 (Bruderer *et al*. 1999; Black 2005) and lighting on vessels may attract some seabirds (Hunter *et al*. 2006), increasing the potential for harmful encounters.

If a bird were to collide with a vessel, injury or mortality could occur. Based on the low Navy vessel density and patchy distribution of seabirds in the MIRC Study Area, the probability of bird/vessel collisions is extremely low.

Vessel movements may increase the likelihood of terrestrial predator introductions to islands containing seabird nesting habitat. For example, solid waste (potentially containing various pest species) is transported from Tinian to Guam for storage and disposal, and vessels from Guam could introduce BTS to Tinian. Further, potential for BTS introductions to Hawaii and other regions may occur with vessel movements associated with departing units after a training exercise. Navy training management measures to minimize and avoid these potential effects include a strict adherence to BTS interdiction protocols during and after an exercise is terminated and backloading commences, and all inbound solid waste cargo is fumigated in Apra Harbor prior to transport to solid waste storage facilities on Guam. BTS interdiction protocols are described in detail in Section 3.11 (Terrestrial Resources).

Vessels operating within the MIRC Study Area could temporarily disturb seabirds actively foraging in offshore surface waters. Seabirds foraging in offshore waters have an ability to identify approaching vessels well in advance of a potential collision. They would then reposition to avoid contact and resume foraging. Any effect on seabirds foraging in offshore waters would be localized and temporary, thus not expected to impact the seabirds' energy expenditure or foraging success. Foraging areas near ocean current boundaries and debris lines that contain a concentration of seabird prey are large features extending over miles of open ocean water. The potential for interaction between transiting or stationed large oceangoing ships and foraging seabirds in offshore waters would be low. Any effects from ocean activities on migratory or breeding seabirds related to reduced foraging success or direct mortality in offshore waters would likely be infrequent and minimal.

Vessel movements under the No Action Alternative would not have a significant adverse effect on seabirds or shorebirds, including migratory bird populations as defined by MBTA regulations applicable to military readiness activities. Vessel movements in territorial waters would have no significant impact on birds. Furthermore, vessel movements in non-territorial waters would not cause significant harm to birds.

Sonar – Mid-Frequency Active and High-Frequency Active Sonar. Information regarding the effects from sonar on seabirds is virtually unknown. One may be able to extrapolate to aquatic birds from TTS and PTS data on terrestrial birds; however, the exposure to anthropogenic underwater sounds by aquatic birds, other than diving species such as penguins, is likely to be limited due to their short time under water. Although there is no data available on seabird dive times for seabirds specific to the MIRC, Tremblay et al. (2003) developed methods for measuring time budgets and diving behavior for common guillemots (Uria aalge). In this study, electronic time-depth recorders were attached to the seabirds' bellies, and measured dives as long as 119 seconds. Average dive times were 38.7 seconds and the average time interval between dives during observed foraging activity was 20.1 seconds (Tremblay et al. 2003). Frere et al. (2002) measured dive times of red-legged cormorants (Phalacrocorax gaimardi). Mean dive duration was approximately 27 seconds while mean time at surface was approximately 9 seconds (n = 2217 dives). If the sound levels are sufficiently intense, even a short exposure could be problematic. In general, birds are less susceptible to both TTS and PTS than are mammals (Saunders and Dooling 1974). Moreover, relatively severe acoustic overexposures that would lead to irreparable damage and large permanent threshold shifts in mammals are moderated somewhat in birds by subsequent hair cell regeneration. Reviewing the probability of explosions or sonar occurring within close proximity of seabirds, and specifically diving seabirds, effects to seabird species would be infrequent.

Aircraft Overflights

Aircraft Disturbance. Various types of fixed-wing aircraft and helicopters are used in training exercises throughout the MIRC Study Area (see Chapter 2). The hearing range for birds is between 1 and 5 kHz with a rapid decrease in sensitivity at higher frequencies (Acoustical Society of America 1978). Seabirds and shorebirds birds could be exposed to airborne noise associated with subsonic and supersonic fixed-wing aircraft overflights and helicopter training activities (see Section 3.5 [Airborne Noise] for a description of the existing noise environment and Appendix H for an overview of airborne acoustics). Birds could be exposed to elevated noise levels while foraging or migrating in open water environments within the Pacific Ocean, but would not be exposed while nesting on land. Therefore, aircraft noise generated under the No Action Alternative would have no effect on bird nests.

Numerous studies have documented that birds and other wild animals respond to human-made noise including aircraft overflights, weapons firing, and explosions (Larkin 1996; National Park Service 1994; 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/absence of associated visual stimuli, and previous exposure. Researchers have documented a range of bird behavioral responses to noise including no response, alert behavior, startle response, flying or swimming away, diving into the water, and increased vocalizations. While 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 is not necessarily indicative of negative consequences to individual birds or to populations (Larkin 1996; National Park Service 1994; Bowles *et al*. 1991 in 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 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 birds can become habituated to noise following frequent exposure and cease to respond behaviorally to the noise (Larkin 1996; National Park Service 1994; Plumpton 2006). Little is known about physiological responses of birds that have habituated to noise.

Bird 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 of individual birds over a short period of time (hours or days) is extremely unlikely. Furthermore, the sound exposure levels would be relatively low. Birds could be exposed to noise levels ranging from just above ambient to approximately 97 dBA (based on an F/A-18E/F at 2,000 ft (610 m) above surface level, at 360 knots indicated air speed). However, most sound exposure levels would be lower than 97 dBA (less than 91.3 dBA for subsonic and less than 116 dBC for supersonic at the sea surface) because a majority (98%) of the subsonic overflights would occur above 3,000 ft (914 m) and supersonic flights would occur above 30,000 ft (9,144 m).

It is quite possible that seabirds at or near the sea surface would not respond to overflight noise based on the relatively high flight altitudes (3,000 to 30,000 ft) (914 to 9,144 m) and relatively low sound exposure levels (less than 91.3 dBA for subsonic and less than 116 dBC for supersonic flights). Most documented responses of birds have been to low-level aircraft overflights occurring below 3,000 ft (914 m) (National Park Service 1994). As discussed above, the duration of exposure would be very short (seconds) and exposures would be infrequent. Unlike the situation at a busy commercial airport or military landing field, repeated exposure of individual birds or groups of birds is unlikely 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 (e.g., alert response, startle response, and temporary increase in heart rate) 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 [23 to 31 m] in drop zones or landing zones), which increase the likelihood that birds would respond to helicopter overflights. In addition, some studies have suggested that birds respond more to disturbance from helicopters than from that of fixed-wing aircraft (Larkin 1996; Plumpton 2006). Noise from low-altitude helicopter overflights would be expected to elicit short-term behavioral or physiological responses (e.g., alert response, startle response, and temporary increase in heart rate) in exposed birds. Repeated exposure of individual birds or groups of birds is unlikely based on the dispersed nature of the overflights. The general health of individual birds would not be compromised.

In summary, aircraft noise under the No Action Alternative could elicit short-term behavioral or physiological responses in exposed birds. Helicopter overflights are more likely to elicit responses than fixed-wing aircraft, but the general health of individual birds would not be compromised. Aircraft noise under the No Action Alternative would not have a significant adverse effect on seabirds or shorebirds, including migratory bird populations as defined by MBTA regulations applicable to military readiness activities. In accordance with NEPA, aircraft noise over territorial waters would have no significant impact on birds. Furthermore, aircraft noise over non-territorial waters would not cause significant harm to birds in accordance with EO 12114.

Aircraft Strikes. Bird/aircraft strikes are a major concern for the Navy, Marine Corps, and Air Force because they can cause harm to aircrews, damage to equipment, and bird mortality. However, even from a Navy-wide perspective, the numbers of bird mortalities that occur annually are insignificant from a population standpoint. From 2002 through 2004 an annual average of 596 known wildlife/aircraft strike events occurred Navy-wide and most of these events involved birds (Navy Safety Center 2004). While bird strikes can occur anywhere aircraft are operated, Navy data indicate they occur most often over land or close to shore. The potential for bird strikes to occur in offshore areas is relatively low because training is widely dispersed at relatively high altitudes (above 3,000 ft [914 m] for fixed-wing aircraft) and bird densities are generally low. For example, from 2002 through 2004 only five known bird strikes involving vessel-based aircraft occurred Navy-wide. Of the 1,789 Navy-wide wildlife strike events reported for 2002 through 2004, only 19 (1%) involved seabirds.

Air Force Instruction (AFI) 91-202 requires Andersen AFB to implement a Bird Aircraft Strike Hazard (BASH) Plan. The Andersen AFB BASH plan provides guidance for reducing the incidents of bird strikes in and around areas where flying training is being conducted. The plan is reviewed annually and updated as needed.

Few, if any, bird/aircraft strikes and associated bird mortalities or injuries are expected to occur in the MIRC Study Area under the No Action Alternative. Aircraft strikes under the No Action Alternative would not have a significant adverse effect on seabirds or shorebirds, including migratory bird populations as defined by MBTA regulations applicable to military readiness activities. Aircraft strikes over territorial waters would have no significant impact on birds. Furthermore, aircraft strikes over non-territorial waters would not cause significant harm to birds.

Amphibious Landings and Over-the-Beach Training. As discussed in Section 3.8 (Sea Turtles), amphibious landings are conducted to transport troops and equipment from ship to shore for subsequent inland maneuvers. The selection of suitable landing craft at each landing beach is based on environmental and training criteria. Concerns associated with amphibious landing activities in the Mariana Islands include potential impacts to coral reefs and impacts to natural and cultural resources in nearby inland areas since disembarked personnel and equipment must often traverse such areas in order to exit and enter a landing beach.

Currently, landing beaches that have been authorized for LCAC, LCU, AAV, CRRC, RHIB, OTB swimmer insertions, and combat swimmer special activities against ships occur at sites on Guam Navy lands within the Main base, Apra Inner and Outer Harbor areas, Tipalao, and Dadi; on Guam Air Force lands; and on Tinian within the EMUA, LBA, and non-DoD leased lands. These landing sites are described in detail in Section 3.8 (Sea Turtles). Shorebirds may forage within these areas, although nesting activity is not likely. Amphibious landings may cause short-term behavioral responses to seabird foraging activity in nearshore waters and on beach areas; however, these effects would be temporary, and any direct mortality of a nesting clutch, if any, is unlikely to occur.

As shown in Table 2-7, increases in amphibious landing activities and OTB under the No Action Alternative include the following:

- One annual training event involving assault, offload and backload training at landing locations on Tinian and within Main Base (Guam).
- At FDM, four FIREX (Land) training per year, which translates to 400 rounds of 5-inch guns and HE shells.

Amphibious landings under the No Action Alternative would not have a significant adverse effect on seabirds or shorebirds, including migratory bird populations as defined by MBTA regulations applicable to military readiness activities. Amphibious landings over territorial waters would have no significant impact on birds. Amphibious landing activities do not occur in non-territorial waters and would therefore not have any significant impact on birds.

Weapons Firing/Non-Explosive Ordnance Use

Weapons Firing Disturbance. Current military training in the MIRC Study Area include firing a variety of weapons employing a variety of non-explosive training rounds and explosive rounds including bombs, missiles, naval gun shells, cannon shells, small caliber ammunition, and grenades. A majority of ordnance fired in the MIRC Study Area consists of non-explosive training rounds (Table 2-7). The analysis presented in this subsection focuses on non-explosive training rounds, while potential effects of explosive rounds are analyzed below in the High Explosives Ordnance subsection. Training exercises that involve weapons firing and ordnance use take place in several training areas. Disturbance associated with noise from weapons firing and direct ordnance strikes are potential stressors to birds.

Similar to fixed-wing aircraft and helicopter training, bird responses to noise from weapons firing would be limited to short-term behavioral or physiological responses (e.g., alert response, startle response, and temporary increase in heart rate). These training events are often preceded by some other type of human activity in the general area, which would likely disperse birds away from the associated noise. Therefore, it is not likely that birds would be exposed to the loudest noise levels associated with weapons firing. The general health of individual birds would not be compromised and noise from weapons firing would not result in significant impacts to migratory bird populations as defined by MBTA regulations applicable to military readiness activities. In accordance with NEPA, noise from weapons firing in territorial waters would have no significant impact on birds. Furthermore, noise from weapons firing in non-territorial waters would not cause significant harm to birds in accordance with EO 12114.

Non-Explosive Ordnance Strikes. Fired ordnance has the potential to directly strike birds as it travels through the air to its intended target. As discussed in Sections 3.7.3 and 3.8.3, modeling conducted for the MIRC Study Area indicates that the probability of ordnance striking marine mammals and sea turtles is extremely low. The probability of ordnance directly striking a seabird is also expected to be extremely low under the No Action Alternative, although seabird density data are not available to conduct ordnance strike probability modeling.

The small number of bombs and missiles that would be expended in the MIRC Study Area annually, coupled with the patchy distribution of seabirds, suggests that the probability of these types of ordnance striking a seabird would be extremely low. Human activity such as vessel or boat movement, aircraft overflights, and target setting, could cause birds to flee a target area prior to the onset of firing, thus avoiding harm. If birds were in the target area, they would flee the area when firing commenced (assuming they were not struck by the initial rounds). Mitigation measures, which include, but are not limited to, avoidance of areas that exhibit relatively high productivity where seabirds tend to concentrate, further reduce the probability of ordnance strikes. Areas within the EMUA on Tinian, Hagoi and the surrounding region are designated as "No Training" areas; therefore, training involving weapons firing or non-explosive inert ordnance will not impact seabirds foraging at Hagoi or in surrounding vegetation. On FDM, the range area where ordnance is restricted to inert munitions, vegetation is recovering in vertical structure and surface cover, relative to range areas on FDM where high explosive ordnance is permitted (Vogt 2008). Vogt (2008) observed Micronesian megapodes within this area, although in apparent lower densities relative to areas north of the "special use area" where no live-fire training occurs. Other land-use constraints on FDM training activities (refer to Figure 2-2) minimize effects of weapons firing and inert munitions use on seabirds include no targeting of eastern cliffs (where masked and brown boobies nest) and all ship and aircraft-based firing strikes FDM from the west only.

While a remote possibility exists that some individuals of some bird species (including chicks and eggs resulting from flushing of adults) may be directly impacted if they are in the target area and at the point of physical impact at the time of ordnance delivery, non-explosive ordnance strikes under the No Action Alternative would not result in significant impacts to seabirds or shorebirds, including populations of migratory birds as defined by MBTA regulations applicable to military readiness activities. Non-explosive ordnance strikes in territorial waters would have no significant impact on birds. Furthermore, non-explosive ordnance strikes in non-territorial waters would not cause significant harm to birds.

*High Explosive Ordnance***.** Explosions that occur in the MIRC Study area are associated with training exercises that use explosive ordnance, including bombs, missiles, and naval gunshells (5-inch [12.7 cm] high explosive projectiles), as well as underwater detonations associated with ASW training. The ordnance use under the No Action Alternative is listed in Table 2-8. Explosive ordnance use and underwater detonation is limited to a few specific training areas. The potential for seabirds to be exposed to explosions is difficult to quantify and depends on several factors including the following:

- The geographic location of the explosions within the MIRC Study Area and whether or not birds are present at the time of the explosion.
- Position of the explosion in relationship to the sea surface (e.g., altitude above the surface, at the surface, and depth below the surface). Explosions associated with bombs, missiles, and naval gunshells occur at or immediately below the sea surface, while underwater detonations occur on the bottom and at depths below the surface.
- Position of the bird in the environment at the time of explosion (e.g., in the air, on the surface, diving below the surface). Studies have shown that birds are more susceptible to underwater explosions when they are submerged versus on the surface (Yelverton *et al.* 1973). Similarly,

birds in flight are expected to be less susceptible to underwater explosions than those on the surface.

- Magnitude of the explosion (i.e., net explosive weight [NEW]) and the zone of influence (ZOI) associated with the explosion. While ZOIs cannot be calculated for seabirds based on available data, higher NEWs would produce larger ZOIs. Of the explosions that occur in the MIRC Study Area, bombs are expected to have the largest ZOIs, followed by naval gunshells, 20 lb (9.1 kilograms [kg]) NEW underwater detonations, 10 lb (4.5 kg) NEW underwater detonations, and Hellfire missiles.

In general, the effects of explosions correspond to the distance of the animal from the explosion, ranging from lethal injury to short-term acoustic effects. Birds in the immediate vicinity of an explosion could be susceptible to lethal injury and birds on the outer edges of the ZOI could exhibit a short-term behavioral response. While the effects of explosions in the MIRC Study Area on seabirds cannot be quantified, lethal injury to some individuals of some bird species could occur based on the total number of explosions that would take place per year under the No Action Alternative.

Underwater Detonations on the Ocean Surface. Underwater detonations may occur during the No Action Alternative at the MIRC, and may include the following exercises: SINKEX, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS. At least thirty minutes prior to commencing any of these exercises, the area within a one-mile radius of the training site will be monitored visually by a bridge watch for marine mammals, sea turtles, seabirds, or mariners (COMNAVMARINST 3500.4). Ordnance cannot be released until the training area is determined clear. In Apra Harbor, explosive charges are limited to 10 lb (4.5 kg) charges or less. These specific training management requirements and restrictions are designed to avoid impact to marine mammals, sea turtles, and seabirds and should be sufficient so as not to cause significant behavioral responses or mortality. Further, the Navy avoids areas of relatively high productivity at sea for exercises involving explosive ordnance where some seabirds tend to concentrate, as discussed in Section 3.6 (Marine Communities).

High explosive events under water or on the surface within territorial waters would have no significant impact on seabirds. Furthermore, high explosive events in non-territorial waters would not cause significant harm to seabirds.

Surface Detonations at FDM. FDM supports colonies of breeding resident seabirds, including masked boobies, brown boobies, red-footed boobies, great frigatebirds, common noddies, black noddies, and white terns. FDM is particularly important for great frigatebirds as it is one of only two small breeding colonies known to exist in the Mariana island chain, and for masked boobies because it represents the largest known nesting site for this species in the Mariana or Caroline Islands (Lusk *et al.* 2000).

As shown in Table 2-8, the existing ordnance use at FDM includes the following:

- Bombs (HE) ≤ 500 lbs: 400 rounds,
- Bombs (HE) 750 / 1000 /2000 lbs: 1,600 rounds,
- Inert Bomb Training Rounds ≤ 2000 lbs: 1,800 rounds
- Missiles [Maverick; Hellfire; TOW; Rockets ≤ 5”]: 30 rockets
- Cannon Shells (20 or 25 mm): 16,500 rounds
- 5” Gun Shells: 400 rounds
- Small Arms [5.56mm; 7.62mm; .50 cal; 40mm]: 2,000 rounds.

Mitigation measures are expected to reduce, but not eliminate, the potential for seabird mortality from explosions. Mitigation measures include:

- Limit the targeting of ship and aircraft live fire and aerial bombardment to interior portions only of FDM. This will avoid cliff and shelf nesting colony concentrations.
- Missile and explosive shell firing at FDM is only directed towards FDM from the west and eastern cliffs of the island are not targeted.
- Maintaining targeting and munitions restrictions on portions of FDM, such as no targeting of explosive munitions within a "special use area" on the northern portion of FDM. Impact Area 1 on FDM is restricted to inert ordnance only.

These mitigation measures were developed during various consultations with the USFWS for listed species that may occur or are known to occur on FDM (green sea turtle and Micronesian megapode) (USFWS 1998, 1999).

Navy biologists conduct monthly aerial bird count surveys via helicopter over FDM (NAVFACPAC 2008b). These surveys show distinct oscillations in the booby populations on FDM. The period from 1999 to 2002 was a low period, followed by increasing numbers recorded from 2003 through 2005. Decreases in booby numbers continued from 2006 through 2007. These surveys also suggest that most great frigatebird sightings occur between December and March and are seasonally-dependent. Sightings for these birds have increased from 2005 through the present during the winter period (NAVFACPAC 2008b).

Human activity such as vessel movement, aircraft overflights, and target setting, could cause birds to flee a target area prior to the onset of an explosion, thus avoiding harm. In addition, birds that are in flight during an explosion would be less susceptible to harm than birds that are on the sea surface or diving underwater during an explosion. While some seabird mortality could occur, these factors indicate that a small number of birds would be affected and that population level effects would not be expected. Underwater detonations and explosive ordnance use under the No Action Alternative would not result in significant impacts to seabirds or shorebirds, including populations of migratory birds as defined by MBTA regulations applicable to military readiness activities. Underwater detonations and explosive ordnance use in territorial waters would have no significant impact on birds. Furthermore, underwater detonations and explosive ordnance use in non-territorial waters would not cause significant harm to birds.

Expended Materials. The Navy uses a variety of ordnance during training exercises conducted in the MIRC Study Area. The types and quantities of expended materials and information regarding fate and transport of these materials within the marine environment are discussed in Section 3.2 (Hazardous Materials and Waste). A majority of the expended materials currently used by the Navy rapidly sink to the sea floor and seabirds would not be exposed to these materials.

Ingestion/Inhalation/Direct Contact. Ordnance related materials would sink in relatively deep waters, would not present an ingestion risk to seabirds, and would have no effect on birds. Most targets are recovered after use, while some targets such as metal drums rapidly sink after use. Targets would have no effect on birds. However, seabirds could be exposed to some materials such as chaff fibers in the air or at the sea surface through direct contact or inhalation. Seabirds could also ingest some types of expended materials if the materials float on the sea surface or are left on land-based range sites, such as FDM.

Based on the dispersion characteristics of chaff, large areas of air space and open water within the MIRC Study Area would be exposed to chaff, but the chaff concentrations would be very low (see Section 3.6.4.1). Several literature reviews and controlled experiments have indicated that chaff poses little environment risk except at concentrations substantially higher than those that could reasonably occur from military training use (Arfsten *et al*. 2002; Hullar *et al*. 1999; USAF 1997). Birds would occasionally come in direct contact with chaff fibers, but such contact would be inconsequential. Chaff is similar in form to fine human hair. Due to its flexible nature and softness, external contact with chaff would not be expected to adversely affect most wildlife (USAF 1997) and the fibers would quickly blow off or wash off shortly after contact. Inhalation of chaff fibers is not expected to have any adverse effects on birds because the fibers are too large to be inhaled into the lung. If inhaled, the fibers are predicted to deposit in the nose, mouth, or trachea and are either swallowed or expelled (Hullar *et al*. 1999).

After falling from the air, chaff fibers float on the sea surface for some period of time depending on wave and wind action. Seabirds would be expected to unintentionally ingest low concentrations of floating chaff fibers, which consist of about 60 percent silica and 40 percent aluminum by weight. Some fibers would likely become entrained in *Sargassum* mats and remain at or near the surface for longer periods of time.

Ingestion of chaff fibers is not expected to cause physical damage to a bird's digestive tract based on the small size (ranging in lengths of 1/4 to 3 in (0.6 cm to 7.6 cm) with a diameter of about 40 micrometers) and flexible nature of the fibers and the small quantity that could reasonably be ingested. In addition, concentrations of chaff fibers that could reasonably be ingested are not expected to be toxic to birds. Scheuhammer (1987) reviewed the metabolism and toxicology of aluminum in birds and mammals and found that intestinal adsorption of orally ingested aluminum salts was very poor, and the small amount adsorbed was almost completely removed from the body by excretion. Dietary aluminum normally has small effects on healthy birds and mammals, and often high concentrations (>0.016 oz/lb [~1,000 mg/kg]) are needed to induce effects such as impaired bone development, reduced growth, and anemia (Nybo 1996). A bird weighing approximately 2.2 lbs (1 kg) would need to ingest more than 83,000 chaff fibers per day to receive a daily aluminum dose equal to 0.016 oz/lb (~1,000 mg/kg) (based on chaff consisting of 40% aluminum by weight and a 5-ounce [142 grams] chaff canister containing 5 million fibers). It is highly unlikely that a bird would ingest a toxic dose of chaff based on the anticipated environmental concentration of chaff (1.8 fibers/ft^2 [19.4 fibers/m^2]) for a worst-case scenario of 360 chaff cartridges simultaneously released at a single drop point).

Other expended materials that could be ingested by seabirds include small plastic end caps and pistons associated with chaff and self-protection flares. The chaff end cap and piston are both round and are 1.3 in (3.3 cm) in diameter and 0.13 in (0.3 cm) thick (Spargo 2007). This plastic expended material sinks in saltwater (Spargo 2007), which reduces the likelihood of ingestion.

Many species of seabirds are known to ingest plastic debris. For example, 21 of 38 seabird species (55%) collected off the coast of North Carolina from 1975 to 1989 contained plastic particles (Moser and Lee 1992). Plastic is often mistaken for prey and the incidence of plastic ingestion appears to be related to a species' feeding mode and diet. Seabirds that feed by pursuit-diving, surface-seizing, and dipping tend to ingest plastic, while those that feed by plunging or piracy typically do not ingest plastic. Birds of the family Procellariidae, which include petrels and shearwaters, tend to accumulate more plastic than do other species. Some seabirds, including gulls and terns, regularly regurgitate indigestible parts of their food items such as shell and fish bones. However, most procellariiforms have small gizzards and an anatomical constriction between the gizzard and proventriculus that make it difficult to regurgitate solid material such as plastic (Azzarello and Van Vleet 1987; Moser and Lee 1992; Pierce *et al*. 2004). Two species of albatross (Diomedeidae) have also been reported to ingest plastic while feeding at sea. While such studies have not conclusively shown that plastic ingestion is a significant source of direct mortality, it may be a contributing factor to other causes of albatross mortality (Naughton *et al.* 2007).

Moser and Lee (1992) found no evidence that seabird health was affected by the presence of plastic, but other studies have documented adverse consequences of plastic ingestion. As summarized by Pierce *et al.* (2004) and Azzarello and Van Vleet (1987), documented consequences of plastic ingestion by seabirds include blockage of the intestines and ulceration of the stomach; reduction in the functional volume of the gizzard leading to a reduction of digestive capability; and distention of the gizzard leading to a reduction in hunger. Studies have found negative correlations between body weight and plastic load, as well as body fat, a measure of energy reserves, and the number of pieces of plastic in a seabird's stomach. Other possible concerns that have been identified include toxic plastic additives and toxic contaminants that could be adsorbed to the plastic from ambient seawater. Pierce *et al*. (2004) described a case where plastic ingestion caused seabird mortality from starvation of a member of family Procellariidae. Dissection of an adult greater shearwater gizzard revealed that a 1.5 in (3.8 cm) by 0.5 in (1.27 cm) fragment of plastic blocked the pylorus, obstructed the passage of food, and resulted in death from starvation.

Based on the information presented above, if a seabird were to ingest a plastic end cap or piston, the response would vary based on the species and individual bird. The responses could range from none, to sublethal (reduced energy reserves), to lethal (digestive tract blockage leading to starvation). Ingestion of end caps and pistons by species that regularly regurgitate indigestible items would likely have no adverse effects. However, end caps and pistons are similar in size to those plastic pieces described above that caused digestive tract blockages and eventual starvation. Therefore, ingestion of plastic end caps and pistons could be lethal to some individuals of some species of seabirds. Species with small gizzards and anatomical constrictions that make it difficult to regurgitate solid material would likely be most susceptible to blockage, such as the wedge-tailed shearwater. Seventeen species of family Procelleriidae, which are generally thought to be more susceptible to adverse consequences of plastic ingestion, are recorded within the MIRC Study Area (listed in Table 3.10-2). Wedge-tailed shearwaters are restricted to Saipan (USFWS 2007) and other species of Procellerridae have not been observed on FDM where most of the expended materials would be concentrated.

Based on available information, it is not possible to accurately estimate actual ingestion rates or responses of individual birds. Nonetheless, the number of end caps or pistons ingested by seabirds is expected to be very low and only an extremely small percentage of the total would be potentially available to seabirds. Anatomical characteristics of species within family Procelleriidae may elevate the risk of plastic ingestion relative to other species or families; however, exposure to species of family Procelleriidae would still remain low. Plastic ingestion under the No Action Alternative would not result in a significant adverse effect on migratory bird populations. Sublethal and lethal effects, if they occur, would be limited to a few individual birds.

Entanglement. Entanglement with expended materials, such as parachutes, presents a different kind of risk to seabirds. Similar to sea turtles, the potential exists for seabirds to become entangled in expended materials, particularly anything incorporating loops or rings, hooks and lines, or sharp objects. Possible expended materials from training and RDT&E activities are nylon parachutes of varying sizes. At water impact, the parachute assembly is expended and it sinks away from the exercise weapon or target. The parachute assembly will potentially be at the surface for a short time before sinking to the sea floor. Entanglement and the actual drowning of a seabird in a parachute assembly is unlikely, since the parachute would have to land directly on the animal, or a diving seabird would have to be diving exactly underneath the location of the sinking parachute. The potential for a seabird to encounter an expended parachute is extremely low, given the generally low probability of a seabird being in the immediate location of deployment.

In summary, ingestion, inhalation, or contact (including entanglement) with expended materials is highly unlikely. Therefore, expended materials would not result in a significant adverse effect on seabird or shorebird populations as defined by MBTA regulations applicable to military readiness activities. Expended materials in territorial waters would have no significant impact on birds. Furthermore, expended materials in non-territorial waters would not cause significant harm to birds.

3.10.3.2 Alternative 1

Vessel Movements. An additional major exercise involving vessel movements will be added under Alternative 1. Unlike the Multiple Strike Group exercise, the additional exercise will be an Amphibious Assault exercise, which will not involve as many vessel movements as a Multiple Strike Group exercise. These changes would result in increased potential for short-term behavioral reactions to vessels. Potential for collision would increase slightly compared to the No Action Alternative; however, Navy training management measures would minimize impacts. Training management measures relevant to vessels include watch duties to alert vessel pilots of seabird proximity in and near offshore waters. The increased amount of vessel movements coupled with the Navy training management measures would not increase the threat of vessel movements. Vessel movements in territorial waters would have no significant impact on seabirds. Furthermore, vessel movements in non-territorial waters would not cause significant harm to seabirds.

Aircraft Overflights. The number of training activities involving fixed-wing aircraft overflights would increase from 704 to 2,942 in the MIRC Study Area under Alternative 1. Most of these increases are associated with activities around FDM and in the ATCAAs. These changes would result in increased exposures of seabirds to fixed-wing overflights. Elevated numbers of overflights would increase the potential for behavioral disturbance from sound and shadow-effects. Training activities involving helicopter overflights would increase from 717 to 1,123 per year. Behavioral reactions to fixed-wing and helicopter overflights would be the same as discussed under the No Action Alternative. Aircraft overflights under Alternative 1 may affect seabirds, but the effects are expected to be insignificant. Aircraft overflights over territorial waters would have no significant impact on seabirds. Furthermore, aircraft overflights over non-territorial waters would not cause significant harm to seabirds.

Amphibious Landings and Over-the Beach Training. As shown in Table 2-7, increases in amphibious landing activities and OTB under Alternative 1 include the following:

- Addition of six annual training events involving assault, raid, offload and backload training at landing locations on Tinian and within Main Base (Guam).

- At FDM, an increase of four FIREX (Land) training events to eight per year, which translates into an additional 400 rounds of 5-inch guns and HE shells.

Protective measures described under the No Action Alternative will continue under Alternative 1. These protective measures, described as “training management measures,” including pre-activity surveys at landing beaches (Unai Chulu and Unai Dankulo on Tinian, and Apra Harbor, Sumay Channel, and Dry Dock Island on Guam) and to adhere to NWD areas and NT areas on Guam and Tinian. Other avoidance measures described in the No Action Alternative will be in effect for Alternative 1. Therefore, amphibious landing exercises within territorial waters and onshore areas would have no significant impact on seabirds. Since amphibious landings or OTB would not occur in non-territorial waters, EO 12114 does not apply.

High Explosive Ordnance. Underwater detonations may occur under Alternative 1, and may include the following exercises: SINKEX, A-S MISSILEX, S-S MISSILEX, BOMBEX, S-S GUNEX, and NSFS. There is a lead time for set up and clearance of the impact area before any event using explosives takes place (at least 30 minutes to several hours). There will, therefore, be a long period of area monitoring before any detonation or live-fire event begins. Ordnance cannot be released until the target area is determined clear.

The use of explosive ordnance will increase under Alternative 1, as shown in Table 2-8. On FDM, the ordnance increases are listed below, relative to existing ordnance use.

- Bombs (HE) ≤ 500 lbs: Increase of 100 rounds per year, from 400 to 500,
- Bombs (HE) 750 / 1000 /2000 lbs: Increase of 50 rounds per year, from 1,600 to 1,650,
- Inert Bomb Training Rounds ≤ 2000 lbs: Increase of 1,000 rounds per year, from 1,800 to 2,800,
- Missiles [Maverick; Hellfire; TOW; Rockets ≤ 5 inches]: Increase of 30 rounds per year, from 30 to 60,
- Cannon Shells (20 or 25 mm): Increase of 3,500 rounds per year, from 16,500 to 20,000,
- Cannon Shells (30 mm): Increase of 1,500 rounds per year, from 0,
- 5” Gun Shells: Increase of 400 rounds per year, from 400 to 800, and,
- Small Arms [5.56mm; 7.62mm; .50 cal; 40mm]: Increase of 1,000 rounds per year, from 2,000 to 3,000.

On FDM, impacts to the great frigatebird population (one of two populations in the Marianas) and the masked booby population (largest known nesting site for this species in the Mariana or Caroline Islands), may be avoided by not targeting known rookery locations and through the concentration of ordnance to designated range areas on the interior of the island. All these factors serve to minimize the risk of harming seabirds, even with the projected increase in training events utilizing explosive ordnance, relative to the No Action Alternative. FDM has been subject to perturbations associated with explosive ordnance training, yet utilization of FDM by seabirds has continued (along with the Micronesian megapode, as discussed in Section 3.11 [Terrestrial Resources]). The increase in the number of rounds deployed per year under Alternative 1 is unlikely to endanger breeding activity for the ten seabird species known to breed at FDM (black noddies, brown noddies, brown boobies, masked boobies, red-footed boobies, white terns, great frigatebirds, red-tailed tropicbirds, sooty terns, and white-tailed tropicbirds). The Navy has reached this conclusion based on (1) population index surveys conducted since 1999 show that populations are relatively stable despite periodic oscillations (NAVFACPAC 2008b), (2) existing conservation measures and targeting restrictions have minimized the potential impact associated with ordnance use, and (3) no new areas of FDM will be targeted, therefore, the increases in munitions use at FDM will occur in areas already impacted by existing munitions use. In accordance with NEPA, high explosive events under water or on the surface within territorial waters would have no significant impact on seabirds. The Navy’s consultation with the USFWS considers these two species, along with other MBTA-protected bird species at FDM, within the Section 7 consultation analysis. Furthermore, high explosive events in non-territorial waters would not cause significant harm to seabirds in accordance with EO 12114.

Expended Materials. The amount of ordnance fired would increase in the MIRC Study Area under Alternative 1. Similar to the No Action Alternative, seabirds would potentially have increased exposure to plastic caps, chaff, and other expended materials, which may be ingested by seabirds; however, due to the high dispersal and low density of expended materials over open ocean, the increased amount of expended materials introduced to the open ocean feeding grounds is not likely to increase sublethal or lethal rates of ingestion. Concentration of expended materials over FDM is also not likely to increase sublethal or lethal ingestion because seabirds forage at sea and not on land. Additionally, the seabird species that is morphologically challenged with the inability to regurgitate (wedge-tailed shearwater) is not known to occur on FDM or in waters off FDM. Under Alternative 1, ingestion of ordnance may be lethal to seabirds and sublethal from the blockage of internal digestive pathways, however, expended material deposition is not expected to significantly alter existing population structures at FDM. In accordance with NEPA, ordnance related materials would have no significant impact on seabirds in territorial waters. Furthermore, ordnance related materials would not cause significant harm to seabirds in non-territorial waters in accordance with EO 12114.

3.10.3.3 Alternative 2

All Stressors. As detailed in Chapter 2 and Table 2-7, implementation of Alternative 2 would include all the actions proposed for MIRC, including the No Action Alternative and Alternative 1, and additional major exercises. Beach landings are highly restricted and dependent on an array of training management measures described under the No Action Alternative. Specifically at Unai Dankulo, landings would be contingent on pre-activity surveys and will be localized at Long Beach One. Utilizing Long Beach One further minimizes impacts because post-activity boat portage to transport vehicles traverses a shorter distance to the beach access road, relative to other beach locations along Unai Dankulo. Although these measures are specifically designed to avoid impacts to sea turtles, the increased presence and disturbance will encourage seabirds to exit the area or to cease foraging activities that may expose them to harm.

The use of explosive ordnance will increase under Alternative 2, as shown in Table 2-8. On FDM, the ordnance increases are listed below, relative to existing ordnance use (No Action Alternative).

- Bombs (HE) ≤ 500 lbs: Increase of 200 rounds per year, from 400 to 600,
- Bombs (HE) 750 / 1000 /2000 lbs: Increase of 100 rounds per year, from 1,600 to 1,700,
- Inert Bomb Training Rounds ≤ 2000 lbs: Increase of 1,200 rounds per year, from 1,800 to 3,000,
- Missiles [Maverick; Hellfire; TOW; Rockets ≤ 5 inch]: Increase of 40 rounds per year, from 30 to 70,
- Cannon Shells (20 or 25 mm): Increase of 5,500 rounds per year, from 16,500 to 22,000,
- Cannon Shells (30 mm): Increase of 1,500 rounds per year, from 0,
- 5” Gun Shells: Increase of 600 rounds per year, from 400 to 1,000, and,
- Small Arms [5.56mm; 7.62mm; .50 cal; 40mm]: Increase of 1,000 rounds per year, from 2,000 to 3,000.

Seabirds would be affected by the increases in exposure to the various stressors considered for analysis, however, mitigation measures reduce the likelihood of impacts out of the realm of significance. The increased exposure to stressors within territorial waters would have no significant impact on seabirds under Alternative 2. Furthermore, increased activities in non-territorial waters would not cause significant harm to seabirds.

3.10.4 ESA-Listed Seabirds and Shorebirds

3.10.4.1 Short-tailed albatross (*Phoebastria albatrus*)

Short-tailed albatross are rare vagrant migrants that forage in offshore, open ocean waters. Albatrosses forage near the sea surface, utilizing pressure differences created by ocean swells to aid in soaring; they are known to land on islands or offshore rocks. Aviation, ocean, and land training within the MIRC Study Area that overlaps areas potentially containing short-tailed albatross includes vessels traveling offshore, ordnance impacting foraging locations, and airspace below 1,000 ft (305 m). The described training activities would present no measurable chance for interaction with this species.

Short-tailed albatross remain one of the world’s most endangered birds (USFWS 2005b). Considering the rarity of this species in general and the lack of frequent sightings, chances for its potential interactions with MIRC exercises would be extremely low. Birds of this family follow wakes of ships, slightly increasing the potential for interaction with aircraft carriers, especially during the launching or landing of aircraft; however, the probability of direct effects to individuals or populations remains low. The spatial and temporal variability of both the occurrence of a short-tailed albatross and the training activities conducted within offshore locations near foraging areas presents an improbable chance that a direct or indirect effect would occur to this species. MIRC training activities would have no effect on short-tailed albatross.

3.10.4.2 Hawaiian Petrel (*Pterodroma sandwichensis*)

Hawaiian petrels are also rare migrants that forage in offshore open ocean waters. Petrels forage near the sea surface, and can range 930 mi (1,500 km) from the Hawaiian Islands, which overlaps with the MIRC Study Area; however, the range shrinks for part of the year to surround the Hawaiian Islands. Aviation, ocean, and land training within the MIRC Study Area that overlaps with areas potentially containing the Hawaiian petrel includes vessels traveling offshore, ordnance impacting foraging locations, and airspace below 1,000 ft (305 m). The described training activities would present no measurable chance for interaction with this species.

Considering the rarity of this species and the lack of frequent sightings within the MIRC Study Area, chances for its potential interactions with MIRC exercises would be extremely low. The probability of direct effects to individuals or populations remains low. The spatial and temporal variability of both the occurrence of a Hawaiian petrel and the training activities conducted within offshore locations near foraging areas presents an improbable chance of direct or indirect effect on this species. MIRC training activities would have no effect on Hawaiian petrel.

3.10.5 Unavoidable Significant Environmental Impacts

The analysis presented above indicates that Alternatives 1 and 2 would not result in unavoidable significant adverse effects to seabirds or migratory birds.

3.10.6 Summary of Environmental Impacts

3.10.6.1 Migratory Bird Treaty Act

As discussed in the analysis presented in Section 3.10.3 and summarized in Table 3.10-3, the No Action Alternative, Alternative 1, and Alternative 2 would not diminish the capacity of a population of a migratory bird species to maintain genetic diversity, to reproduce, and function effectively in its native ecosystem. The implementation of the Action Alternatives would not have a significant adverse effect on migratory bird populations at sea, although increased activity at FDM may increase potential for impacts to great frigatebird and masked booby rookeries. FDM is one of two locations where breeding occurs for the great frigatebird within the Mariana Islands, and the largest nesting location for the brown booby in the Mariana and Caroline Islands. The Navy is in consultation with USFWS to minimize effects to ESA listed species, some of which occur at FDM (Micronesian megapode, discussed in Section 3.11, and sea turtles, discussed in Section 3.8). The consultation also addresses MBTA issues, specifically at FDM, due to increased range utilization under Alternative 1 and Alternative 2. As a result and in accordance with 50 CFR Part 21, the Navy is in consultation with the USFWS on the development and implementation of conservation measures to minimize or mitigate adverse effects to seabirds and shorebirds that are not listed under the ESA.

3.10.6.2 National Environmental Policy Act and Executive Order 12114

As summarized in Table 3.10-3, the No Action Alternative, Alternative 1, and Alternative 2 would have no significant impact on seabirds and migratory birds in territorial waters, with the possible exception of great frigatebirds and brown boobies occurring at FDM. Furthermore, the No Action Alternative, Alternative 1, and Alternative 2 would not cause significant harm to seabirds and migratory birds in non-territorial waters.

Table 3.10-3: Summary of Environmental Effects of the Alternatives on Seabirds and Migratory Birds in the MIRC Study Area

Alternative and Stressor	NEPA (Land and Territorial Waters, < 12 nm)	Executive Order 12114 (Non-Territorial Waters, >12 nm)
No Action Alternative, Alternative 1, and Alternative 2		
Vessel Movements	Short-term behavioral responses to vessels and extremely low potential for injury/mortality from collisions, primarily at night. No long-term population-level effects.	Short-term behavioral responses to vessels and extremely low potential for injury/mortality from collisions, primarily at night. No long-term population-level effects.
Aircraft Overflights	Short-term behavioral responses to overflights, primarily helicopters. Extremely low potential for injury/mortality from strikes. No long-term population-level effects.	Short-term behavioral responses to overflights, primarily helicopters. Extremely low potential for injury/mortality from strikes. No long-term population-level effects.
Amphibious Landings	Short-term behavioral responses from landing activity associated with vehicles and personnel on beaches. No long-term population effects.	Not Applicable. Amphibious landings exclusively occur within territorial waters.
Weapons Firing/Non-Explosive Ordnance Use	Short-term behavioral responses to firing noise. Extremely low potential for injury/mortality from strikes. No long-term population-level effects.	Short-term behavioral responses to firing noise. Extremely low potential for injury/mortality from strikes. No long-term population-level effects.
Underwater Detonations and Explosive Ordnance	Short-term behavioral responses to explosion noise. Potential for a small number of injuries/mortalities in the immediate vicinity of an explosion at sea. Increased danger to seabirds at FDM, although under current conditions, no long-term population-level effects. Under Alternative 1 and Alternative 2 increases in training activities at FDM would increase exposure to resident seabirds, although with no long-term population-level effects.	Short-term behavioral responses to explosion noise. Potential for a small number of injuries/mortalities in the immediate vicinity of an explosion. No long-term population-level effects. Impacts to FDM are not applicable because these impacts do not occur in non-territorial waters.
Expended Materials	No effects associated with ordnance related materials, targets, parachutes, or marine markers. Extremely low potential for sublethal or lethal effects from ingestion of chaff or flare end caps or pistons. No long-term population-level effects.	No effects associated with ordnance related materials, targets, parachutes, or marine markers. Extremely low potential for sublethal or lethal effects from ingestion of chaff or flare end caps or pistons. No long-term population-level effects.
Impact Conclusion	No significant impact to seabirds and migratory birds.	No significant harm to seabirds and migratory birds.

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3.11 TERRESTRIAL SPECIES AND HABITATS

This section focuses on terrestrial, or land, habitats in the MIRC Study Area. The principal habitats found on Guam, Rota, Saipan, Tinian and FDM are described followed by a discussion of the 12 endangered species that could potentially be affected by the Proposed Action.

3.11.1 Introduction and Methods

3.11.1.1 General Approach to Analysis

Each alternative analyzed in this EIS/OEIS includes several warfare areas (*e.g.,* Mine Warfare and Air Warfare) and most warfare areas include multiple types of training activities (*e.g.,* Mine Neutralization and Air to Surface Missile Exercises [A-S MISSILEX]). Likewise, several activities (*e.g.,* aircraft overflights and weapons firing.) are accomplished under each event, and those activities typically are not unique to that event. For example, many of the training activities involve aircraft overflights. Accordingly, the analysis for terrestrial species and habitats is organized by specific activity and/or stressors associated with that activity, rather than warfare area or training activities.

The following general steps were used to analyze the potential environmental consequences of the alternatives to terrestrial species and habitats:

- Identify those aspects of the Proposed Action that are likely to act as stressors to biological resources 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 resources that may occur in the MIRC Study Area.
- Identify those biological 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 biological resources are likely to respond given their exposure and available scientific knowledge of their responses (response analysis).
- Determine the risks those responses pose to biological resources and the significance of those risks.

3.11.1.2 Study Area

The MIRC Study Area for terrestrial biological resources is limited to the landmasses of Guam, Rota, Tinian, Saipan, and FDM.

3.11.1.3 Data Sources

A comprehensive and systematic review of relevant literature and data has been conducted to complete this analysis of terrestrial biological resources within the MIRC Study Area. The primary sources of information used to describe the affected environment included the following:

- NAVFACPAC terrestrial natural resource experts and specialists;
- Relevant INRMPs that are in effect on Navy lands on Guam (DoN, 2005), Navy leased lands within the CNMI (DoN, 2006), and Andersen AFB (2003);
- Monthly monitoring surveys for wildlife resources on Tinian, specifically for forest birds, and monthly and periodic aerial and ground surveys of FDM;

- Species occurrence information was derived from the sources listed above and supplemented by various Environmental Assessments (EAs), Biological Assessments (Bas), Environmental Impact Statementss (EISs), U.S. Fish and Wildlife Service (USFWS) Biological Opinions (BOs), and various USFWS recovery plans relevant to species within the MIRC.

3.11.1.4 Factors Used to Assess the Significance of Effects

This EIS/OEIS analyzes potential effects to terrestrial species and habitats in the context of the ESA (listed species only), NEPA, and EO 12114. The factors used to assess the significance of effects vary under these Acts and are discussed below.

For purposes of ESA compliance, effects of the action were analyzed to make a determination of effect for listed species (*e.g.*, 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 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 (i.e., 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 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.

The factors outlined above were also considered in determining the significance of effects under NEPA and EO 12114.

3.11.1.5 Regulatory Framework

3.11.1.5.1 Federal Laws and Regulations

Endangered Species Act. The 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 the NMFS jointly administer the ESA and are also responsible for the listing of species (*i.e.*, the labeling of 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.

Section 7 formal consultation with USFWS is necessary because some training activities proposed by the Navy may potentially affect Federally protected species, habitats, and recovery efforts. Informal consultation by the Navy has been ongoing with the USFWS and the formal consultation is scheduled for late January 2009. The listed species that could potentially be affected by the No Action Alternative and/or the Action Alternatives (Alternatives 1 and 2) include three plant species, eight bird species, and one species of fruit bat. Two species of sea turtles are also considered in the analysis, and are included in this EIS/OEIS in Section 3.8 (Sea Turtles). Section 3.7 (Marine Mammals) addresses impacts to five species of marine mammals protected under the ESA, as well as for several non-ESA listed marine mammals protected under the Marine Mammal Protection Act (MMPA). Non-ESA listed species protected by the Migratory Bird Treaty Act (MBTA) are addressed in Section 3.10 (Seabirds and Shorebirds).

3.11.1.5.2 Territory and Commonwealth Laws and Regulations

In addition to the Guam Territorial Seashore Protection Act of 1974 and the regulations for Fish, Game, Forestry and Conservation described in subsection 3.10, Article 2 of Chapter 63 in Title 5 of the Guam Code Annotated (GCA) establishes the Guam Endangered Species Act, which authorizes protection and conservation of the ecosystem upon which resident endangered or threatened species depend. This act provides a program for the conservation and management of such endangered and/or threatened species as appropriate to achieve the purposes of the ESA.

The CNMI has enacted Public Law 2-51 (Fish, Game and Endangered Species Act) which establishes a conservation policy for fish, game, and wildlife and the protection of endangered and threatened species. The Division of Fish & Wildlife is one of several agencies under the CNMI Department of Lands and Natural Resources that is responsible for conservation management, restoration of habitat, preserving habitat and species populations in protected areas, issuing licenses and permits, and regulating human use and interaction with CNMI’s natural resources.

3.11.1.6 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 terrestrial species and habitats. Navy subject matter experts de-constructed the warfare areas and training 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, EOs, 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. As shown in Table 3.11-1, potential stressors to terrestrial species and habitats include aircraft overflights (disturbance), weapons firing/ordnance use (disturbance and strikes), use of high explosive ordnance (disturbance, strike, habitat alteration), and expended materials (ordnance related materials, targets, chaff, self-protection flares). The potential effects of these stressors on terrestrial species and habitats are analyzed in detail in Section 3.11.3, Environmental Consequences.

Table 3.11-1: Summary of Potential Stressors to Terrestrial Species and Habitats

Training Event Name/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Terrestrial Species and Habitats
Army Training			
Surveillance and Reconnaissance (S&R)/Finegayan and Barrigada Housing, Tinian MLA		Land-based movements Explosive Ordnance Practice Munitions Weapons Firing	Temporary behavioral disturbances as troops move through habitat areas. Potential for inadvertent trampling of vegetation and ground nests (Micronesian megapode) causing nest mortality within Tinian MLA. Temporary behavioral disturbance from explosive ordnance and weapons firing. Potential for direct strike of terrestrial species from weapons firing.
Field Training Exercise (FTX) / Polaris Point Field, Orote Point Airfield/Runway, NLNA, Northwest Field, Andersen South, Tinian EMUA		Land-based movements Explosive Ordnance Practice Munitions Weapons Firing	Temporary behavioral disturbances as troops move through areas with terrestrial species. Potential for inadvertent trampling of vegetation and ground nests (Micronesian megapode) causing nest mortality within Tinian MLA. Temporary behavioral disturbance from explosive ordnance and weapons firing. Potential for direct strike of terrestrial species from weapons firing.
Parachute Insertions and Air Assault/ Orote Point Triple Spot, Polaris Point Field, Ordnance Annex Breacher House		Aircraft Overflights	Potential for short-term behavioral responses to overflights at access insertion locations in the Main Base. Potential exposure to aircraft noise inducing short-term behavior changes.

Table 3.11-1: Summary of Potential Stressors to Terrestrial Species and Habitats

Training Event Name/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Terrestrial Species and Habitats
Military Activities in Urban Terrain (MOUT) /Orote Point CQC Facility, Ordnance Annex Breacher House, Barrigada Housing, Andersen South		Explosive Ordnance Weapons Firing	Temporary behavioral disturbance from blast noise of low-yield explosive ordnance. Direct strikes may be discountable. Temporary behavioral disturbance from weapons firing noise. Direct strikes may be discountable.
Marine Corps Training			
Ship to Objective Maneuver (STOM)		None	No Impact
Operational Maneuver/		None	No Impact
Noncombatant Evacuation Order (NEO) /Tinian EMUA		Aircraft Overflights Weapons Firing	Temporary behavioral disturbance from explosive ordnance and weapons firing. Temporary behavioral responses from aircraft overflights.
Assault Support (AS) / Polaris Point Field, Orote Point KD Range, Tinian EMUA		Aircraft Overflights Weapons Firing	Potential for short-term behavioral responses to overflights at access insertion locations in the Main Base and within the EMUA on Tinian. Potential exposure to aircraft noise inducing short-term behavior changes.
Reconnaissance and Surveillance (R&S) / Tinian EMUA		Land-based movements Explosive Ordnance Weapons Firing	Temporary behavioral disturbances as troops move through areas with terrestrial species. Potential for inadvertent trampling of ground nests (Micronesian megapode) causing nest mortality within Tinian MLA. Temporary behavioral disturbance from explosive ordnance and weapons firing.

Table 3.11-1: Summary of Potential Stressors to Terrestrial Species and Habitats

Training Event Name/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Terrestrial Species and Habitats
MOUT/ Ordnance Annex Breacher House, Orote Point CQC		Explosive Ordnance Weapons Firing	Temporary behavioral disturbance from blast noise of low-yield explosive ordnance. Direct strikes may be discountable. Temporary behavioral disturbance from weapons firing noise. Direct strikes may be discountable.
Direct Fires/ FDM, Orote Point KD Range, ATCAA 3A		Aircraft Overflights Weapons Firing	Potential for short-term behavioral responses to overflights to access firing sights at FDM and Orote Point KD Range. Potential for direct strike of terrestrial species.
Exercise Command and Control (C2)		None	No Impact
Protect and Secure Area of Activities		None	No Impact
		Navy Training	
Anti-Submarine Warfare (ASW)		None	No Impact
Mine Warfare (MIW)		None	No Impact
Air Warfare (AW)		None	No Impact
Surface Warfare (SUW)/ FDM, W-517	Surface to Surface Gunnery Exercise (GUNEX)	None	No Impact
	Air to Surface GUNEX	None	No Impact

Table 3.11-1: Summary of Potential Stressors to Terrestrial Species and Habitats

Training Event Name/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Terrestrial Species and Habitats
	Visit Board Search and Seizure (VBSS)	None	No Impact
Strike Warfare (STW)/ FDM	Air to Ground Bombing Exercises (Land) (BOMBEX-Land)	Aircraft Overflights Explosive Ordnance Practice Munitions Weapons Firing	Temporary behavioral responses from aircraft overflights. Temporary behavioral disturbance from explosive ordnance and weapons firing. Potential for direct strikes of Micronesian megapode nests and Mariana fruit bats on FDM. Impacts to habitat of Micronesian megapode and other species from wildland fires ignited by explosive ordnance.
	Air to Ground Missile Exercises (MISSILEX)	Aircraft Overflights Explosive Ordnance Practice Munitions Weapons Firing	Temporary behavioral responses from aircraft overflights. Temporary behavioral disturbance from explosive ordnance and weapons firing. Potential for direct strikes of Micronesian megapode nests and Mariana fruit bats on FDM.
Naval Special Warfare (NSW) / Orote Point Training Areas, Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field, Reserve Craft Beach, Polaris Point Field, Dan	Naval Special Warfare Activities (NSW OPS)	Aircraft Overflights Weapons Firing Explosive Ordnance	Temporary behavioral responses from aircraft overflights. Temporary behavioral disturbance from explosive ordnance and weapons firing.
	Insertion/Extraction	Aircraft Overflights	Potential for short-term behavioral responses to overflights.
	Direct Action	Aircraft Overflights Weapons Firing	Potential for short-term behavioral responses to overflights. Temporary behavioral disturbance from explosive ordnance and weapons firing.
	MOUT	Explosive Ordnance Weapons Firing	Temporary behavioral disturbance from explosive ordnance and weapons firing.

Table 3.11-1: Summary of Potential Stressors to Terrestrial Species and Habitats

Training Event Name/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Terrestrial Species and Habitats
Dan Drop Zone	Airfield Seizure	Explosive Ordnance Weapons Firing Land-based Movements	Temporary behavioral disturbance from explosive ordnance and weapons firing. Temporary behavioral disturbances as troops move through areas with terrestrial species.
	Over the Beach (OTB)	Aircraft Overflights Land-based movements	Potential for short-term behavioral responses to overflights. Temporary behavioral disturbances as troops move through areas with terrestrial species.
	Breaching	Weapons Firing	Temporary behavioral disturbance from explosive ordnance and weapons firing.
Amphibious Warfare (AMW) / FDM, Orote Point and Finegayan Small Arms Ranges, Orote Point KD Range, Reserve Craft Beach, Outer Apra Harbor, Tipalao Cove, Tinian EMUA	Naval Surface Fire Support (FIREX Land)	Explosive Ordnance Weapons Firing Land-based Movements	Temporary behavioral disturbance from explosive ordnance and weapons firing. Temporary behavioral disturbances as troops move through areas with terrestrial species.
	Marksmanship	Weapons Firing	Temporary behavioral disturbance from explosive ordnance and weapons firing.
	Expeditionary Raid	Explosive Ordnance Weapons Firing Land-based Movements	Temporary behavioral disturbance from explosive ordnance and weapons firing. Temporary behavioral disturbances as troops move through areas with terrestrial species.
	Hydrographic Surveys	None	No Impact

Table 3.11-1: Summary of Potential Stressors to Terrestrial Species and Habitats

Training Event Name/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Terrestrial Species and Habitats
Explosive Ordnance Disposal (EOD) / (refer to specific training event)	Land Demolition/ Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point (Airfield/Runway, Small Arms Range/Known Distance Range, CQC Facility, Triple Spot), Ordnance Annex Breacher House, Ordnance Annex Emergency Detonation Site, NLNA, Ordnance Annex, SLNA, Barrigada Communications Annex	Explosive Ordnance Practice Munitions Land-based movements	Temporary behavioral disturbance from explosive ordnance and weapons firing. Temporary behavioral disturbances as troops move through areas with terrestrial species.
	Underwater Demolition	None	No Impact
Logistics and Combat Services Support	Combat Mission Area	None	No Impact
	Command and Control (C2)	None	No Impact
Combat Search and Rescue	Embassy Reinforcement	None	No Impact

Table 3.11-1: Summary of Potential Stressors to Terrestrial Species and Habitats

Training Event Name/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Terrestrial Species and Habitats
(CSAR)	Anti-Terrorism (AT)	None	No Impact
Air Force Training			
Counter Land		None	No Impact
Counter Air (Chaff)/ W-517, ATCAAs 1 and 2		Expended Material	Potential for ingestion of chaff and/or flare plastic end caps and pistons.
Airlift		None	No Impact
Air Expeditionary		None	No Impact
Force Protection		None	No Impact
Intelligence, Surveillance, Reconnaissance (ISR) and Strike Capacity/ R-7201, FDM, Andersen AFB	Air-to-Air Training	Aircraft Overflights	Overflight increases over the Pati Point Mariana fruit bat colony may induce colony abandonment (Andersen AFB).
	Air-to-Ground Training	Aircraft Overflights Explosive Ordnance	Overflight increases over the Pati Point Mariana fruit bat colony may induce colony abandonment (Andersen AFB). Temporary behavioral disturbance from explosive ordnance and weapons firing. Direct mortality of Micronesian megapodes on FDM is possible.
Rapid Engineer Deployment Heavy Operational Repair Squadron Engineer (RED	Silver Flag Training	Land-based movements Explosive Ordnance Practice Munitions Weapons Firing	Temporary behavioral disturbances of Mariana crows and Mariana fruit bats as troops move through areas within the Northwest Field. Temporary behavioral disturbances of Mariana crows and Mariana fruit bats from practice munitions that simulate combat noise.

Table 3.11-1: Summary of Potential Stressors to Terrestrial Species and Habitats

Training Event Name/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Terrestrial Species and Habitats
HORSE) / Northwest Field	Commando Warrior Training	Land-based movements Explosive Ordnance Practice Munitions Weapons Firing	Temporary behavioral disturbances of Mariana crows and Mariana fruit bats as troops move through areas within the Northwest Field. Temporary behavioral disturbances of Mariana crows and Mariana fruit bats from 18-kg cratering charges (every 15 days) and other practice munitions.
	Combat Communications	None	No Impact

3.11.2 Affected Environment

3.11.2.1 Terrestrial Habitats within the MIRC Study Area

3.11.2.1.1 Guam

Guam is the largest of the Mariana Islands, with an area of 212 square miles (mi^2) (549 square kilometers [km^2]) and a population of 173,456. A limestone plateau covers the northern half of Guam, ranging in elevation from 295 to 590 ft (90 to 180 meters [m]) above mean sea level (MSL) and drops to the shoreline in steep cliffs. In southern Guam, soil and bedrock are mostly of volcanic origin. Streams have carved this half of the island into a rugged mountainous region; the highest peak is Mount Lamlam, 1,335 ft (407 m) above MSL near the southwest coast. Guam is distinct from Rota, Tinian, and FDM in that it is being intensively developed in some areas. Despite this development, however, habitat for both birds and mammals is still extensive on the island, especially in areas under DoD control. Protected areas on the island include Guam National Wildlife Refuge (Ritidian Unit), military lands designated as USFWS Refuge Overlay Units, GovGuam Conservation Areas, and various Federally managed marine protected areas and ecological reserve areas.

Much of the original limestone forest acreage was reduced by a variety of human and natural disturbances and converted to tangantangan thickets and grassland. Erosion is a major concern in southern Guam. A long history of island settlement, combined with more recent urbanization, fire, agricultural development, and the impacts of World War II, have all contributed to the alteration of Guam's forests. The most suitable vegetation communities for native faunal habitat are native limestone and ravine forests, while wetlands also provide habitat for native and migratory bird species. Limestone forests occur most frequently on the limestone plateau of northern Guam, which includes Andersen AFB lands (including Northwest Field, Andersen Main, and Andersen South), Finegayan Communications Annex, the Barrigada Housing Area, and Orote Point.

The vegetation of Guam was categorized (Mueller-Dombois and Fosberg, 1998) according to the major underlying soil types: (1) northern limestone vegetation, and (2) southern volcanic vegetation. The limestone vegetation was further broken down into five classes by Fosberg (1960): Artocarpus-Ficus forest, Mammea forest, Cordia forest, Merrilliodendron-Ficus forest, and Pandanus forest. Pure examples of these forest types are now rare on Guam; instead, these forests tend to be mixtures with secondary species predominating, including invasive tangantangan and *Triphasia trifolia*. Donnegan *et al.* (2004) classified broad habitat types of Guam into the following four categories:

Limestone forests. Intact limestone forests may be found along clifflines or remnant pockets on DoD lands that were not subject to clearing and grading or recent severe typhoon events. Species that characterize intact limestone forests may include *Neisosperma oppositifolia*, *Premna obtusifolia*, *Instia bijuga*, *Pisonia grandis*, *Ficus prolixa*, *Mammea odorata*, *Elaeocarpus joga*, and *Artocarpus mariannensis*. Understory species may include *Aglaia mariannesis*, *Guamia mariannae*, *Hibiscus tiliaceus*, and *Cycas micronesica.* Secondary forests are characterized by shorter stature forests with less native species contributing to the species richness, and may include *Aglaia mariannae*, *Guamia mariannae*, *Pandanus tectorius*, *Leucaena leucocephala*, and *Triphasia trifolia*. Extensive tangantangan thickets (mono-typic stands of *Leucaena leucocephala*) are also found on limestone forest edges in disturbed areas with no canopy covers since this species is sun loving. *Leucaena leucocephala* is also found on roadsides where crushed road base is exposed.

Volcanic/ravine forests. Patchy forests in southern Guam are typically associated with topographic features such as river drainages, sheltered depressions, and ravines. These forested areas in southern Guam include *Areca catechu, Ficus prolixa, Glochidion mariana, Hibiscus tiliaceus, Pandanus tectorius, Pandanus dubius*, and *Premna serratifolia* (Fosberg, 1960).

Savanna communities. Currently, savanna communities comprise approximately one-third of Guam's vegetated area (Donnegan *et al.*, 2004). Guam's savannas are a xeric ecosystem characterized by a relatively continuous grass layer intermixed with solitary trees and bushes and bare patches of exposed soil with high clay content (Raulerson and Rinehart, 1991). Stone (1970) recognized four subtype communities in the savanna: (1) swordgrass savanna (dominated by *Miscanthus floridulus*), (2) Native climax savanna (dominated by the native grass *Dimeria chloridiformis)*, (3) erosion scar savanna (dominated by *Dicranopteris linearis),* and (4) *Phragmites* savanna (dominated by *Phragmites karka*). Fire is a major disturbance factor that maintains savanna communities (Raulerson and Rinehart, 1991).

Wetlands. Wetlands communities include mangrove forests, estuarine systems, palustrine wetlands, and riverine fringes. The largest concentrations of mangroves exist along the eastern shores of Apra Harbor, with smaller zones present in Merizo and Inarajan. Estuarine habitats are found in lagoons, embayments, and river mouths of southern Guam. Nine of Guam's 46 rivers that empty into the ocean have true estuarine zones. Palustrine wetlands include inland wet wooded areas (in forested depressions, along edges of marshes, and along riverine systems), dominated by *Hibiscus tiliaceus* or *Barringtonia racemosa*. Natural and man-made palustrine emergent marsh areas are .also common and tend to be dominated by *Phragmites karka* with other grasses and sedges present, such as *Panicum muticum*, *Eleocharis ochrostachys*, and *Cyperus* spp.).

3.11.2.1.2 Guam Land-Based Training Areas

The United States Department of Agriculture (USDA) Forest Service recently further classified these habitat types into distinct vegetation communities (USDA Forest Service, 2006), which are listed for each MIRC training area on Guam below in Table 3.11-2. Figures 3.11-1 and 3.11-5 show these vegetation community types within the MIRC training areas in terrestrial habitats on Guam. MIRC training areas on Guam include Apra Harbor Naval Complex (Main Base) (Figure 3.11-1), Ordnance Annex (Figure 3.11-2), Finegayan Communications Annex (Figure 3.11-4), Barrigada Communications Annex (Figure 3.11-3), and Andersen AFB (Figure 3.11-5).

Apra Harbor Naval Complex (Main Base) (Figure 3.11-1). Many of the training activities that occur within the terrestrial habitats of the Apra Harbor Naval Complex are associated with amphibious landings and are examined in Section 3.8 (Sea Turtles).

Tipalao Cove: Tipalao Cove provides access to a small beach area capable of supporting a shallow draft amphibious landing craft and has been proposed for use as a LCAC and AAV landing site.

Gab Gab Beach: The western half of Gab Gab Beach is primarily used to support EOD and NSW training requirements. Activities include military diving, logistics training, and small boat activities.

Reserve Craft Beach: Reserve Craft Beach is a small beach area located on the western shoreline of Dry Dock Island. It supports both military and recreational activities. It is used as an offload area for amphibious landing craft including LCACs; EOD inert training activities.

Sumay Channel / Cove: Sumay Channel/Cove provides moorage for recreational boats and EOD small boats. It supports both military and recreational activities. It is used for insertion/extraction training for NSW and amphibious vehicle ramp activity, military diving, logistics training, small boat activities, security activities, and AT/FP.

San Luis Beach: San Luis Beach is used for both military and recreational activities. San Luis Beach is used to support EOD and NSW training requirements. Activities include military diving, logistics training, small boat activities, security activities, drop zones, VBSS, and AT/FP.

Polaris Point Field: Polaris Point Field supports both military and recreational activities and beach access to small landing craft. PPF supports small field training exercises, temporary bivouac, craft laydown, parachute insertions (freefall), assault training activities, AT/FP, and EOD and Special Forces Training.

Polaris Point Beach: Polaris Point Beach supports both military and recreational activities and beach access to small landing craft and LCAC. Polaris Point Beach supports military diving, logistics training, small boat activities, security activities, drop zones, and AT/FP.

Orote Point Airfield / Runway: Orote Point Airfield consists of expeditionary runways and taxiways and is largely encumbered by the ESQD arcs from Kilo Wharf. They are used for vertical and short field military aircraft. They provide a large flat area that supports FTX parachute insertions, emergency vehicle driver training, and EOD and Special Warfare training.

Orote Point Close Quarter Combat Facility: The OPCQC, commonly referred to as the Killhouse, is a small one story building providing limited small arms live-fire training. CQC is one activity within MOUT-type training. It is a substandard training facility and the only designated live-fire CQC facility in the MIRC.

Orote Point Small Arms Range / Known Distance Range: The OPKDR supports small arms and machine gun training (up to 7.62mm), and sniper training out to a distance of 500 yards. The OPKDR is a long flat cleared, earthen bermed area that is used to support marksmanship. The OPKDR is currently being upgraded to an automated scored range system.

Orote Point Triple Spot: The Orote Pt. Triple Spot is a helicopter landing zone adjacent to the Orote Pt. Airfield Runway. It supports personnel transfer, logistics, parachute training, and a variety of training activities reliant on helicopter transport.

Ordnance Annex (Figure 3.11-2)

Ordance Annex Breacher House: The breacher house is a concrete structure in an isolated part of the Ordnance Annex that is used for tactical entry using a small explosive charge. Live-fire is not authorized in the breacher house. A helicopter LZ allows for raid/assault type events to be conducted.

Ordnance Annex Emergency Detonation Site: The OAEDS is located within a natural bowl shaped high valley area within the Ordnance Annex and is used for emergency response detonations, up to 3,000 pounds. A flat area near OAEDS allows for helicopter access. EOD activities are the primary types of training occurring at OAEDS.

Sniper Range: The Ordnance Annex Sniper Range is an open terrain, natural earthen backstop area that is used to support marksmanship training. The Ordnance Annex Sniper Range is approved for up to .50 cal sniper rifle fire, and although distance to targets are variable, direction of fire is generally fixed towards the natural earthen backstop.

Northern Land Navigation Area (NLNA): The NLNA is located in the NE corner of Ordnance Annex where small field exercises (FTX) and foot and vehicle land navigation training occurs. The NLNA contains mostly open terrain characterized by savanna vegetation.

Southern Land Navigation Area (SLNA): The SLNA is located in the southern half of Ordnance Annex where foot land navigation training occurs.

Fena Reservoir Activity: Air training activities including close air support, combat search and rescue (CSAR), insertion/extraction, and fire bucket training.

Finegayan Communications Annex (Figure 3.11-3). Finegayan Communications Annex supports FEX and MOUT training. Haputo Beach is used for small craft (*e.g.*, CRRC) landings and Over the Beach insertions. Haputo Beach is part of the Haputo ecological reserve area. The Finegayan Small Arms Ranges are located in the Finegayan Communications Annex. Also referred to as the "North Range," FSAR supports qualification and training with small arms up to 7.62mm. The small arms ranges are known distance ranges consisting of a long flat cleared, earthen bermed area that is used to support marksmanship. Within the Finegayan Housing area is a small group of unoccupied buildings that support a company size (200-300) ground combat unit to conduct MOUT-type training including use of landing zones and drop zones (a new drop zone, called Ferguson-Hill, is under review with the FAA). Open areas provide command and control (C2) and logistics training, bivouac, vehicle land navigation, and convoy training, and other field activities. These open areas are characterized by savanna vegetation communities and training does not occur in forested areas within the Finegayan Communications Annex.

Barrigada Communications Annex (Figure 3.11-4). Barrigada Communications Annex supports FEX and MOUT training. The Barrigada Housing area contains a few unoccupied housing units available for MOUT-type training. Open areas (former transmitter sites) provide C2 and logistics training, bivouac, vehicle land navigation, and convoy training, and other field activities. These open areas are characterized by savanna vegetation communities and training does not occur in forested areas within the Barrigada Communications Annex.

Andersen AFB (Figure 3.11-5)

Northwest Field: Northwest Field is an unimproved expeditionary WWII era airfield used for vertical and short field landings. Approximately 280 acres (115 hectares) of land are cleared near the eastern end of both runways for parachute drop training. The south runway is used for training of short field and vertical lift aircraft and often supports various types of ground maneuver training. Helicopter units use other paved surfaces for Confined Area Landing (CAL), simulated amphibious ship helicopter deck landings, and insertions and extractions of small maneuver teams. About 3,562 acres (1,440 hectares) in Northwest Field are the primary maneuver training areas available at Andersen AFB for field exercises and bivouacs. Routine training exercises include camp/tent setup, survival skills, land navigation, day/night tactical maneuvers and patrols, blank ammunition and pyrotechnics firing, treatment and evaluation of casualties, fire safety, weapons security training, perimeter defense/security, field equipment training and chemical attack/response. The Air Force will complete its Northwest Field Beddown and Training and Support Initiative, co-locating at Northwest Field the Rapid Engineer Deployable Heavy Operations Repair Squadron Engineers (RED HORSE) and its Silver Flag training unit, the Commando Warrior training program, and the Combat Communications squadron. Impacts to terrestrial species and habitats within the Northwest Field due to military training activities were addressed in Section 7 ESA consultations associated with the Northwest Field Beddown Initiative EA and Andersen Air Force Base Cargo Parachute Drop Zone EA.

Andersen South: Andersen South consists of abandoned military housing and open area consisting of 1,922 acres (778 hectares). Andersen South savanna areas and tangantangan thickets are used for basic ground maneuver training including routine training exercises, camp/tent setup, survival skills, land navigation, day/night tactical maneuvers and patrols, blank ammunition and pyrotechnics firing, treatment and evaluation of casualties, fire safety, weapons security training, perimeter defense/security, field equipment training. Vacant single family housing and vacant dormitories are used for MOUT training and small-unit tactics.

Main Base: Andersen Main Base is dedicated to its primary airfield mission. Administered by 36th Wing, the Main Base at Andersen AFB is comprised of about 11,500 acres (4,654 hectares). The base is used for aviation, small arms, and Air Force EOD training. As a working airfield, the base has a full array of operations, maintenance, and community support facilities. 36th Wing supports all U.S. military aircraft and personnel transiting the Mariana Islands. Facilities are available for cargo staging and inspection.

Pati Point / Tarague Beach CATM Range and EOD Pit: The existing CATM Range and EOD Pit consists of 21 acres (8.5 hectares) used for the small arms range and supports training with pistols, rifles, machine guns, and inert mortars up to 60 mm. Training is also conducted with the M203 40 mm grenade launcher using inert training projectiles only and do not have percussive force.

Table 3.11-2: Vegetation Community Types on MIRC Lands on Guam

Vegetation Community Type	Department of the Navy Lands Acres (Hectares)					Andersen Air Force Base Lands Acres (Hectares)			
	Main Base		Communications Annex		Ordnance Annex	Northwest Field	Main Base	Pati Point / Tarague Beach	Andersen South
	Apra Harbor and Polaris Point	Orote Point	Barrigada Housing	Finegayan					
Native-Mixed Limestone Forest	-	95.9 (38.8)	-	1,484.6 (600.8)	1,449.5 (586.6)	3,322.1 (1,344.4)	6,161.1 (2,493.3)	171.7 (69.5)	-
Ravine Forest	0.7 (0.3)	-	-	-	6,144.0 (1,486.4)	-	-	-	-
Scrub Forest	1,844.4 (746.4)	123.6 (50.0)	728.71 (294.9)	58.1 (23.5)	94.4 (38.2)	-	187.6 (75.9)	-	1,482.4 (599.9)
Casuarina Thicket	-	-	-	-	-	20.5 (8.3)	-	-	-
Leucaena Thicket	121.8 (49.3)	542.4 (219.5)	119.6 (48.4)	-	-	53.9 (21.8)	39.8 (16.1)	-	81.8 (33.1)
Savanna Complex	545.6 (220.8)	-	-	-	2866.7 (1160.1)	-	-	-	-
Strand Vegetation	-	10.8 (4.4)	-	12.1 (4.9)	-	-	27.7 (11.2)	30.6 (12.4)	-
Wetlands (Marshes, Ponds, etc)	225.1 (91.1)	2.0 (0.8)	-	-	198.42 (80.3)	-	-	-	-
Agroforestry	-	(3.7) 1.5	-	9.9 (4.0)	-	-	-	249.3 (100.9)	-
Cropland	-	-	-	-	-	-	-	-	-
Urban / Developed	1246.4 (504.4)	1662.3 (672.7)	1,300.3 (526.2)	852.5 (345.0)	198.4 (80.3)	969.6 (392.4)	4,340.9 (1756.7)	31.6 (12.8)	496.4 (200.9)

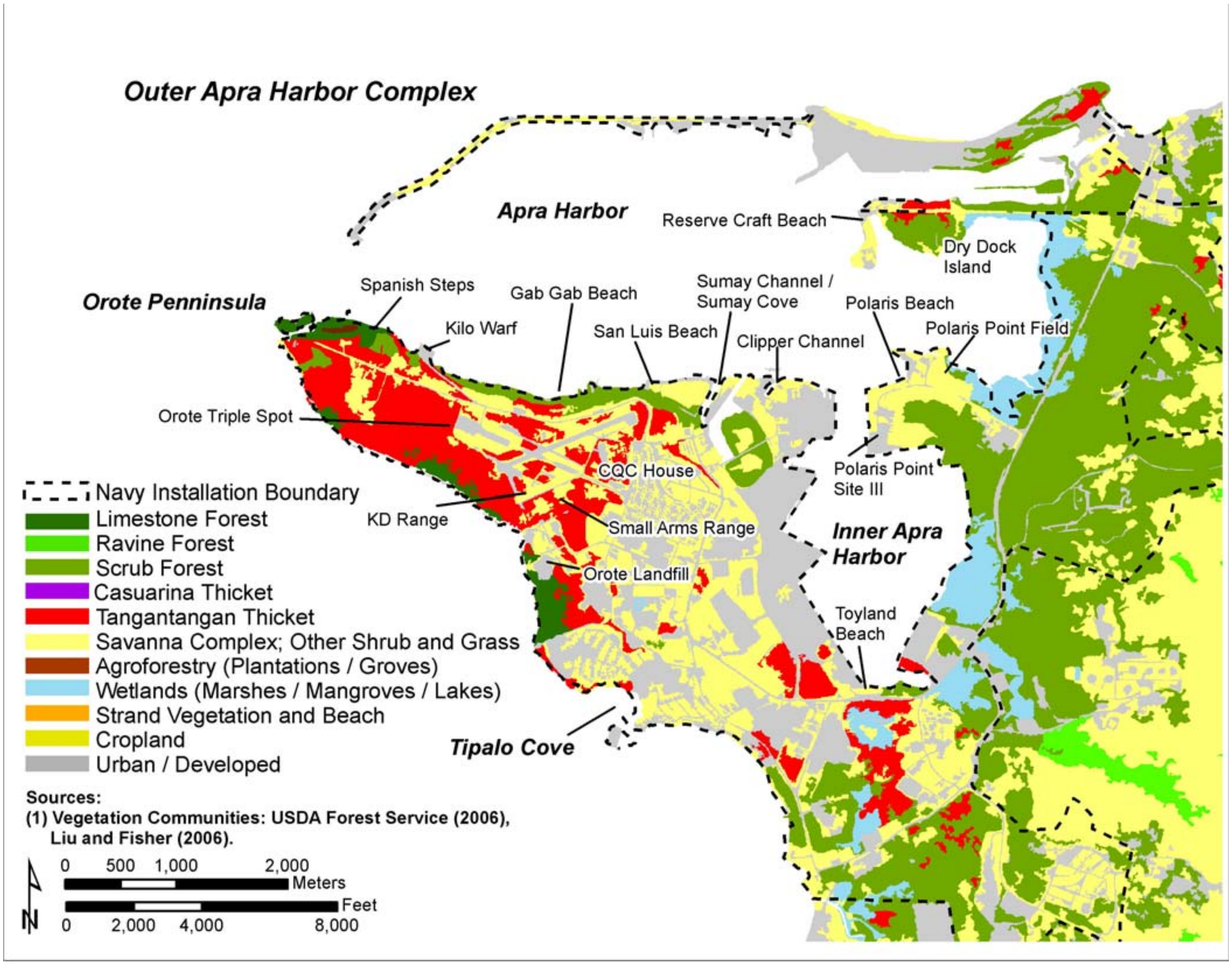

Figure 3.11-1: Vegetation Community Types within Apra Harbor Naval Complex / Main Base

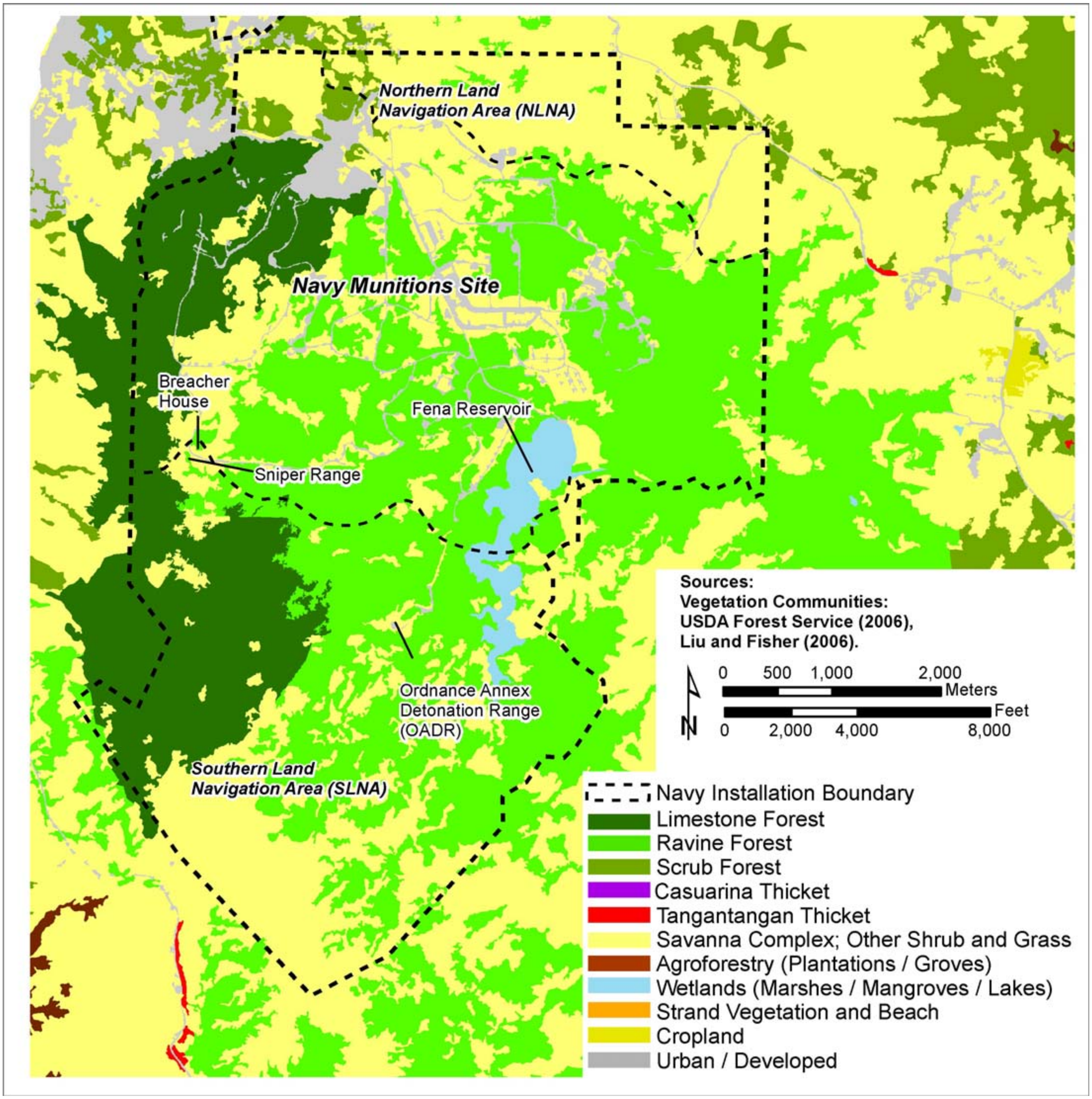

Figure 3.11-2: Vegetation Community Types within the Ordnance Annex

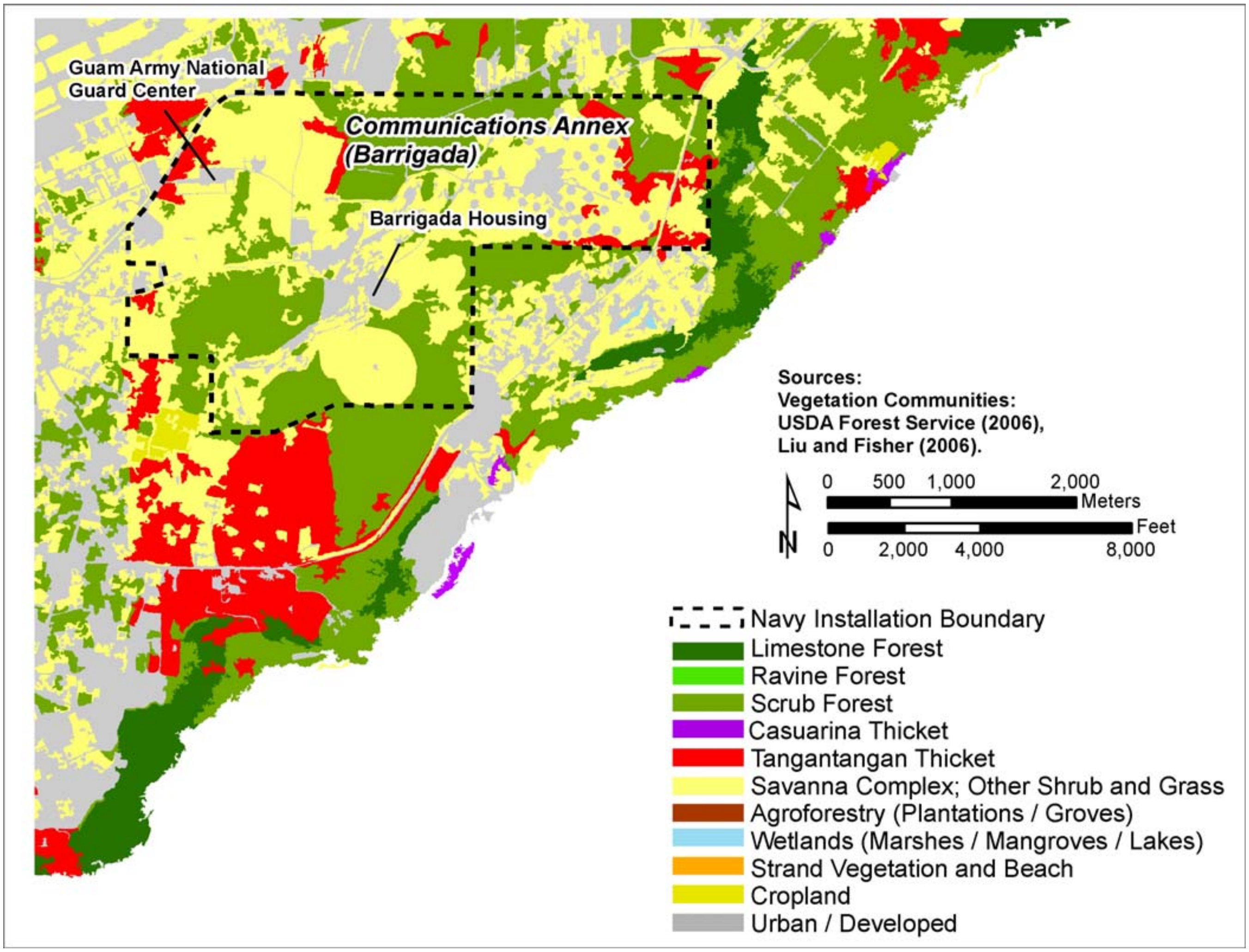

Figure 3.11-3: Vegetation Community Types within Communications Annex (Barrigada)

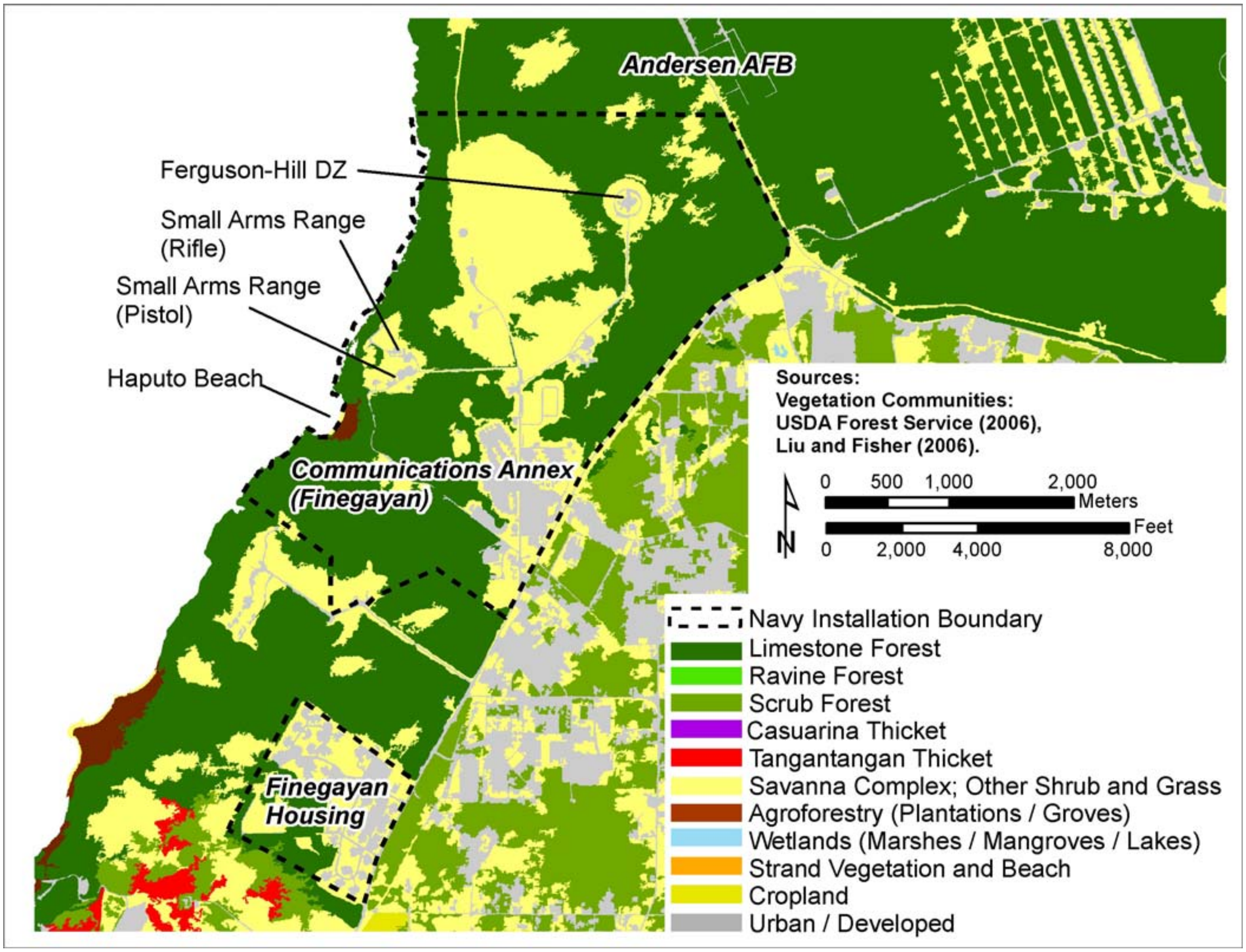

Figure 3.11-4: Vegetation Community Types within Communications Annex (Finegayan)

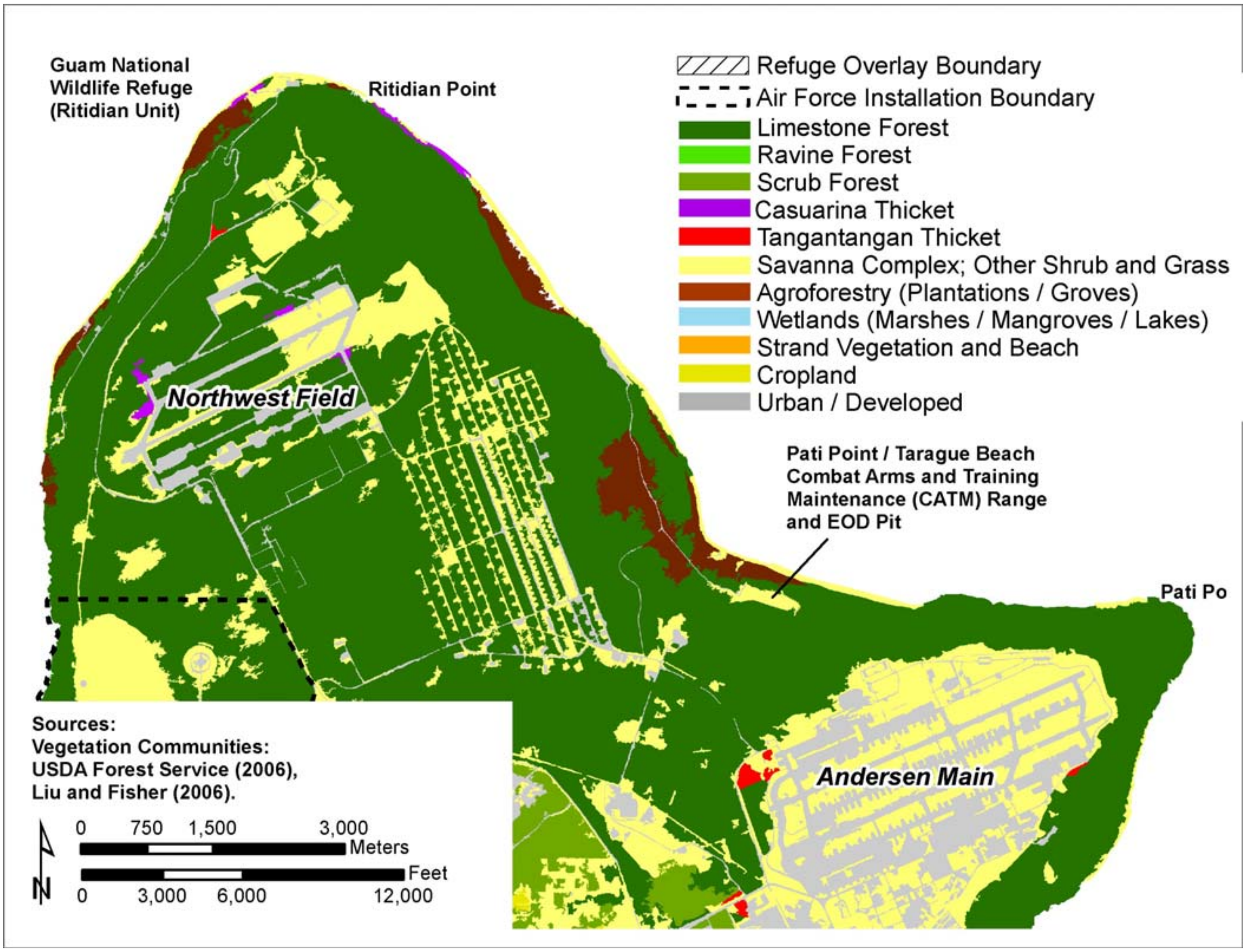

Figure 3.11-5: Vegetation Community Types within Andersen AFB

3.11.2.1.3 Rota

Rota is the third largest island in the CNMI, located 30 mi (49 km) north of Guam. The island landmass is 32.9 mi^2 (85.2 km^2). There are two villages on the island of Rota, Sinapalo and Song Song; and the population as of 2000 was 3,283 people (U.S. Census Bureau 2000). The island contains a series of limestone terraces surrounding a volcanic core known as Mount Manira (1,627 ft [500 m] above MSL) that protrudes slightly above the highest terrace. Volcanic soil is exposed along the south and southeast slopes of the island in an area known as the Talakhaya where all of Rota's surface drainages are located. The Sabana region is an uplifted plateau 1,476 ft (450 m) in elevation covering approximately 5 mi^2 (12 km^2) on the western half of the island. Cliffs border the Sabana on all sides except to the northeast, where the Sabana slopes down to the eastern part of the island, which has been covered since the 1930s in secondary growth forest intermingled with residential and agricultural lands. The cliff lines surrounding the plateau remain primary forest due to their steepness, a hindrance to past agricultural development. Approximately half of the island is now forested, and much of the forest is of medium stature and degraded by land conversion, introduced plants and animals, logging of large emergent canopy tree species, and the effects of warfare from World War II (USFWS 2004a,b). I Chinchon Bird Sanctuary is located on the northeastern coastline of Rota. The sanctuary is an important seabird and shorebird location and contains intact limestone forest and exposed limestone outcrops suitable for nesting habitat.

Rota Land-Based Training Areas. No maneuver training occurs on Rota and all training activities are confined to the Navy Leased Pier Space and Angyuta Island. MOUT training occurs within a developed area of Song Song Village. No MIRC associated training activities would occur in or affect designated critical habitat units or other habitats designated for conservation use. The critical habitat units, discussed in Section 3.11.2.3 of this EIS/OEIS, and other conservation lands on Rota are shown on Figure 3.11-6. The training areas on Rota are summarized below:

Commonwealth Port Authority: The Navy has access to Angyuta Island seaward of Song Song's West Harbor as a Forward Staging Base/overnight bivouac site. The island is adjacent to the commercial port facility used for boat refueling and maintenance.

Municipality of Rota: Certain types of special warfare training including hostage rescue, Noncombatant Evacuation Operations (NEO), and MOUT are conducted with local law enforcement, on non-DoD lands. All live-fire exercises utilize bullet traps and are generally associated with WWII structures.

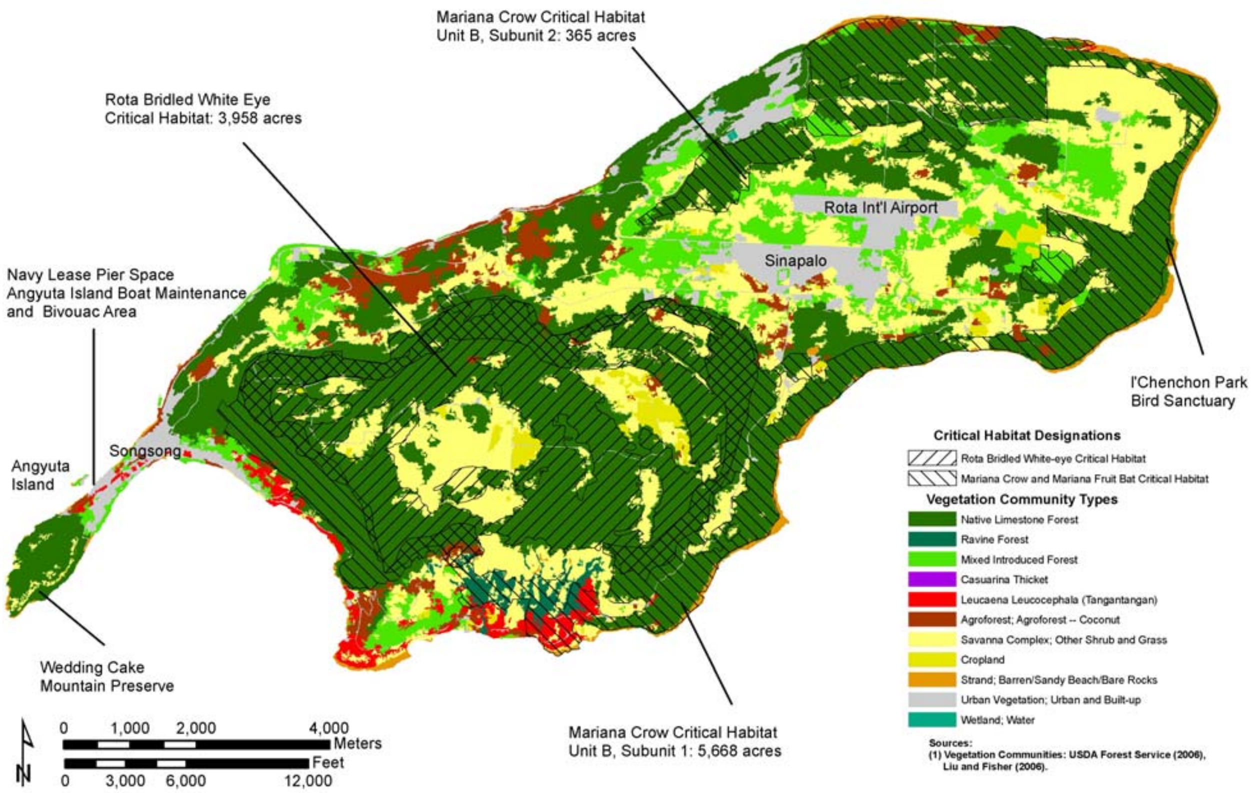

Figure 3.11-6: Vegetation Community Types on Rota

3.11.2.1.4 Saipan

Saipan is the most populous island in the CNMI, with approximately 62,000 inhabitants, which represents 90 percent of the total CNMI population. The island has a land area of 46.5 mi^2 (120 km^2). Much of Saipan was likely once forested, particularly on limestone soils (Fosberg, 1960). Such limestone forest is relatively xerophytic except at the highest elevations, where near cloud forest conditions prevail. This forest is typically dense, with a canopy dominated by two relatively common trees, *Pisonia grandis* and *Cynometra ramiflora*, and an understory comprised of mostly *C. ramiflora* and *Guamia mariannae*. Other natural habitats, including ravine forest, swordgrass savannah (monotypic stands of *Miscanthus joridus* with occasional woody species persisting), mangrove swamp, freshwater swamp, reed marsh (monotypic stands of *Phragmites karka*), strand forest, and coastal scrub are also present. Combined, native habitats presently cover approximately 30 percent of the island. The remainder of Saipan's natural habitat has developed on disturbed sites. Level areas are largely abandoned agricultural lands (Fosberg 1960) vegetated by elephant grass meadows (monotypic stands of *Pennisetum purpureum*), and tangantangan thickets. Secondary forests of introduced species, particularly *Acacia confusa*, *Albizia lebbeck*, and *Delonix regia* are also common, as are areas of agroforest (Engbring *et al.* 1986) where trees such as coconut (*Cocos nucifera*) and mango (*Mangifera indica*) are frequent.

Saipan Land-Based Training Areas. The MIRC-associated training areas on Saipan include the Army Reserve Center and Navy Lease Pier Space. MIRC activities are expected to occur in well-developed areas, which cover nearly 70 percent of the island. The training areas are summarized below and shown on Figure 3.11-7:

Army Reserve Center: Saipan Army Reserve Center contains armory, classrooms, administrative areas, maintenance facilities, and laydown areas and supports C2, logistics, AT/FP, bivouac, vehicle land navigation, and convoy training, and other headquarter activities. All of these activities take place in either developed or previously disturbed areas.

Marpi Maneuver Area: With the coordination of the Army Reserve Unit Saipan and the approval of CNMI government, land navigation training is conducted on non-DoD lands in the Marpi area (east side of northern Saipan). Commonly referred to as "Cow Town," the approximately 5 acre (2 hectare) Marpi tract is privately owned and is characterized by elephant grass meadows. Land navigation training does not include vehicular training, and no fires are allowed for associated bivouac activities. Training on other non-DoD lands may occur on Saipan, such as on privately owned open grasslands east of Mount Takpochao. Generally, maneuver training on Saipan is infrequent and rare.

The Saipan Upland Mitigation Bank (SUMBA), shown on Figure 3.11-7, was established in 2004 on 1,035 acres (419 hectares) of the CNMI-owned Marpi Commonwealth Forest. The SUMBA was developed in cooperation with the USFWS to serve as mitigation for the incidental take of nightingale reed-warblers (*Acrocephalus luscinia*) by public and private development projects on Saipan. The SUMBA and Marpi tract are separated by approximately one mile of CNMI and private lands, which includes a road and a cliffline.

Commonwealth Port Authority: The Navy has access to approximately 100 acres (40.5 hectares) of Port Authority including wharf space which supports VBSS, AT/FP, and NSW training activities. Land-based training activities do not occur outside of the access area under the jurisdiction of the Port Authority.

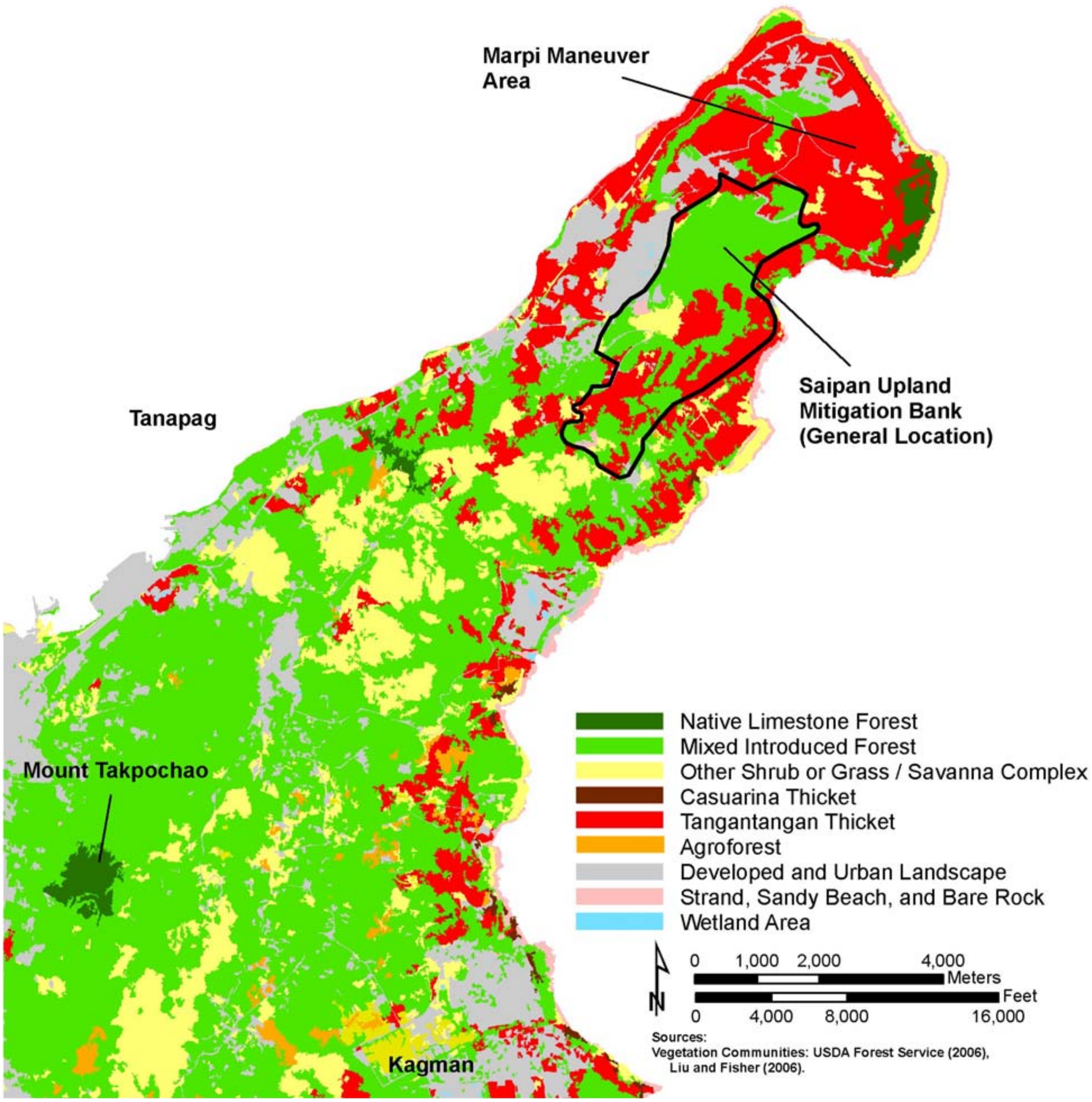

Figure 3.11-7: Vegetation Community Types on Saipan

3.11.2.1.5 Tinian

Tinian is the second largest island of the CNMI, with a land area of 39.3 mi^2 (101.8 km^2) and a human population of 3,500, which represents approximately five percent of the total CNMI population. The nearest neighboring islands are Saipan (2.8 mi [4.5 km] northeast) and Aguijan (5.6 mi [9 km] southwest) (Wiles *et al.* 1990). Vegetation community types on Tinian were disturbed during the last 300 years by both man-made and natural disturbances. Although historical evidence is sparse, it appears that in the late 1700s, Tinian was dominated by dense limestone forest, including observed trees *Pisonia grandis*, *Cerbera* spp., and *Guamia mariannae* (Fosberg, 1960). By the early 1800s forested areas were rapidly replaced by fields, and abandoned fields were covered by thickets of *Psidium* spp., *Triumfetta* spp., *Sida* spp., *Gossypium* (cotton) varieties, various species of *Ipomoea* and various other vines (Hawaiian Agronomics 1985). In the 1920s, the island was cleared for sugarcane production under Japanese occupation. The cane plantations were abandoned during the intense military actions of World War II. Aerial photographs reveal that World War II bombing, fires, and military reconstruction significantly reduced the amount of native limestone forest on Tinian, and once-forested areas not under cultivation were susceptible to encroachment of invasive tangantangan.

Tinian consists of a series of five limestone plateaus at various elevations, separated by escarpments and steeply sloping areas. The four primary habitat types identified on Tinian are coastal waters, lowlands, wetlands, and cliff lines. Within these habitat types, the USDA Forest Service has recently further classified distinct vegetation communities, which are listed in Table 3.11-3.

Cliffline Habitat Type – Represented at the top of Mt. Lasso and around the north escarpment of Maga, these forests contain native tree species such as *Pisonia grandis*, *Ficus* spp., *Cynometra* spp., *Guamia mariannae*, *Pandanus tectorius*, *Cerbera dilata*, and *Ochrosia mariannensis* that are important for the Mariana fruit bat (*Pteropus marianus marianus*) and Micronesian megapode (*Megapodius laperouse*). This habitat type is important for the Tinian monarch, as well.

Lowland Habitat Type – Two forest types are found in lowland areas—tangantangan thickets and secondary growth forests. Tangantangan thickets dominate most of the level and moderately sloping areas, especially in the northern portions of the island, and are considered foraging habitat for the Mariana fruit bat and Micronesian megapode, and nesting and foraging habitat for the Tinian monarch. Secondary growth forests contain a mixture of predominantly introduced trees, shrubs, and dense herbaceous plants such as *Leucaena leucocephala, Acacia confusa, Pithecellobium dulce,* and *Casuarina equisetiflora*. Bamboo (*Bambusa* spp.) also occurs in dense thickets. Open fields are dominated by herbaceous species, such as *Lantana camara*, *Operculina* spp., *Mikania scandens*, and *Mimosa invisa*, with small groupings of trees such as *Spathodea campanulata*.

Wetlands Habitat Type – Wetlands on Tinian are discrete areas of impermeable clay that impound rainwater. Hagoi is the largest inland freshwater (palustrine) marsh on the island, and supports populations of the Mariana common moorhen. The mixed vegetation around the open water is dominated by *Scirpus litoralis* (a species of bulrush), *Acrostichum aureum* and *Paspalum orbiculare*. A native species of phragmites (*Phragmites karka*) surrounds the Hagoi, and in more upland areas surrounding the Hagoi, herbaceous species more typical of open fields are found.

Coastal Habitat Type – Strand vegetation occurs on sandy beaches, and is often mixed with halophytic-xerophytic species (such as *Pemphis acidula*). The strand vegetation includes *Tornefortia argentea*, *Bidens pilosa*, *Stachtarpheta jamaicensis*, *Lantana camara*, *Thespesia populnea*, *Ipomoea pes-caprae*. In near-shore marine habitats, seagrass beds at Puntan Lamanibot, Unai Chiget, Unai Masalok and Tachogna Beach (Belt Collins, 1997) are important feeding areas for sea turtles.

Tinian Land-Based Training Areas. All of the habitat types described above are represented within the administrative units that comprise the MLA on Tinian (EMUA and LBA). Figure 3.11-3 is a map of these habitat types within the EMUA and LBA. The MIRC training areas within the Tinian MLA are summarized below:

Exclusive Military Use Area (EMUA): The EMUA is DoD-leased land (7,600 acres [3,080 hectares]) covering the northern third of Tinian. The key feature is North Field, an unimproved expeditionary WWII era airfield used for vertical and short field landings. North Field is also used for expeditionary airfield training including C2, ATC, logistics, armament, fuels, rapid runway repair, and other airfield-related requirements. The surrounding area is used for force on force airfield defense and offensive training. The

EMUA has two sandy beaches (Unai Chulu and Unai Dankulo [Long Beach]) that are capable of supporting LCAC training. Only Unai Chulu has been used for LCAC training, however damage caused by recent storms requires beach repairs prior to use. Unai Dankulo can also be used for LCAC landings. Unai Babui is a rocky beach capable of supporting AAV landings with improvements.

There are no active live-fire ranges on the EMUA, except small arms fire into bullet traps and is primarily associated with North Field WW II structures. Sniper training expend fewer rounds than urban assault training activities, and are also generally associated with North Field WW II structures; however, COMNAVMAR may work with local government and regulators to gain permission for sniper training outside of the EMUA on a case-by-case basis. Bivouac training confines fires to hardtop surfaces, such as runway areas of the North Field, and involves no vegetation clearing.

Lease Back Area (LBA): The LBA (7,800 acres [3,150 hectares]) is used for ground element training including MOUT-type training, C2, logistics, bivouac, vehicle land navigation, and convoy training, and other field activities. There are no active live-fire ranges on the LBA, except sniper small arms fire into bullet traps associated with WW II structures. The bivouac training in the LBA does not permit fires in vegetated areas (only on hardtop surfaces such as West Field), and no vegetation clearing occurs during training events.

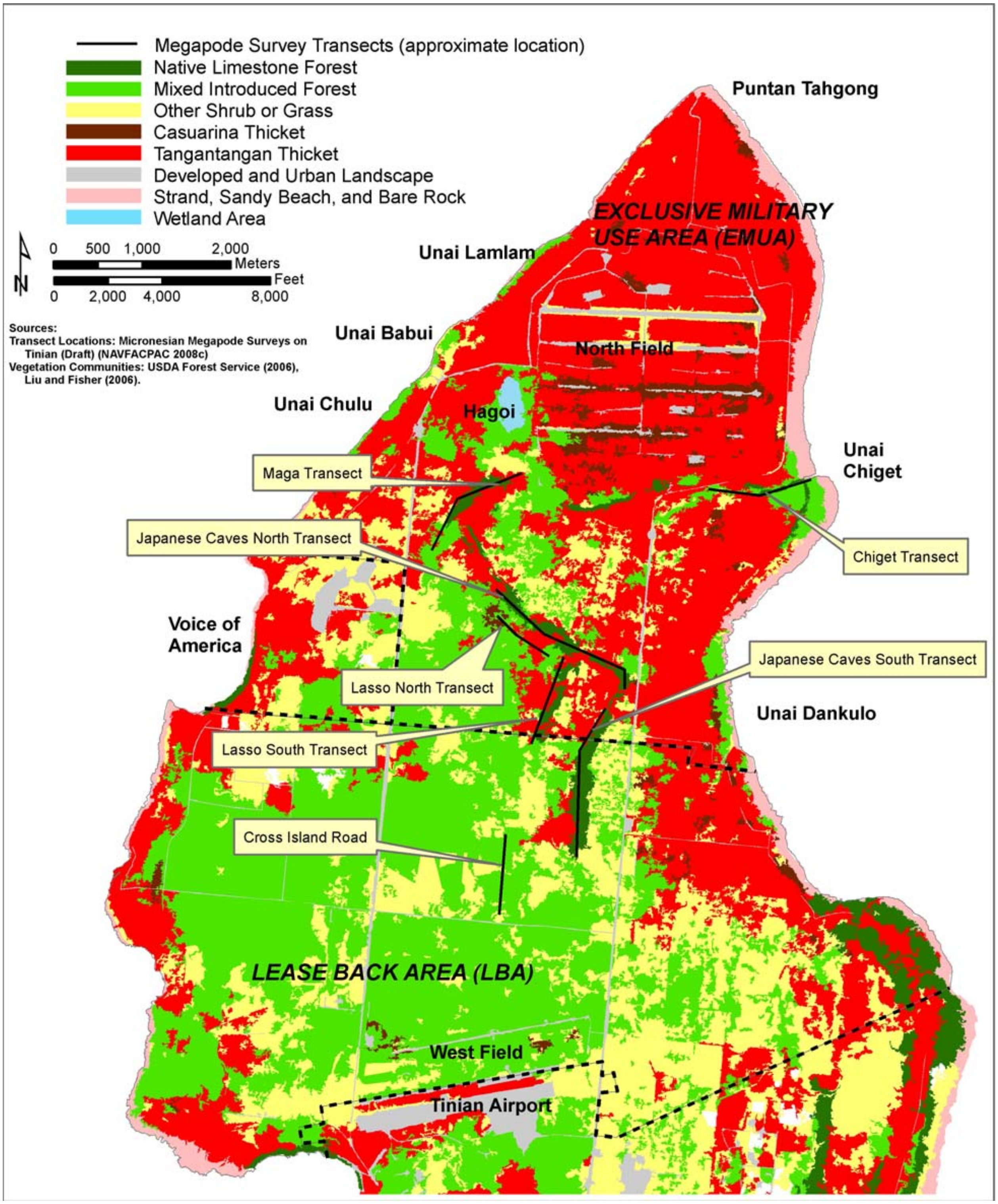

Figure 3.11-8: Vegetation Community Types on Tinian

Table 3.11-3: Vegetation Community Types on Tinian within the MLA

Vegetation Community	EMUA		LBA		Total MLA	
	Hectares	Acres	Hectares	Acres	Hectares	Acres
Native Limestone Forest	59.7	147.5	90.7	224.1	150.4	371.6
Mixed Introduced Forest	415.3	1026.2	1606.5	3969.7	2021.8	4995.9
Casuarina Thicket	102.0	252.0	25.9	64.0	127.9	316.0
Leucaena Leucocephala (Tangantangan)	1682.6	4157.7	619.9	1531.8	2302.5	5689.5
Savanna Complex / Other Shrubs and Grass	300.0	741.3	857.4	2118.6	1157.4	2859.9
Agroforest and Coconut groves	0.0	0.0	11.1	27.4	11.1	27.4
Wetlands	13.7	33.9	0.0	0.0	13.7	33.9
Strand and Barren/Sandy Beach/Bare Rock	114.9	283.9	70.5	174.2	185.4	458.1
Cropland	0.0	0.0	1.0	2.5	1.0	2.5
Urban and Urban Vegetation	93.9	232.0	53.9	133.2	147.8	365.2
Total	**2782.1**	**6874.6**	**3336.9**	**8245.5**	**6119.0**	**15120.0**

3.11.2.1.6 Farallon de Medinilla (FDM)

The island of FDM, which is leased by the DoD from the CNMI, consists of the island land mass of approximately 182 acres (73 hectares) and the restricted airspace designated R-7201. The island is approximately 1.7 mi (2.7 km) long and 0.3 mi (0.5 km) wide. FDM is north of Saipan and south of Anatahan. It contains a live-fire and inert bombing range and supports live-fire and inert engagements such as GUNEX, BOMBEX, MISSILEX, FIREX, and Precision Weapons (including laser seeking). R-7201 is the restricted airspace surrounding FDM (3 nm [5.6 km] radius, altitude limits zero to infinity). FDM habitat types fall into three distinct groups shown on Figure 3.11-9 and described below.

Coastal habitat type – This habitat type includes the marine and intertidal areas on the periphery of the island. There are only two beach sand deposits on the island; the remainder of the coastline is delineated at the base of steep cliffs. Both beaches are intertidal and are completely inundated during high tides. Although green and hawksbill sea turtles were observed in coastal waters, the beaches are not favorable for nesting (DoN, 2003a). Limited vegetation surveys on FDM have identified algal colonies of genera *Padina*, *Neomeris*, *Jania*, and *Dictyota* (Belt Collins, 2001) on reef platforms and boulders within this habitat type.

Cliffline habitat type – This habitat type is characterized by steep cliffs with sparse halotrophic vegetation. No T&E species are associated with these areas. Limited vegetation surveys on FDM have identified prostrate and sprawling woody shrubs within this habitat type. These shrubs are adapted to shallow soil, xeric soil conditions, and salt spray (halophytes), and include *Exocoecaria aqallocha* (dominant), *Digitaria guadichaudii*, *Bikkia tetandra*, *Hedyotis stringulosa* and *Portulaca oleracea* (Whistler, 1996). Concentrations of vegetation are limited to small patches interspersed between bare exposed rocks.

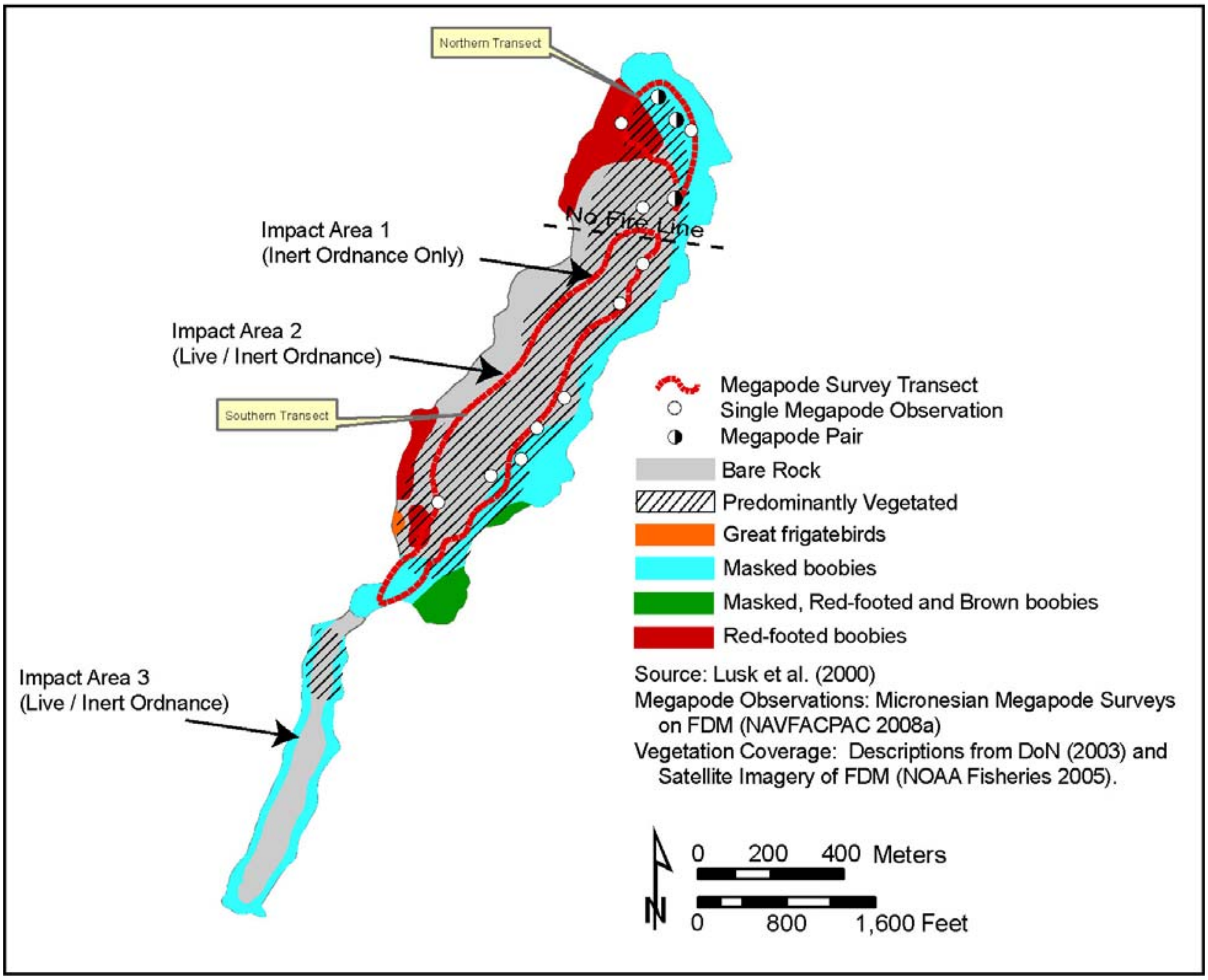

Figure 3.11-9: Vegetation Community Types—Farallon de Medinilla

Interior mesic flats habitat types – This habitat type includes the relatively flat portions of the island that support vegetation, dominated by dense herbaceous communities. Species observed include *Wollastonua biflora*, *Mariscus javanicus*, *Capparis spinosa*, *Ipomoea pes-caprae*, *Boerhavia* spp., *Portulaca lutea*, *Operculina ventricosa*, and small stature *Pisonia grandis*. Figure 3.11-10 shows photographs of bombing activities and impacts to vegetation communities within the interior mesic flats habitat types. The Micronesian megapode was identified in this habitat type. In 1999, the USFWS estimated the population of Micronesian megapodes to be 10 or less; however, more recent surveys (NAVFACPAC, 2008a) suggest an island population of 21 pairs, with higher densities in the northern portion of the island.

Figure 3.11-10: FDM Vegetation Impacts and Recovery

3.11.2.2 Threatened and Endangered Species

The Threatened and Endangered (T&E) Species (administered by the USFWS) that could potentially be affected by the Proposed Action include three plant species, two reptilian species (sea turtles), eight bird species, and one terrestrial mammal species. Sea turtles are analyzed in Section 3.8. Table 3.11-4 provides a list of T&E terrestrial species that have confirmed or potential occurrence in the MIRC Study Area.

Table 3.11-4: Threatened and Endangered Species within the MIRC Study Area

Scientific Name	English Name(s)	Chamorro/ Carolinian Name(s)	Federal Listing Status	Habitat(s) [1]
Plants				
Nesogenes rotensis	-	-	Endangered	Endemic to Rota, exposed, raised limestone flats in non-forested coastal strand habitat, subject to sea spray
Osmoxylon mariannense	-	-	Endangered	Endemic to Rota, found in limestone forests on the Sabana, a raised plateau often covered in clouds
Serianthes nelsonii	Fire tree	Hayun lago (Guam) Tronkon guafi (Rota) / Shaapil Fief'fi	Endangered	Limestone forests
Birds				
Acrocephalus luscinia	Nightingale reed-warbler	Ga'ga karisu, Padudo / Malial ghariisu, Litchoghoi bwel	Endangered	Areas in or near brackish water or marsh habitats
Aerodramus bartschi	Island swiftlet, Mariana swiftlet	Chuchaguak, Yayaguak / Leghekeyang	Endangered	Nests in caves; forages in savanna and ravine forest
Corvus kubaryi	Mariana crow	Aga / Mwii'lap	Endangered	Limestone forest habitats, Historically, all forest types
Gallinula chloropus guami	Mariana common moorhen	Palattat / Ghereel bweel	Endangered	Freshwater aquatic habitat types (lake, pond, and springs)
Halcyon cinnamomina cinnamomina	Micronesian kingfisher (Guam subspecies)	Sihek / Waaw	Endangered	Limestone forest habitats
Megapodius laperous	Micronesian megapode	Sasangat / Sasangal	Endangered	Limestone forest habitats and Coconut groves
Rallus owstoni	Guam rail	Ko'ko	Endangered	Secondary habitats, some use of savanna and limestone forests
Zosterops rotensis	Rota bridled white-eye	Nosa luta / -	Endangered	Endemic to Rota, found in limestone forests on the Sabana, a raised plateau often covered in clouds
Mammals				
Pteropus mariannus mariannus	Mariana fruit bat	Fanihi / Payesyes, Pai' scheei	Endangered	Limestone and ravine forests

1. Habitat and island distribution data sources from Guam DAWR (2006), USFWS Recovery Plan for Two Endangered Species (USFWS, 2006a), USFWS Draft Recovery Plan for the Aga or Mariana Crow (USFWS, 1995), USFWS Biological Opinion on the Establishment and Operation of an Intelligence, Surveillance, and Strike Capability on Andersen AFB, Guam (USFWS, 2006b), USFWS Draft Recovery Plan for Rota bridled white-eye of Nusa Lota (USFWS, 2006c), personal communications from Navy biologists on Guam (Brooke, 2007), Micronesian Megapode (*Megapodius laperouse laperouse*) Surveys on Farallon de Medinilla, Commonwealth of the Northern Mariana Islands.

3.11.2.2.1 *Nesogenes rotensis* (No known common or local name)

Species Description and Regulatory Status. *Nesogenes rotensis* is a low-growing herbaceous (non-woody) plant with small, opposite, broadly lance-shaped, coarsely toothed leaves, restricted to Rota. Flowers are located on a stem in the area between the stem and the petiole. They are tubular in shape, with five white petals and both male and female components. Often a flowering branch grows upright, which might aid in pollination or seed dispersal (Raulerson and Rinehart, 1997). Plants typically branch near the base at about five to seven nodes, and stature may range from not quite flat-growing to upward-growing, scrambling over flattened shrubs, with whole plants up to almost 3 ft (1 m) in diameter (Fosberg and Herbst, 1983). It appears that the above-ground portions of individual plants die back annually or in times of water stress. *N. rotensis* was listed as endangered on April 8, 2004 (FR 04-7934). No critical habitat is designated for this species.

Life History and Ecology. Little is known of the life history or ecology of *Nesogenes rotensis*. Based on information from collections and observations, *Nesogenes rotensis* flowers in March, April, May, and November (Raulerson and Rinehart, 1997). It was observed in fruit in January, March, and November (Raulerson and Rinehart, 1997). All available information and recent observations suggest that these plants are perennials, but their above-ground parts die back annually (USFWS, 2006a).

Population Status and Distribution. One population of fewer than 100 plants was reported in 1982 at the Poña Point Fishing Cliff public park land, owned by and under the jurisdiction of the CNMI DFW (USFWS, 2006a). In 1994, Raulerson and Rinehart (1997) recorded a population of about 20 plants, occupying 240 square yards (2160 ft^2 (200 m^2) of habitat at the Poña Point Fishing Cliff.

Biannual surveys for this species have been conducted since 2001 at Poña Point Fishing Cliff. A direct count was made on June 27, 2000. At that time there were 80 individuals within an approximate area of 960 square yards (800 m^2). In May and November 2001, direct counts made by staff from the CNMI DFW identified 458 and 579 adult plants, respectively. No individuals of *N. rotensis* were observed in May or November of 2003 following super typhoon Pongsona, but subsequent surveys in 2005 found 20 individual plants (USFWS, 2006a).

Threats. Threats to *Nesogenes rotensis* include typhoons; ungulate impacts associated with herbivory, trampling, rooting; disease; decreased genetic variability, and pests.

3.11.2.2.2 *Osmoxylon mariannense* (No known common or local name)

Species Description and Regulatory Status. *Osmoxylon mariannense* is a spindly, soft-wooded tree in the ginseng family (*Araliaceae*), which can reach 33 ft (10 m) in height. It has several upward-growing (ascending), gray-barked branches that bear conspicuous leaf scars. Leaves vary in size; mature leaves are palmately lobed (hand-shaped) and about 1 ft (30 cm) long and 1.7 ft (50 cm) wide. The seven to nine lobes are coarsely toothed, and each lobe has a conspicuous, depressed mid-vein. The leaves are alternate or whorled and grow only at the branch tips. The petioles are 1 to 1.5 ft (35-40 cm) long and based in distinctive, conspicuous green multiple “sockets” (Raulerson and Rinehart, 1991). The flowers are yellow and have both male and female components. They are borne in many branched, compact terminal cymes or umbels. The fruits are round and maroon in color when ripe (Raulerson and Rinehart, 1991).

Osmoxylon mariannense was listed as endangered on April 8, 2004 (FR 04-7934). No critical habitat is designated for this species.

Life History and Ecology. Little is known of the life history or ecology of *Osmoxylon mariannense*. It occurs as an understory species in mixed ocshal forests (limestone forests with *Hernandia labyrinthica* and *Pisonia umbellifera* dominating), and is often hard to see until some trunks are tall enough to mingle with the trunks of the other two species (Raulerson and Rinehart, 1997). There are conflicting reports about the habitat requirements of *Osmoxylon mariannense*. *Osmoxylon mariannense* may be considered an edge species (USFWS, 2006a). Trees were observed flowering in February, March, and October and fruiting in November, December, January, February, and March (USFWS, 2006a). The fruit may provide food for birds and bats, which may also be the dispersal agents, though this is not confirmed (Raulerson and Rinehart, 1991). The seeds of *Osmoxylon mariannense* are difficult to germinate, and this may be due to production of "false seeds" (structures that appear to be seeds) or low viability rates (USFWS, 2006a).

Population Status and Distribution. *O. mariannense* was first collected more than 100 years ago and was not collected again until 1932 when Kanehira made at least two collections from dense primary forest at about 1,320 ft (400 m) elevation (USFWS, 2006a). However, there are no written records of the distribution and population size of *Osmoxylon mariannense* until 1980. Reports from 1980 to 1995 indicate that approximately 20 individuals from one scattered population were in the same vicinity as reported by Kanehira (USFWS, 2006a). One of the larger subpopulations had approximately nine individuals in 1994, but typhoons appeared to have damaged many of the trees and only two were visible in 1997 (Raulerson and Rinehart, 1997).

In January 1998, shortly after typhoon Paka, a total of eight trees, known to be from five different locations, were observed along the Sabana road (USFWS, 2006a). The trees were completely defoliated and damaged by the high typhoon winds. Many of the locations had several trees present 15 years earlier but by 1998, only single trees remained in each of the areas, and none were reproducing naturally (USFWS, 2006a).

In 2000, a survey conducted by biologists with the CNMI DFW identified six living and five dead individuals of *Osmoxylon mariannense* on Rota. A survey conducted in 2002 by E. Taisacan confirmed eight occurrences in the same vicinity, again with only one living mature tree in each location (USFWS, 2006a). *Osmoxylon mariannense* was found on both private (two individuals) and publicly owned (CNMI) land (six individuals). *Osmoxylon mariannense* individuals were again defoliated in 2003 during Super-typhoon Pongsona; however, in 2003, E. Taisacan reported that some individuals were leafing out and appeared to be recovering (USFWS, 2006a). Currently, all eight known wild individuals of this species occur along a simple system of unimproved roads crossing the top of the Sabana. This distribution is possibly an artifact of limited access for surveys, as large areas of the Sabana away from the roads are difficult or dangerous to survey due to natural topography and large, often hidden holes left from abandoned mining activities.

An unknown number of trees currently exist in cultivation, and two trees that were outplanted in 2002 adjacent to wild individuals of *Osmoxylon mariannense* continue to survive, bringing the total number of currently known individuals in the wild to 10.

Threats. Threats to *Osmoxylon mariannense* include habitat degradation due to ungulate herbivory, decreased genetic diversity, disease, and pests.

3.11.2.2.3 *Serianthes nelsonii* (Fire tree, Hayunn lago, Tronkon guafi)

Species Description and Regulatory Status. *Serianthes nelsonii* is one of the largest native trees in the Mariana Islands. Tree heights may reach 118 ft (36 m), with a trunk diameter (measured at breast-height) reaching 6.6 ft (2 m). Mature individuals frequently have large spreading crowns, with several of the largest trees on Rota having crown diameters of 69 – 75 ft (21-23 m). Cylindrical boles also characterize this species, deep trunk folds in mature trees, and one or more large roots exposed at the surface. Bark is smooth and light brown in color. Fine rusty hairs cover the flowers, seed pods, and newer vegetation growth. Leaves measure 7.1 – 15.0 in. (18-38 cm), are long, doubly pinnated, with 10 – 20 pairs of pinnae and 13 – 30 pairs of small dark green leaflets on each pinna. Leaflets are oblong, obtuse, and measure about 0.2 in. (5 mm) long. Seeds are hard, shiny, and slightly elliptical, and measure 0.3 by 0.4 in. (8 by 10 mm). Seedlings resemble those of tangantangan (USFWS, 1994).

Serianthes nelsonii was listed as endangered under authority of ESA on February 18, 1987 (52 CFR 4907 – 4910), and is listed as endangered by both Guam and CNMI (Guam Public Law 15 – 36, CNMI Public Law 2 – 51). Critical habitat is not designated for this species.

Life History and Ecology. Life The life history of *Serianthes nelsonii* is poorly known (USFWS, 1994). New leaves are produced continually throughout the year, but production is sensitive to the dry season (January to June), a time when most branches are dormant. Mature seed pods were reported during all seasons, and seed crops can be large, with 500 to 1,000 pods (USFWS, 1994). The age and size necessary for reproduction is unknown, but flowers and pods were seen on a tree known to be 10 years old with a diameter of 7.5 in. (19 cm).

On Rota, Mariana fruit bats were observed to feed on *Serianthes nelsonii* flowers, which may be a method of pollination (USFWS, 1994). Saplings in recent years were only observed under parent trees, which may underscore the importance of absent and declining birds and bats on Guam and Rota in *Serianthes nelsonii* seed dispersal.

Population Status and Distribution. Rota is believed to support as many as 121 *Serianthes nelsonii* mature trees; however, only six trees are known to occur on Guam. The largest tree is located near Ritidian Point on the upper plateau. A second tree is located in the eastern portion of Northwest Field and has suffered damage (blow over) from Typhoon Omar. Four other trees were outplanted in the Tarague Basin by Andersen AFB natural resource staff.

Threats. Threats to *Serianthes nelsonii* include herbivory by introduced ungulates, insect infestations (such as *Eurema blanda* and mealybugs), typhoon damage, habitat loss, loss of genetic variability, wildland fires, and possible bark consumption by the introduced black drongo (*Dicrurus macrocercus*) (USFWS, 1994).

3.11.2.2.4 *Acrocephalus luscinia* (Nightingale reed-warbler, Ga'ga karisu, Padudo / Malial ghariisu)

Species Description and Regulatory Status. The species is approximately 7 in. (17 cm) long, and is grayish olive-brown above with a pale-yellow underside. It inhabits wetlands, thickets and the margins of forests. The female is slightly smaller than the male, and both genders have a long bill compared to other reed warbler species. The Nightingale reed-warbler was listed as endangered on June 2, 1970 (35 FR 8491 - 8498).

Life History and Ecology. The Nightingale reed-warbler may be characterized as a secretive species that prefers screening provided by dense underbrush. Like many warbler species, the male is vocal and aggressive toward nonspecific intruders. Breeding may occur year-round (USFWS, 1998a); however, Craig (1994) suggests the peak breeding period lasts from January through February.

Nests are typically cup shaped, constructed of coarse and fine plant fibers and attached on its side to branches. Nests are found at an average height of 18 ft (5.5 m). *Leucaena leucocephala* are preferred nest trees, although nests were observed in *Casuarina equisetifolia*, *Bixia orellana*, *Brufuiera gymnorrhiza*), *Hibiscus* spp., and *Pithecellobium dulce*. Clutch size is typically two eggs (Marshall, 1949; Mosher and Fancy, 2002), the incubation period is 14 to 16 days, and fledging occurs after about 17 days (USFWS, 1998a). Territories are defended by males singing from exposed treetops, interior thickets, or large elephant grass stems (Reichel *et al.,* 1992).

Most birds found on Saipan occur in thicket-meadow mosaics, forest edge, reed-marshes and forest openings, and are largely absent from mature native forest, beach strand, and swordgrass vegetation community types. Nests on Sapian are found in upland introduced tangantangan forest, a native mangrove wetland, and a native reed wetland. On Alamagan, it inhabits open forest with brushy understory and wooded edges adjacent to open grassland. On Aguijan, it inhabits formerly disturbed areas vegetated by groves of trees and thickets. On Guam and Pagan, it inhabits freshwater wetland and wetland edge vegetation almost exclusively. Nightingale reed-warblers were observed to prey on insects by gleaning invertebrates from live and dead leaves. Other food sources include snails and lizards (Marshall, 1949).

Population Status and Distribution. Historical accounts of the Nightingale reed-warbler include populations on Guam, Tinian, Aguijan, Saipan, Alamagan, and Pagan. The Nightingale reed-warbler is thought to now inhabit only three islands in the Marianas chain—Saipan, Aguijan, and Alamagan (USFWS, 1998a). Only a small remnant population may persist on Aguijan. On Saipan, the Nightingale reed-warbler is distributed island wide, and is estimated to number 4,225 individuals (USFWS, 1998a), which represents a 13 percent decline in the reed-warbler population reported by Engbring *et al.* (1986). The population on Alamagan is estimated at 2,000 individuals (Stinson *et al.,* 1997).

Threats. Threats to Nightingale reed-warblers include predation by brown tree snakes, cats, rats, monitor lizards; habitat loss associated with agricultural activities such as wetlands draining and forest burning; and habitat degradation due to ungulates, such as feral goats on Aguijan and Alamagan.

3.11.2.2.5 *Aerodramus bartschi* (Mariana swiftlet, Chuchaguak, Yayaguak / Leghekeyang)

Species Description and Regulatory Status. The Mariana gray swiftlet is a small swift with a dark grayish plumage. The face is marked by a dark line through the eye. The tail is squared and without spines typical of other swifts. Sexes are monomorphic. The Mariana swiftlet is able to echolocate, an unusual adaptation that allows the birds to nest within deep caves, and sounds like a rapid monotonic clicking noise.

The Mariana swiftlet was listed as endangered on August 27, 1984 (49 FR 33881 – 33885). No critical habitat for this species is designated. On April 29, 2008, the USFWS initiated a five-year status review to evaluate the regulatory status of this species based on recent species information (73 FR 23264 - 23266).

Life History and Ecology. The Mariana swiftlet nests and roosts in limestone caves with entrances typically at least 6.2 ft (2 m) high. In suitable caves, nesting occurs in the troglic zone, which is facilitated by the swiftlets ability to echolocate. By nesting in total darkness, the birds escape harassment from visually oriented predators. As a further protection, this swiftlet often selects nest sites on the highest parts of the cave, often choosing clefts in the cave roof, overhanging walls, or stalactites. Caves are occupied throughout the year (USFWS, 1991).

Nests are cup shaped, constructed of moss or other plant material, and adhered together with sticky saliva extract. The nesting season lasts between January and July, although may be year round (Jenkins, 1983). A clutch typically consists of only one egg, measuring 0.7 by 0.4 in. (17 by 11 mm). Incubation period lasts at least 12 days, followed by a long period for fledging to occur, perhaps up to 35 days. Foraging habitat is found in a wide range of areas, while favoring ridge crests and open grassy savanna areas where they capture small insects while flying (USFWS, 1991). No information is available on preferred prey species.

Population Status and Distribution. The Mariana swiftlet occurs on Guam (in three known caves within the Ordnance Annex), Aguiguan Island (in nine known caves), and Saipan (10 known caves), and the swiftlet is considered extirpated from Tinian and Rota (Cruz *et al.* 2008). The swiftlet was thought to be once very abundant on Guam. Rota was once thought to support large populations of swiftlets, as evidenced by prehistoric guano and bone deposits, persistent unused nests, and ethnographic reports (Steadman 1999, Cruz *et al.* 2008).

Since the previous 1999 consultation between the USFWS and the Navy, the Guam swiftlet has colonized an additional third cave within the Ordnance Annex. In 2008, the Navy completed swiftlet count surveys at the three known swiftlet caves, which estimated the current Guam population at 1,150 swiftelts (NAVFACPAC 2008e).

Brown treesnakes have been found in swiftlet caves and are known to prey on the swiftelts. Since 2000, the Navy has contracted USDA WS to trap brown treesnakes in the areas surrounding the swiftet caves within the Ordnance Annex. Since the trapping program began in 2005, a total of 488 snakes have been removed (USDA WS 2008). The continued trapping is a likely factor in the increase in swiftlet numbers.

Threats. By nesting in the relatively stable and protected climate of troglic zones within caves, swiftlets are largely sheltered from natural perturbations. Human impacts that directly disturb cave systems, such as the intense warfare during World War II (Japanese utilization of caves and subsequent bombing by the U.S.), guano mining (intensified under the Japanese mandate), impacts due to collectors and hikers, vandalism and intentional killing of swiftlets, and feral mammals, are associated with declines in swiftlets on Guam and in the CNMI (USFWS, 1991). Brown tree snakes are also blamed for reducing swiftlet numbers, at least on Guam. Cockroaches are suggested as a major impact to swiftlet nesting by consuming nest material inside of caves on Saipan.

3.11.2.2.6 *Corvus kubaryi* (Mariana crow, Aga / Mwii'lap)

Species Description and Regulatory Status. The Mariana crow, known as "aga" in Chamorro, is a forest dwelling crow in the family Corvidae. Endemic to the islands of Guam and Rota in the Mariana Islands, the Mariana crow is the only corvid in Micronesia. Males and females look outwardly similar but, on average, females (8.5 oz [242 gm]) weigh less than males (9.0 oz [256 gm]; Baker, 1951). The adult Mariana crow is black with brown eyes, a slender black bill, and short visible nasal bristles. With the exception of the occasional brown gloss to its tail, the immature Mariana crow resembles an adult.

The Mariana crow was listed as endangered on August 27, 1984 (49 FR 33881 – 33885). On October 28, 2004, approximately 376 acres (152 hectares) were designated as critical habitat for the Mariana crow on Guam, and 6,033 acres (2,552 hectares) were designated on Rota (69 FR 629446). All critical habitat for the species on Guam is found on the fee simple portion of the Guam National Wildlife Refuge.

Life History and Ecology. Mariana crows are omnivorous and forage at all heights in the forest and on the ground. They are observed feeding on a variety of native and non-native invertebrates, reptiles, young rats, and birds' eggs, as well as on the foliage, buds, fruits, and seeds of at least 26 plant species (Jenkins, 1983; Tomback, 1986; Michael, 1987; USFWS, 2005a).

Mariana crows likely breed year round. However, peak nesting occurs between August and February on Rota (Morton *et al*., 1999) and October and April on Guam (Morton, 1996). Both parents generally participate in building the nest, incubating the eggs, and rearing the chicks through fledging (Morton *et al.*, 1999). Nest construction typically takes a week, and the incubation and nestling periods are between 21 to 23 days and 36 to 39 days, respectively (Morton *et al.*, 1999). Clutch sizes range from one to four eggs and the number of nestlings average 1.42 (n = 50; Morton *et al.*, 1999). In general, Mariana crows only produce a single brood a year but nest failure and other factors lead to multiple nest attempts. On Rota, 32 pairs constructed an average of two nests a year and nested up to seven times in one season

(Morton *et al.*, 1999). After fledging, Mariana crows will typically remain in family groups until the following breeding season, but fledgling attendance can vary from 99 to 537 days (Morton *et al.*, 1999).

Population Status and Distribution. Historically, the distribution of Mariana crows among habitats is similar on Guam and Rota. Crows are known to use secondary, coastal, ravine, and agricultural forests, including coconut plantations (Baker, 1951; Jenkins, 1983), but all evidence indicates they are most abundant in native limestone forests (Michael, 1987, Morton *et al.*, 1999). Mariana crow nests on Guam were found in 11 tree genera, all but one of which are native, but most nests are located high in emergent *Ficus* spp. or *Elaeocarpus joga* trees (Morton, 1996). On Rota, crows primarily use both mature and secondary limestone forests (Morton *et al.*, 1999). Of 156 nest sites on Rota, 39 percent and 42 percent were in mature and secondary limestone forest, respectively (Morton *et al.*, 1999). Of 161 nest trees found during 1996-99, 63 percent were of four species: fagot, *Eugenia reinwardtiana*, *Intsia bijuga*, and *Premna obtusifolia* (Morton *et al.*, 1999). Individual nest trees averaged 6.7 inch (in.) (16.9 centimeter [cm]) diameter at breast height and 28.5 ft (8.7 m) high. Canopy cover over nest sites averaged 93 percent and was never less than 79 percent. Nests were located at least 950 ft (290 m) from the nearest road and 203 ft (62 m) from the nearest forest edge, in areas with forest canopy cover that averaged 93 percent. The distances from edges strongly suggest that nesting crows are sensitive to disturbance by humans (Morton *et al.*, 1999).

As of March 2008, only two crows remained at Andersen AFB, both male (Brooke 2008, personal communication). On Rota, Morton *et al*. (1999) found that breeding crows on six study areas averaged one pair per 50 acres (22 hectares) of forested habitat, and each territory was dominated by native forest. Pair densities ranged from one per 91 acres (37 hectares) in relatively fragmented forest, to as high as one pair per 30 acres (12 hectares) in mostly intact limestone forest along a coastal terrace. Territories were aggressively defended from July through January, although established pairs occupied these areas throughout the year.

Threats. The primary threats to the Mariana crow throughout its range are habitat destruction and modification, predation by introduced predators like the brown tree snake, human persecution, and small population problems (USFWS, 2005a; Plentovich *et al.*, 2005).

3.11.2.2.7 *Gallinula chloropus guami* (Mariana common moorhen, Sasangat / Sasangal)

Species Description and Regulatory Status. The Mariana common moorhen resembles other moorhen subspecies found throughout the world. The Mariana subspecies is a slate-black bird approximately 14 in. (35 cm) long. The distinguishing physical characteristics include a red bill and frontal shield, white undertail coverts, a white line along the flank, and olive green legs with unwebbed feet. Males and females are nearly identical in appearance and are difficult to distinguish from each other (USFWS, 1991).

The Mariana common moorhen was listed as endangered in 1984 (49 FR 33881 – 33885). No critical habitat is designated for this species. On April 29, 2008, the USFWS initiated a 5-year status review to evaluate the regulatory status of this species based on recent species information (73 FR 23264 - 23266).

Life History and Ecology. The Mariana common moorhen is an inhabitant of emergent palustrine marshes, ponds, and placid rivers. In the Mariana Islands, its preferred habitat includes freshwater lakes, marshes, and swamps. Both constructed and natural wetlands are used. Key components of the Mariana moorhen habitat include a combination of deep (greater than 23 in. [60 cm]) marshes with robust emergent vegetation and equal areas of cover and open water. This species is known to be secretive and wary, and favors the screening characteristics of edge vegetation. Moorhens feed on both plant and animal material in or near the water. Grass, adult insects, insect larvae, algae, aquatic insects, mollusks, and seeds may be important dietary components.

Takano and Haig (2004) radio tracked 25 moorhens on Guam and 18 moorhens on Saipan throughout the dry and wet seasons of 2000 and 2001. During the dry season, no inter-island movements were detected and most birds remained at a single wetland, although some birds dispersed to other wetland areas. Increased movement was observed during the wet season, including inter-island movements of moorhens originally captured on Saipan. Guam moorhens also exhibited increased movement between wetlands, although no inter-island movements were observed by the Guam moorhens.

Breeding is assumed to occur year-round for the Mariana moorhen, as nests were located in all months except for October (USFWS, 1991). Similar subspecies in Hawaii build nests by folding over emergent vegetation into a platform nest. Apparently, vegetation structure is more important than species composition for nest construction and nest location, and nesting is apparently associated with water depth and screening vegetation availability (USFWS, 1984).

Clutch sizes of four to eight eggs for the Mariana common moorhen are recorded, although clutch sizes of similar subspecies were observed as high as 13 eggs. Incubation lasts approximately 22 days, and chicks hatch precocial and swim away from the nest shortly after hatching, but remain dependent on the parent birds for several weeks.

Population Status and Distribution. The Mariana common moorhen was historically restricted to wetland areas of Guam, Saipan, Tinian, and Pagan. These are the only islands in Guam and CNMI to support sufficient wetlands capable of supporting the moorhen. Major wetland areas of Guam apparently supported substantial populations, particularly marshes, taro patches, and rice fields. The greatest historical concentrations on Guam appeared to be in Agana Swamp, along the Ylig River in southern Guam (Baker, 1951). Other large populations in the CNMI were associated with Hagoi on Tinian and Lake Susupe on Saipan (USFWS, 1991). The Pagan population is believed to be extirpated due to ash and cinder fallout from a 1981 eruption of Mount Pagan, as well as ungulate impacts to wetlands vegetation.

The moorhen population within the Mariana archipelago is currently estimated to be approximately 300 individuals (Takano and Haig, 2004). On Guam, 90 birds are estimated to persist in three primary habitats: Agana Marsh, Fena Valley Reservoir, and Naval Station Marsh. Numerous small ponds have single birds or pairs of moorhens that move with changing water levels (Brooke, 2008). On Tinian, Hagoi in the EMUA portion of the MLA supports a population estimated at 41 with increased numbers at the start of the wet season (Takano and Haig, 2004). On Saipan, Lake Susupe is the most significant wetland feature that supports approximately 150 birds (Takano and Haig, 2004). The Navy conducts quarterly surveys on Guam at Fena reservoir and on Tinian at Hagoi.

On Tinian, the Hagoi area in the EMUA portion of the MLA supports a population estimated to range from 41 birds with increased numbers at the onset of the wet season (Takano and Haig 2004). Monthly monitoring surveys conducted by the Navy at Hagoi document predation of moorhen nests by monitor lizards (*Varanus indicus*) (NAVFACPAC, 2008b). These monitoring surveys began in 1998 and are performed (generally) on a monthly basis at the end of each month. As index surveys, the surveys document population trends over time, but do not estimate the number of animals in the population.

Yearly averages of the monthly monitoring program show that 2003 and 2007 were peak years for moorhen numbers at Hagoi (16.9 and 17.1, respectively), and troughs during 1999 and 2005 (10.1 and 9.9, respectively). The number of birds observed appears to correlate to periodic dry conditions at the Hagoi wetland (Hagoi was completely dry in April 2005); however, it is unknown if the apparent fluctuation in moorhen numbers observed at Hagoi reflect true population changes, emigration or immigration, or observer bias (NAVFACPAC, 2008b). Nest searches and egg counts are also conducted as part of the monthly monitoring program. Nest numbers increased from 2005 to 2006 from two to six nests per monthly survey, and egg numbers closely followed the nesting trends. Figure 3.11-11 summarizes the monthly moorhen surveys from 1998 to 2007 at the Hagoi wetland.

Threats. Loss of wetland habitat is the most significant factor in the decline of the Mariana common moorhen. Past wetland agricultural practices (rice, taro) probably allowed for an increase in moorhen populations before other development activities, such as land clearing, road building, and draw downs of water tables, impacted wetlands. Invasive species, such as *Phragmites karka*, can seriously degrade habitat, as observed in Agana Marsh and Naval Station Marsh. Introduced predators, such as cats, dogs, rats, and brown tree snakes, along with poaching activities, are also to blame for declines of the moorhen.

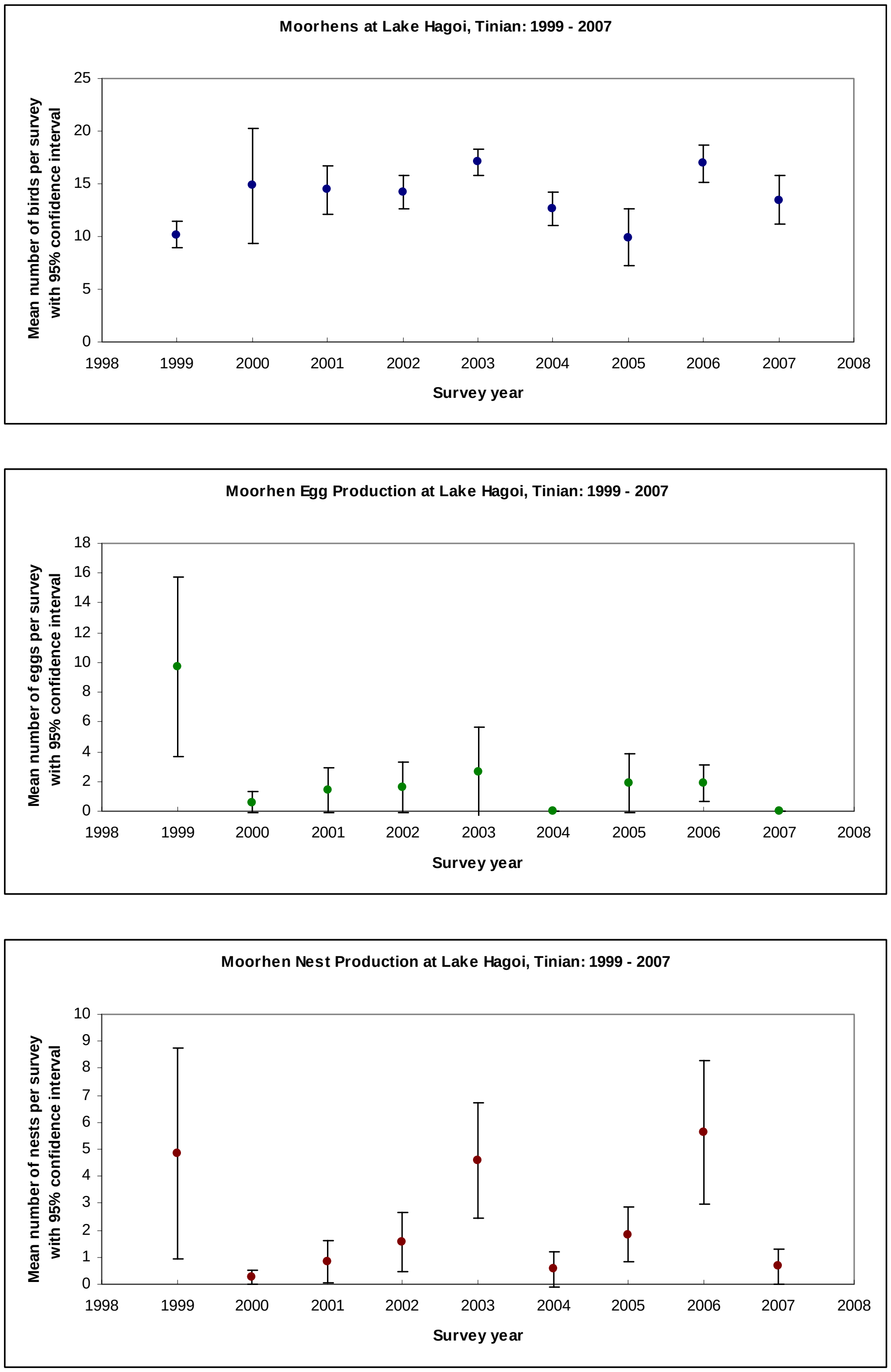

Figure 3.11-11: Moorhen Trend Data, Lake Hagoi, Tinian: 1999 - 2007

3.11.2.2.8 *Halcyon cinnamomina cinnamomina* (Micronesian kingfisher, Sihek / Waaw)

Species Description and Regulatory Status. The Guam Micronesian kingfisher, known as "sihek" in Chamorro, is a sexually dimorphic forest kingfisher in the family *Alcedinidae* (Baker, 1951). The adult male has a cinnamon-brown head, neck, upper back, and under parts. The lower back, lesser and underwing coverts, and scapular feathers are greenish-blue and the tail is blue. The feet and iris of the eye are brown and the bill is black except for some white at the base of the lower mandible. The female resembles the adult male, but the upper breast, chin, and throat are paler and the remaining underparts and underwing lining are white instead of cinnamon. Males weigh between 1.8 to 2.3 oz (51 and 64 gm) and females weigh between 2.0 to 2.7 oz (58 and 76 gm) (Baker, 1951; Jenkins, 1983).

The Guam Micronesian kingfisher was listed as endangered on August 27, 1984 (49 FR 33881 – 33885). On October 28, 2004, approximately 376 acres (152 hectares) were designated as critical habitat for the Guam Micronesian kingfisher on Guam (69 FR 629446). All critical habitat for this subspecies is found on the fee simple portion of the Guam National Wildlife Refuge.

Life History and Ecology. Guam Micronesian kingfishers feed both on invertebrates and small vertebrates, including insects, segmented worms, hermit crabs, skinks, geckoes, and possibly other small vertebrates (Baker, 1951; Jenkins, 1983). This species typically forage by perching motionless on exposed perches and swooping down to capture prey on the ground (Jenkins, 1983). Guam kingfishers also will capture prey from foliage and were observed gleaning insects from tree bark (Maben, 1982).

This subspecies nests in cavities, and breeding activity appears to be concentrated from December to July (Baker, 1951; Jenkins, 1983). Nests are reported in a variety of trees, including *Ficus* spp., *Cocos nucifera*, *Artocarpus* spp., *Pisonia grandis*, and *Tristiropsis obtusangula* (Baker, 1951; Jenkins, 1983). Pairs may excavate their own nests in soft trees, arboreal termitaria (the nests of termites [*Nasutitermes* spp.]), arboreal fern root masses, or they may utilize available natural cavities such as broken tree limbs (Jenkins, 1983). Jenkins (1983) observed that some excavated cavities were never used as nesting sites, which suggests that the process of excavating nest sites may be important in pair-bond formation and maintenance.

Both male and female Guam Micronesian kingfishers incubate eggs and brood and feed nestlings (Jenkins, 1983). Clutch sizes from wild populations (n = 3) were either one or two eggs (Baker, 1951; Jenkins, 1983) and clutch sizes of one to three eggs are reported in the captive population (Bahner *et al.*, 1998). Incubation, nestling, and fledgling periods for populations of Guam Micronesian kingfishers in the wild are unknown. However, incubation and nesting periods of captive birds averaged 22 and 33 days, respectively (Bahner *et al.*, 1998).

Jenkins (1983) reported that the Guam Micronesian kingfishers nest and feed primarily in mature, secondary growth, and, to a lesser degree, in scrub limestone forest. It is also found in coastal strand vegetation containing coconut palm as well as riparian habitat. However, Jenkins (1983) reported that it was probably most common along the edges of mature limestone forest. Few data exist about specific kingfisher nest sites in the wild, but in one study in northern Guam 16 nest sites were correlated with closed canopy cover and dense understory vegetation. In this study, nest cavities were excavated in the soft, decaying wood of large, standing dead trees averaging 17 in. (43 cm) in diameter. Research on the Pohnpei Micronesian kingfisher indicates an area of approximately 20 to 25 acres (8 to 10 hectares) of mixed forest, and open area may be needed to support a pair of kingfishers. It should be noted that Micronesian kingfisher territories may differ from Pohnpei Micronesian kingfisher territories due to differences in forest structure on Guam and Pohnpei (Mueller-Dombois and Fosberg, 1998).

Population Status and Distribution. This subspecies of *Halcyon cinnamomina* is endemic to Guam. The other two subspecies occur on the islands of Pohnpei (*Halcyon cinnamomina reichenbachii*) and Palau *(Halcyon cinnamomina pelwensis*). The Guam Micronesian kingfisher was considered "fairly common" and occurred throughout forested areas on Guam in 1945 (Baker, 1951). Populations in southern and central Guam disappeared by the 1980s (Jenkins, 1983) and only 3,023 individuals were recorded in 1981 in northern Guam (Craig, 1994). This population subsequently declined rapidly, and by 1985 only 30 individuals were recorded on Guam. This subspecies was believed extirpated in the wild by 1988 (Wiles *et al.,* 2003).

Between 1984 and 1986, 29 Guam Micronesian kingfishers were captured and sent to zoological institutions in the mainland Unites States (Hutchins *et al.*, 1996). As of December 2005, the captive population included 79 individuals in 12 captive breeding institutions (Smithsonian National Zoological Park, 2007).

The Guam Micronesian kingfisher is currently found only in captivity and is not found in the MIRC Study Area. However, habitat required to support the recovery of the species is located within the Study Area. As stated in the "Population Status and Distribution" section above, Guam Micronesian kingfishers are believed to utilize mature limestone forest, secondary forests, and coastal forests dominated by coconut trees for foraging and nesting. Unfortunately, a detailed assessment of the available Guam Micronesian kingfisher habitat on Guam is not complete. However, Donnegan *et al.* (2004) completed a vegetation survey of Guam that classifies the vegetation into general categories. Of these categories, limestone forest and plantation forest contain components that Guam Micronesian kingfishers utilize for nesting and may be potential breeding habitat for this species. In 2002, the USFWS identified approximately 14,338 acres (5,803 hectares) in northern Guam as essential habitat for the Guam Micronesian kingfisher (USFWS, 2004a). Utilizing the recent vegetation assessment (Donnegan *et al.*, 2004), it is estimated that approximately 12,026 acres (4,867 hectares) of potential Guam Micronesian kingfisher breeding habitat is located within these essential habitat areas. Approximately 9,508 acres (3,848 hectares) of this habitat are located on Andersen AFB.

Threats. The primary threats to the Guam Micronesian kingfisher are habitat destruction and modification, predation by brown tree snakes, and limited population growth in the captive population (USFWS, 2004a).

3.11.2.2.9 *Megapodius laperous* (Micronesian megapode, Sasangat / Sasangal)

Species Description and Regulatory Status. The Micronesian megapode, known as the "sasangat" in Chamorro and "sasangal" in Carolinian, is a member of Family Megapodiiadae within Order Galliformes. Micronesian megapodes are pigeon-sized, ground dwelling birds inhabiting primarily forest floors, but are capable of inter-island flying (DoN, 2003a). The megapode weighs approximately 12.3 oz (350 gm) (USFWS, 1998b), has dark gray-brown to black plumage, and a gray head with a slightly darker, short, rough chest. The flight and tail feathers are gray-black. Feathers around the eye, ear, and throat are sparse or absent, revealing red skin and a red gular skin patch when the neck is extended. The bill is yellow with the upper mandible clove-brown to black at the base, and the iris is orange-brown to dark brown (Baker, 1951).

The Micronesian megapode was first listed as endangered in 1970 in the Northern Mariana Islands (under the Endangered Species Conservation Act, 35 FR 8491 – 8498); the species is not listed on Guam due to prior extirpation on the island. No critical habitat is designated for this species. On April 29, 2008, the USFWS initiated a 5-year status review to evaluate the regulatory status of this species based on recent species information (73 FR 23264 - 23266).

Life History and Ecology. Megapodes are generally associated with forest habitats; however, the breeding population on FDM and other islands suggests that megapodes may be less dependent on forested areas as previously thought. Megapodes primarily select nest sites in sun-warmed cinder fields on volcanic islands and exposed limestone flats, but may nest in roots of rotting trees, logs, and in patches of rotting sword grass.

The breeding season for Micronesian megapodes is reported on Saipan to begin in November and last through December, although the season may be year round. Megapodes are considered “incubator” birds because they rely on external energy sources, such as solar heat, volcanic activity, or heat produced from microbial decomposition of organic matter as heat sources for incubation (Clark, 1964).

Multiple eggs are laid singly in a breeding season, each egg laid after an interval of approximately one week. Each egg measures approximately 3 in. by 2 in. (70 mm by 44 mm). Chicks emerge from nests super-precocial and able to function (and fly) independent of the parent birds (USFWS, 1998b).

Population Status and Distribution. Small remnant populations are known to exist on the southern Mariana Islands of Aguijan, Tinian, Saipan, and FDM; larger populations are reported on uninhabited northern islands of Anatahan, Guguan, Sarigan, Lamagan, Pagan, Ascuncion, Maug, and possibly Agrihan (USFWS, 1998b). The total number of individual birds is thought to range from 1,440 to 1,975.

On Guam and Rota, megapodes were probably extirpated before the arrival of the brown tree snakes to Guam, as they were reported as “very rare” by early European naturalists (USFWS, 1998b), but one or two were collected in the late 1890s on Guam and one on Rota. Saipan is believed to support a population less than 100 individuals (DoN, 2004).

On Tinian, megapode detections have never been numerous (O’Daniel and Kreuger, 1999). Megapodes have been sighted on Tinian within forested portions of the Maga area (to the northeast of the Voice of America Relay Station (Witteman, 2001), a small section of native forest adjacent to Cross Island Road in the Bateha area (O’Daniel and Kreuger, 1999) and the Mount Lasso area south of the overlook on the ridgeline (O’Daniel and Kreuger, 1999). NAVFACPAC biologists conduct monthly monitoring surveys through native forest habitats on Navy-leased lands. Seven transects are surveyed monthly for forest birds (including megapodes), and more intensive surveys (point counts using megapode call playbacks following Witteman’s methods [2001]) along the transects were conducted in August 2005 and February 2006. Because of past detection of megapodes along the Maga transect, (shown on Figure 3.11-8) focused “sweep” surveys are conducted in conjunction with playback call recordings. Since 1995, biologists have detected 13 megapodes on Tinian during 234 individual survey efforts (NAVFACPAC, 2008c). Because some of these detections may be repeat observations of the same bird, it is not possible to determine a population size for Tinian. Occasional sightings of megapodes suggest fairly regular but occasional movement from Aguigan. Aguigan is known to have a small population of megapodes: 16 birds were heard during forest bird point-count surveys in 2002, 12 in 2000, 11 in 1992 (CNMI DFW, 2003).

Surveys on FDM in 1996 documented the presence of the Micronesian megapode (Lusk *et al*. 2000). From this survey, it was estimated that a population of 10 megapodes were on FDM (Lusk and Kessler 1996, USFWS, 1998). However, due to an incoming typhoon, biologists were only on the island for about 5.5 hours, so this estimate was based on limited data. FDM was surveyed more thoroughly in December 2007 by NAVFACPAC biologists, which provided an estimate of 21 adult pairs (NAVFACPAC, 2008a). Results of the most recent surveys on FDM are shown in Figure 3.11-9). Mitigation measures specified in previous Section 7 ESA consultations between the Navy and USFWS coupled with the restricted access preventing poaching activities may have benefited megapodes on FDM. The mitigation measures included maintaining a no fire zone on the northern portion of the island and the use of inert ordnance in an area south of the no fire zone (explosive ordnance is deployed to the south of this area).

Threats. Threats to Micronesian megapodes include poaching, invasive species predation (such as monitor lizards, feral dogs, cats, and pigs, and various species of rats), introductions of brown tree snakes from Guam, competition from introduced game birds and feral chickens (USFWS, 1998b), and the diseases associated with introduced species. Other threats include volcanic activity (such as Anatahan island eruptions), typhoons, and drought. Although these threats to megapodes are largely absent on FDM, direct mortality from live-fire activities limits megapode success on FDM. Although the stunted woody vegetation of FDM and lack of tall stature forests does not represent ideal habitat for megapodes, a lack of people appears to be enough for higher megapode numbers regardless of habitat type. Hunting pressure and egg harvesting may affect megapode success (presence and density) more than previously thought on other inhabited or accessible islands. Islands with higher densities (Sarigan, Guguan and now FDM) are those islands that have not been inhabited in the last 50 years or so (CNMI DFW, 2000 [Technical Reports #3-8]). As vegetation continues to recover and provide habitat for megapodes on the northern portion of FDM and within the inert ordnance area, the vegetation may increase potential for wildland fires in occupied megapode habitat areas by increasing the fuel load.

3.11.2.2.10 *Rallus owstoni* (Guam rail, Ko'ko)

Species Description and Regulatory Status. The Guam rail, known as "koko" in Chamorro, is a flightless rail in the family Rallidae. Males and females look outwardly similar but, on average, females (8 oz [212 gm]) weigh less than males (9 oz [241 gm]; Jenkins, 1983). The head, neck, and eye stripe of the Guam rail are brown and the eyebrow, lower neck, and upper breast are grey. Their lower breast, abdomen, under tail coverts, and tail are blackish with white barrings. Their legs, feet, and iris are brown and their bill is gray. The Guam rail was listed as endangered in 1984 (USFWS, 1984).

Life History and Ecology. Guam rails are territorial ground nesters that breed year-round (Jenkins, 1983, USFWS, 1990a); however, peak breeding may occur during the rainy season (July through November; Perez, 1968). Clutches typically consist of three to four eggs and broods range from one to four chicks. Guam rails are omnivorous but appear to prefer animal matter over vegetable foods. They are known to eat gastropods, skinks and geckos, insects, carrion, seeds, and palm leaves (USFWS, 1990a). This species is primarily believed to prefer secondary vegetation although it was found in all habitats except wetlands, although savanna and mature forest may be marginal habitats (Jenkins, 1983; USFWS, 1990a).

Population Status and Distribution. The Guam rail is endemic to Guam. This species was once distributed throughout Guam but by 1981 a population of approximately 2,300 birds existed in northern Guam (Craig, 1994; USFWS, 1990a). In 1983, it was estimated that fewer than 100 individuals remained and it was considered extinct in the wild by 1987 (Witteman *et al.*, 1990). As of 2003, 129 individuals are found in captivity in zoological institutions and GovGuam DAWR captive propagation facilities (USFWS, 2006a). Efforts to establish an experimental population on the island of Rota have been underway since 1989 (Beuprez and Brock, 1999a). The current population on Rota is estimated to be approximately 40 to 70 individuals (USFWS, 2006b).

Threats. The primary threats to the Guam rail are predation by brown tree snakes and feral cats (USFWS, 1984; 1990a). Predation by brown tree snakes is believed to be the primary factor in the decline of the species on Guam, and high snake populations on Guam still threaten recovery efforts. However, feral cat predation is found to be a major obstacle to efforts to establish an experimental population on Rota and re-establish a population on Guam (Beauprez and Brock, 1999a; 1999b).

3.11.2.2.11 *Zosterops rotensis* (Rota bridled white-eye, Nosa luta)

Species Description and Regulatory Status. The Rota bridled white-eye is a passerine forest bird endemic to Rota. Its plumage is mostly yellow, and its bill, legs, and feet are yellowish-orange (Pratt *et al.*, 1987). Wing, tail, and tarsal lengths taken from 21 adult birds averaged 2.2 in. (5.6 cm), 1.5 in. (3.8 cm), and 1 in. (2.6 cm), respectively (USFWS, 2006b). Average weights taken from these birds were 0.34 oz (9.7 gm) for males and 0.32 oz (9.2 gm) for females.

The Rota bridled white-eye was listed as endangered on January 22, 2004 (69 FR 3022 - 3029), and because it is endemic to the island of Rota, its listing is specific to the island. On April 29, 2008, the USFWS initiated a 5-year status review to evaluate the regulatory status of this species based on recent species information (73 FR 23264 - 23266).

Life History and Ecology. Rota bridled white-eye primarily forage in the outer canopy of forests for insects, fruit, or nectar. These forests are divided into the following three types based on dominant canopy tree species: 1) mixed oschal and joga forests (dominated by *Hernandia labyrinthica* and *Elaeocarpus joga*); 2) faniok forest (dominated by *Merrilliodendron megacarpum*); and 3) sosugi forest (dominated by *Acacia confusa*, an introduced species). The majority of foraging observations were reported in *Elaeocarpus joga*, *Hernandia labyrinthica*, *Macaranga thompsonii*, *Merrilliodendron megacarpum*, and *Premna obtusifolia*. Rota bridled white-eye nests are reported in *Merrilliodendron megacarpum*, *Hernandia labyrinthica*, *Elaeocarpus joga*, and *Acacia confusa* trees 10 to 49 ft (3 to 15 m) tall and 1 to 24 in. (2 to 60 cm) in diameter (USFWS, 2006c).

Breeding was observed between December and August (Amidon *et al.*, 2004). Because this time period covers portions of both the wet season and dry season, the species may breed year-round, similar to the Guam bridled white-eye (Marshall, 1949; Jenkins, 1983). Rota bridled white-eye nests are cup-like and typically suspended between branches and branchlets or leaf petioles (Amidon *et al.*, 2004).

Eggs are light blue, and clutch sizes of one to two eggs were observed (Amidon *et al.,* 2004), although clutch sizes of three eggs are possible based on observed clutch sizes for bridled white-eyes on Guam, Tinian, and Saipan (USFWS, 2006c). Incubation times range from 10 to 12 days, followed by 10 to 14 days before hatchlings fledge. The post-fledging parental attendance period is unknown, but observations of one banded nestling indicate it is at least 8 days (Amidon *et al.,* 2004).

Population Status and Distribution. The Rota bridled white-eye is endemic to Rota. Currently, the species is primarily restricted to mature forests above 490 ft (150 m) in the Sabana region of Rota. As of August 1999, the population on Rota numbered approximately 1,000 individual birds and the species' core range consisted of 682 acres (254 hectares) (USFWS, 2006c).

Threats. Current threats include habitat loss and degradation, predation by introduced rats and black drongos (*Dicrurus macrocercus*), and susceptibility of the single small population to random catastrophic events, such as typhoons. In addition, potential establishment of a new predator, such as the brown tree snake or avian diseases, such as West Nile virus, also threaten recovery of the species.

3.11.2.2.12 *Pteropus mariannus mariannus* (Mariana fruit bat, Fanihi / Payesyes, Pai' scheei)

Species Description and Regulatory Status. The Mariana fruit bat or flying fox, known as "fanihi" in Chamorro and "Pyesyes" or "Pai' scheei" in Carolinian, is a medium-sized fruit bat in the Family Pteropodidae that weighs 0.66 to 1.15 lb (0.33 to 0.58 kg). Males are slightly larger than females. The underside (abdomen) is black to brown with gray hair interspersed that creates a grizzled appearance. The shoulders (mantle) and sides of the neck are bright golden brown, but may be paler in some individuals.

The head varies from brown to dark brown. The well-formed, rounded ears and large eyes give the face a canine appearance.

The Guam population of the Mariana fruit bat was listed as endangered on August 27, 1984 (49 FR 33881 – 33885). However, in 2005 the subspecies was listed as threatened throughout the Mariana Islands and downlisted to threatened on Guam (70 FR 1190 - 1210). On October 28, 2004, approximately 376 acres (152 hectares) were designated as critical habitat for the Mariana fruit bat on Guam (69 FR 629446). All critical habitat for the species is found on the fee simple portion of the Guam National Wildlife Refuge.

Life History and Ecology. During the day, Mariana fruit bat roosts in colonies of a few to over 800 animals (Wiles, 1987a; Pierson *et al.,* 1996; Worthington and Taisacan, 1995a), as well as in non-colonial roost sites. Bats are typically grouped into harems (one male and two to 15 females) or bachelor groups (predominantly males); some single males reside at the colony's periphery (Wiles, 1987a). On Guam, the average estimated sex ratio in one colony varied from 37.5 to 72.7 males per 100 females (Wiles, 1982). A smaller number of bats roost solitarily away from the colony (Wiles *et al*., 1989; Janeke, 2006). Reproduction in Mariana fruit bats was observed year-round on Guam (Perez, 1972; Wiles, 1983) and on Rota; individual females have a single offspring each year (Pierson *et al.,* 1996). Wiles (1987a) found no apparent peak in births on Guam, but a peak may occur in May and June on Rota. Glass and Taisacan (1988) suggested a similar pattern on Rota, but also indicated that a peak birthing season may occur during May and June. Although specific data for the Mariana fruit bat are lacking, female bats of the family *Pteropodidae* have one offspring per year, generally are not sexually mature until at least 18 months of age, and have a gestation period of four to six months (Pierson *et al.,* 1996; McIlwee and Martin, 2002). The average lifespan of this species is unknown; the longevity of a similar species in Australia is 4 to 5 years, with a maximum of eight years (Vardon and Tidemann, 2000).

Colonial roost sites are an important aspect of the Mariana fruit bat's biology because they are used for sleeping, grooming, breeding, and intra-specific interactions (USFWS, 1990b). Published reports of roost sites on Guam indicate these sites occur in mature limestone forest and are found within 328 ft (100 m) of 262 to 591-ft (80- to 180-m) tall clifflines (USFWS, 1990b). Native forest habitat is also an important aspect of fruit bat biology as it is also used for roosting, feeding, etc. by non-colonial bats. On Guam, Mariana fruit bats prefer to roost-mature *Ficus* spp. and *Mammea odorata* trees but will also roost in other tree species such as *Casuarina equisetifolia*, *Macaranga thompsonii*, *Guettarda speciosa*, and *Neisosperma oppositifolia* (Wheeler and Aguon, 1978; Wiles, 1981; 1982b). On other islands in the Mariana archipelago, Mariana fruit bats were observed in secondary forest and *Casuarina equisetifolia* groves (Glass and Taisacan, 1988; Worthington and Taisacan, 1995a; Worthington *et al.,* 2001). Factors involved in roost site selection are not clear, but data from Guam indicate that some sites may be selected for their inaccessibility by humans and thus limited human disturbance. Fruit bats will abandon roost sites if disturbed and are reported to move to new locations up to 6 mi (10 km) away (USFWS, 1990b).

Several hours after sunset, bats depart their roost sites to forage for fruit and other native and non-native plant materials such as leaves and nectar (USFWS, 1990a; Janeke, 2006). This species feeds on a variety of plant material but is primarily frugivorous (Wiles and Fujita, 1992). Specifically, Mariana fruit bats forage on the fruit of at least 28 plant species, the flowers of 15 species, and the leaves of two plant species (Wiles and Fujita, 1992). Some plants used for foraging include *Artocarpus* spp., *Carica papaya*, *Cycas micronesica*, *Ficus* spp., *Pandanus tectorius*, *Cocos nucifera*, and *Terminalia catappa*. Many of these plant species are found in a variety of forested habitats on Guam, including limestone, ravine, coastal, and secondary forests (Stone, 1970; Raulerson and Rinehart, 1991; Janeke, 2007).

Population Status and Distribution. This subspecies of *Pteropus mariannus* is endemic to the Mariana archipelago, where it is found on most of the 15 major islands. There are no records of fruit bats on Uracas, and fruit bats were observed only once on FDM.

On Guam, the sighting of fruit bats was considered to be "not... uncommon" in the 1920s (USFWS, 2006b). Woodside (1958) reported that in 1958, the Guam population was estimated to number no more than 3,000, although the method used to make this estimate is not known. This estimate had dropped by an order of magnitude to between 200 and 750 animals by 1995 (Wiles *et al.*, 1995; Wiles, 1996). The most recent surveys at Pati Point estimated the bat population at 30-40 individuals (USFWS, 2006b). Non-colonial bats roost throughout Northwest Field, Tarague basin, Jinapsan, Guam National Wildlife Refuge lands, NCTS and private lands in northern Guam. In September 2008, an observation of a fruit bat was recorded within the Ordnance Annex (Brooke, 2008). The island-wide population on Guam is likely not to exceed 100 (Brooke, 2007).

The island of Tinian once held a large number of fruit bats; however, by 1979, Wheeler (1980) estimated the population declined to 25-100 individuals. The population continued to decline with fewer than 25 bats remaining in the 1980s (Wiles *et al.*, 1989; Stinson *et al.*, 1997). By 1994 the status of the fruit bat on the island was uncertain, being rare or extirpated (Stinson *et al.*, 1997). Kreuger and O'Daniel (1999) conducted surveys for Mariana fruit bat on Tinian and recorded two incidental observations, and Navy biologists have recorded fruit bat observations within the MLA (Brooke, 2007).

No known historical records exist to document the status of the Mariana fruit bat prior to the 20th century, although the abundance of bats is mentioned in many writings from early Europeans. Surveys on most or all islands in the archipelago were conducted in 1983 (Wiles *et al.*, 1989), 2000 (Cruz *et al.*, 2000a-f), and 2001 (Johnson, 2001). The relatively isolated northern islands support the majority of the fruit bats in the archipelago, but because of their remote location, these islands were not surveyed as frequently as the southern islands (*i.e.*, Saipan, Tinian, Aguijan, and Rota). Individual surveys were conducted on several of the southernmost of these islands at relatively frequent intervals (*e.g.*, Kreuger and O'Daniel, 1999; Kessler, 2000; Worthington *et al.*, 2001). A conservative interpretation of these data indicates a 37 percent decline in fruit bat numbers between 1983 and 2000 among the six northern islands surveyed in both years (USFWS, 2007). The majority of this decline was recorded on two of the three largest northern islands, Anatahan and Pagan, which together harbored roughly 70 percent of the archipelago's fruit bats in the 1980s (Wiles *et al.*, 1989).

Threats. The primary threats to the Mariana fruit bat throughout its range are illegal hunting, habitat destruction both by volcanic eruptions and man-made disturbances, (USFWS, 2005b). In addition, predation by the BTS threatens the Mariana fruit bat on Guam (USFWS, 2005b) and is attributed to the absence of Mariana fruit bat juveniles at the Pati Point colony.

3.11.2.3 Designated Critical Habitat

Potential impacts to critical habitat designations on Guam and Rota are also evaluated in this EIS. As shown in Table 3.11-5, critical habitat has only been designated by the USFWS on Guam and Rota. On Guam, critical habitat has been designated for the Mariana fruit bat, Mariana crow, and Micronesian kingfisher. On Rota, critical habitat has been designated for the Rota bridled white-eye, Mariana fruit bat, and Mariana crow. No other critical habitat designations are in effect on other islands within the MIRC Study Area.

Table 3.11-5: Critical Habitat Designations in the Mariana Islands for Terrestrial Species

Scientific Name	English Name(s)	Chamorro/ Carolinian Name(s)	Critical Habitat Description
Corvus kubaryi	Mariana crow	Aga / Mwii'lap	Unit A: located on Guam National Wildlife Refuge, Ritidian Unit, occupying 376 acres (152 hectares) of forested and coastal habitat, entirely on Federal government land. Unit B, Subunit 1: Located in southwestern Rota associated with the Sabana raised limestone plateau region, occupying a total of 5,668 acres (2,294 hectares) [5,221 acres] (2,113 hectares) on CNMI lands, 447 acres (181 hectares) on private lands] Unit B, Subunit 2: Located in southwestern Rota associated with the Sabana raised limestone plateau region, occupying a total of 365 acres (148 hectares) [349 acres (141 hectares) on CNMI lands, 16 acres (7 hectares) on private lands] Spatial extent provided in 69 FR 62944 and GIS files downloaded from USFWS Critical Habitat Portal.
Halcyon cinnamomina cinnamomina	Micronesian kingfisher (Guam subspecies)	Sihek / Waaw	Micronesian Kingfisher Unit, located on Guam National Wildlife Refuge, Ritidian Unit, occupying 376 acres (152 hectares) of forested and coastal habitat, entirely on Federal government land. Spatial extent provided in 69 FR 62944 and GIS files downloaded from USFWS Critical Habitat Portal.
Pteropus mariannus mariannus	Mariana fruit bat	Fanihi / Payesyes, Pai' scheei	Mariana Fruit Bat Unit, located on Guam National Wildlife Refuge, Ritidian Unit, occupying 376 acres (152 hectares) of forested and coastal habitat. Spatial extent provided in 69 FR 62944 and GIS files downloaded from USFWS Critical Habitat Portal.
Zosterops rotensis	Rota bridled white-eye	Nosa luta / -	Rota Bridled White-Eye Unit, located in southern Rota containing 3,958 ac (1,602 hectares) of forested land. This area contains forested areas on 3,700 ac (1,498 hectares) of public and 258 ac (104 hectares) of private lands along the slopes and top of the Sabana plateau. Approximately 62 percent (2,292 acres [928 hectares]) of the public land within this proposed designation is within the Sabana Conservation Area. Spatial extent provided in 50 FR 53589 and GIS files downloaded from USFWS Critical Habitat Portal.

3.11.2.4 Candidate and Delisted Species

3.11.2.4.1 Candidate Species

A candidate species is one that is the subject of either a petition to list or status review, and for which the USFWS has determined that listing may be warranted (USFWS and NMFS, 1998). Candidate species receive no statutory protection under the ESA. However, the USFWS encourages the formation of partnerships to conserve these species because they are by definition species that may warrant future protection under the ESA. Four candidate species are addressed in this EIS and include three partulid snail species and one butterfly species.

***Hypolimnas octocula mariannensis* (Mariana eight-spot butterfly, Ababbang / Libwueibogh)**

Species Description and Regulatory Status. The Mariana eight-spot butterfly, known in Chamorro as the “Ababbang” and in Carolinian as “Libwueibogh,” is a nymphalid butterfly species endemic to Guam and Saipan. Like most nymphalid butterflies, orange and black are the primary colors exhibited by this species. Females are larger than males, and appear more orange in color than males, and have black bands across the top margins of both pair of wings. Males are predominantly black with an orange stripe running vertically on each wing. The stripe on the hindwings exhibits small black dots in a vertical row. Large white spots are exhibited across the entire length of the wings (Swezey, 1942).

This species is a Federal candidate for T&E listing (USFWS, 2002), and the candidate status was re-affirmed in 2005 (71 FR 53755 – 53835, USFWS 2005b).

Life History and Ecology. The larvae of this species feed on two native herbaceous plants, *Procris pedunculata* and *Elatostema calcareum*. These forest fleshy herbs only grow on karst limestone within limestone forests.

Population Status and Distribution. The Mariana eight-spot butterfly was apparently always uncommon on Guam and declined primarily due to browsing of the two host plants by introduced deer. The Mariana eight-spot butterfly is believed to have been extirpated from Saipan, but occurs rarely in Guam’s northern forests. During surveys conducted in 1995, areas of Saipan supported healthy populations of the host plants, but no butterflies were observed (Schreiner and Nafus, 1996). Two Mariana eight-spot butterflies were observed in 2006 (Lawrence, 2006) along a rocky pinnacle karst area toward Pati Point, approximately 0.5 mi (0.8 km) from the Aircraft Staging Area (ASA) project area on Andersen AFB. The two butterflies were observed to be aggressively defending an area containing *Procris pedunculata* and *Elatostema calcareum* from an individual *Euploea* spp. butterfly, later identified from similar observations as *Euploea eunice hobsonii* (Parsons, 2006). The observation of the Mariana eight-spot butterfly and behavior were reported to Andersen AFB and USFWS (Parsons, 2006).

Threats. Threats include habitat degradation and removal, ungulate browse pressure, competition from other introduced butterfly species (such as *Euploea eunice hobsonii*), disease, predation by ants and wasps, and typhoons.

Partulid Snails

Species Descriptions and Regulatory Status. Three snails in the Partulid family are collectively known as “Akaleha” in Chamorro—the humped tree snail (*Partula gibba*), the Guam tree snail (*Partula radiolata*), and the fragile tree snail (*Samoana fragilis*). The shell of the humped tree snail is described as somewhat enlarged resembling a hump in a conical shape with four to five whorls. The shell color is chestnut brown to whitish yellow, or occasionally purple with white or brown line along the suture between the whorls on the shell (USFWS, 2005c). The humped tree snail was added to candidate listing in 1994 by USFWS (USFWS, 2005c). The candidate status was reaffirmed in 2005 by USFWS (71 FR 53755 – 53835; USFWS, 2005c).

The shell of a Guam tree snail is described as somewhat oblong and having a conical shape with five whorls. The shell color is pale straw yellow with darker axial rays and brown lines (USFWS, 2005d). The Guam tree snail was added to candidate listing in 1994 by USFWS (USFWS, 2005d). The candidate status was reaffirmed in 2005 by USFWS (71 FR 53755 – 53835, USFWS, 2005d).

The shell of the fragile tree snail has four whorls and the background color of the shell is buff tinted by narrow darker maculations and whitish banding that are derived from internal organs of the animal that are visible through the shell. The fragile tree snail was added to candidate listing in 1994 by USFWS (USFWS, 2005d). The candidate status was reaffirmed in 2005 by USFWS (71 FR 53755 – 53835, USFWS, 2005d).

Life History and Ecology. Like the other Partulid snails, the humped tree snail prefers to live on sub-canopy vegetation in lower forest strata and is not found in the high forest canopy. The conditions favorable to Partulid snails are only found in intact limestone forests, mesic coastal strand vegetation, and forested river corridors.

Little is known about the breeding ecology of the Partulid tree snails of the Mariana Islands. Similar Partulid species, however, suggest that tree snails in the Marianas are hermaphroditic, like all other terrestrial pulmonate snails. In general, Partulids begin reproducing in less than 12 months, and may live as long as five years. Up to 18 young are produced each year. While most terrestrial pulmonate snails lay eggs, the Partulids give birth to fully developed young. The snails are generally nocturnal, living on bushes or trees and feeding on decaying plant material.

Population Status and Distribution. The humped tree snail is the most widely distributed tree snail in the Marianas Islands, and is known from Guam, Rota, Saipan, Tinian, Aguijan, Anatahan, Sarigan, Alamagan, and Pagan. The snail was once thought to be the most common tree snail on Guam. Now, however, the humped tree snail is considered extremely rare across its range (Hopper and Smith, 1992), numbering under 2,600 individuals (USFWS, 2005c). On Guam and Rota, the humped tree snail has gone from being widely distributed and super abundant to being highly localized and rare. All current populations on Guam are found on the Guam intact forests of the Ordnance Annex, and probably number less than 1,000 individuals (USFWS, 2005c). The same number of snails probably persists on Rota (USFWS, 2005c). Because of the abundance of a predatory flat worm, coupled with land use before, during, and after World War II, in addition to intense warfare during the U.S. landings on Tinian, humped tree snails are thought to be extirpated from Tinian (USFWS, 2005c). A small population (<20 individuals) was found on a National Park Service parcel (War of the Pacific National Park) on Saipan.

In the Mariana Islands, the range of the fragile tree snail is considered to be restricted to Guam and Rota, and populations on Guam are believed to have been extirpated (USFWS, 2005d). Hopper and Smith (1992) estimated that the number of sites that support the Guam tree snail have decreased by 74 percent since surveys conducted in 1920 by Crompton (USFWS, 2005d). When discovered, the fragile tree snail was considered to be rare, but wide spread on Guam and Rota. Populations on Rota are estimated to not exceed 100 individuals (USFWS, 2005d).

Threats. Threats to the humped tree snail and other Partulid snails include habitat destruction and degradation; the presence of predatory Manokwar flat worms (*Platydemis manokwari*) and rosy carnivore snails (*Euglandina rosea*); typhoons which open up canopy and may reduce mesic conditions in the lower forest strata; and wildfires. Manokwar flat worms, introduced to control the giant African snail, were observed in intact forested areas of the Northwest Field, along with shells of giant African snails (Parsons, 2006).

3.11.2.4.2 Recovered Delisted Species

Delisted species are species that have met specified recovery goals and no longer warrant protection under the ESA. Once a species is delisted, Section 4(g)(1) of the ESA requires the USFWS to monitor for no fewer than five years the species' status. The purpose of post-delisting monitoring is to verify that a species delisted due to recovery remains secure from risk of extinction after it has been removed from the ESA protections. Once a species reaches recovery goals, the USFWS engages in a five-factor analysis to assess whether the species still warrants protection under the ESA, which includes: (1) an assessment of threats to species habitat, (2) an analysis of delisting ramifications, including over utilization for commercial, recreational, scientific, or educational purposes, (3) an assessment of predation and disease threats, (4) an assessment of non-Federal programs that protect species and habitats, and (5) an assessment of natural or human induced factors that may cause future jeopardy after delisting.

Monarcha takatsukasae (Tinian monarch)

Description and Regulatory Status. In September 2004, the Tinian monarch (*Monarcha takatsukasae*) was removed from the Federal list of endangered and threatened wildlife (69 FR 65367). In cooperation with the Navy, CNMI DFW, the USGS, and the USDA, the USFWS is monitoring the Tinian monarch through the year 2010.

Life History and Ecology. The Tinian monarch inhabits a variety of forest types on Tinian, including native limestone forest (dominated by such species as *Ficus* spp., *Elaeocarpus joga*, *Mammaea ordata*, *Guamia mariannae*, *Cynometra ramiflora*, *Aglaia mariannensis*, *Premna obtusifolia*, *Pisonia grandis*, *O. mariannnensis*, *Neisosperma oppositifolia*, *Intsia bijuga*, *Melanolepis multiglandulosa*, *Eugenia* spp., *Pandanus* spp., *Artocarpus* spp., *and Hernandia* spp.), secondary vegetation (consisting of primarily *Acacia confusa*, *Albizia lebbeck*, *Casuarina equisetifolia, Cocos nucifera, and Delonix regia)*, and nearly monotypic stands of tangantangan (Engbing *et al.*, 1986; USFWS, 1996; USFWS, 2004b).

Tinian monarch home ranges are four to five times smaller in native limestone forest than in secondary forests or tangantangan thickets, which indicate that invertebrate prey species for the monarchs are more abundant in limestone forests. Although territories are denser in limestone forests and nest success appears to be greater (Lusk *et al.*, 2000; USFWS, 1996), Tinian monarchs are believed to benefit from the increase in both tangantangan thickets and secondary forests as a result of forest recovery.

Population Status and Distribution. The original decision to list the Tinian monarch was based on an estimate by Gleize (1945) of only 40 – 50 monarchs on Tinian shortly after World War II. In 1982, the USFWS found the Tinian monarch to be the second most abundant bird species, with a population estimate of 40,000 birds, distributed throughout the island and across all forested habitats. In 1995, the USFWS in subsequent surveys estimated the population at approximately 52,900 birds (USFWS, 2004b).

Threats. Threats to the Tinian monarch include reduction of available forest habitat and introduction of the brown tree snake. There are at least seven reported sightings of brown tree snakes from 1994 and 2004 on Tinian (USFWS, 2004b). As part of the long term monitoring of the Tinian monarch population, both of these major threat factors will be assessed through land use monitoring and bird surveys. If declines are shown in surveys scheduled in 2010, the species may be relisted by the USFWS.

3.11.2.5 Natural and Human-Induced Mortality within the MIRC Study Area

3.11.2.5.1 Natural Mortality

Natural mortality of terrestrial species within the MIRC Study Area is caused by a variety of natural events such as weather (storms, drought, wind), disease and parasites, old age, injury, and predation by native species.

Periodic Weather Events. Guam and the CNMI are regularly struck by typhoons, and typhoon frequency and severity are expected to increase with global climate change (Donnegan *et al.*, 2004). Based on records compiled by the U.S. Navy Joint Typhoon Warning Center, islands within the MIRC Study Area were affected by typhoons in 37 of the 50-year period between 1955 and 2005 (National Marine Forecast Center, 2005).

Forest systems on Guam and the CNMI are adapted to periodic perturbations from typhoons. A typhoon typically will leave a patch-work pattern of cleared areas in a forest, especially relatively higher and exposed areas. The emergent upper canopy layer is removed, allowing secondary species to quickly colonize a cleared area. These secondary species “nurse” emergent species into the upper canopy over time. This cycle is typically repeated over the entire landscape as typhoons approach from different orientations. The primary growth limestone forest of the northern portion of Guam was a tall, closed canopy forest dominated by very large *Artocarpus mariannensis*, and *Ficus prolixia* trees. In addition, several other species were probably well-represented throughout the plant community, *Eleocarpus joga, Instia bijunga, Neisosperma oppositifolia, Trisiropis obtusangula*, and *Pisonia grandis* (Fosberg, 1960). Throughout northern Guam, these species would have formed a nearly contiguous canopy 45 to 60 ft (13 to 18 m) tall. However, typhoon winds may blow down clusters of trees, making gaps in the forest canopy where understory vegetation could proliferate and seedlings of canopy species could germinate (Andersen AFB, 2003; Quinata, 1994). The modified forest that regenerated after typhoons was historically composed of a denser understory vegetation, including ferns, herbaceous vegetation, and small shrubby species (Quinata, 1994), which supported native bird and animal species. Some portions of northern Guam still contain forests that can be considered primary growth forest and typhoon-modified forest (Fosberg, 1960; Quinata, 1994). With the introduction of ungulates, invasive plant species, and removal of pollinator species (on Guam), the ability of forests to regenerate is greatly reduced after typhoon events.

Typhoon events can induce stress in listed fauna by reducing foraging opportunities, removing nest and roost trees, and through direct mortality associated with flying debris and high winds. Esselstyn *et al.* (2006) examined the abundance of Mariana fruit bats on Rota and Guam before and after Super Typhoon Pongees in December 2002. After the typhoon, bat abundance declined by 70 percent on Rota. On Guam, bat abundance initially increased by approximately 100 individuals (103%), perhaps due to immigration from Rota, but then declined an average of 32 percent from pre-typhoon levels for the remainder of 2003.

Disease and Parasites. Disease is not currently considered to be a significant factor in the decline of listed species within the MIRC Study Area (USFWS, 1990a; 1990b; 2004a; 2004b; 2005); however, a number of pathogens were identified in endemic birds. Avian pox (*Plasmodium* spp.) and Haemoproteus were found in bridled white-eye vireos from Saipan (Savidge, 1987). Salmonella species were reported in both native and introduced bird species on Guam, as well as *Candida tropicalis,* Newcastle's disease, and influenza virus (Savidge *et al.*, 1992). West Nile virus may pose a significant risk to listed bird species within the MIRC if the virus reaches the Pacific Rim, especially the Mariana crow (USFWS, 2005a), as corvid species are particularly susceptible to mortality and are experiencing serious declines in infected states on the U.S. mainland.

3.11.2.5.2 Human-Induced Mortality

Human-induced additive mortality occurs when factors cause mortality in a population in addition to natural mortality. These factors are either directly caused by human activity, such as poaching, or may indirectly result from human activities, such as habitat loss and degradation, artificial lighting, environmental contaminants, purposeful introductions of ungulates, accidental introductions of predators, and accidental introductions of wildlife diseases.

3.11.2.6 Poaching

Poaching is considered a direct threat primarily to Mariana fruit bats, sea turtles, and birds. Traditional hunting of Mariana fruit bats by native populations in the Mariana Islands, most notably Chamorro populations on Guam, were generally assumed to be sustainable, until the introduction and spread of fire arms after World War I (Wiles, 1994). Illegal hunting at the Pati Point fruit bat colony has not been noted in the last decade. However, opportunistic hunting of solitary bats roosting throughout Andersen AFB may occur in conjunction with legal hunting and illegal poaching of feral ungulates (Brooke, 2006).

Poaching of Mariana fruit bats are generally viewed as a threat on Guam and Rota, especially after typhoon events when bats may be dispersed to areas with higher human populations. Poaching of sea turtles occurs on all inhabited islands with suitable nesting habitat. Conversely, the restriction of access to FDM is one reason attributed to the success of seabirds and the Mariana megapode on the island.

3.11.2.7 Ungulate Introductions

Invasive ungulate species greatly reduce growth of native limestone woody species into the upper canopy, thereby altering forest composition and structure. For example, in 2005, Wiles identified ungulate pressure as the major factor for inhibiting recruitment of the native breadfruit (*Artocarpus mariannensis*) tree (Wiles, 2005). Wiles documented a decrease in *A. mariannensis* trees within a portion of Andersen AFB from 549 individual trees in 1989, to 190 trees in 1999, a 65.4 percent decrease. In the same study area, ungulate densities are reported to be 462 Philippine deer per square mile (183 Philippine deer per square kilometer), and 38 feral pigs (*Sus scrofa*) per square kilometer (Knutson and Vogt, 2002). Other declining native trees in secondary forests due to lack of recruitment include the S*erianthes nelsonii, Elaeocarpus joga, Heritiera longipetiolata, Pisonia grandis, Barringtonia asiatica, Tristiropsis obtusangula, and Instia bijuga* (Wiles *et al.*, 1995; Wiles, 2005). Ungulates found on CNMI islands include deer on Guam and Rota and goats on Tinian and Aguigan. Pigs are found on all islands within the MIRC Study Area, except for FDM.

3.11.2.8 Exotic Predator Introductions

Brown tree snake predation is believed to be the primary factor in the decline of the Mariana crow, Guam Micronesian kingfisher, and Guam rail (Wiles *et al.*, 2003), along with the rest of the now-extinct or extirpated avifauna of Guam. Brown tree snake predation on juvenile Mariana fruit bats may also be an important factor in the poor recruitment of this species on Guam (Wiles, 1987; USFWS, 2005b). Wiles (1987a) observed saliva, presumed to be from a brown tree snake, on a dead baby Mariana fruit bat, and one report of a snake discovered with three small fruit bats in its stomach.

Snake densities on Andersen AFB and DoN lands are not known specifically. However, density estimates for snakes over 31 in. (80 cm) snout-vent length in tangantangan scrub forest on Guam range from nine to 26 snakes per acre (20 to 60 snakes per hectare), while densities in grassland, ravine forest, or native forest vegetation types range from four to nine snakes per acre (10 to 20 snakes per hectare) (Rodda *et al*., 1997; Rodda and Savidge, 2007). Guam is now a source population of brown tree snake. One brown tree snake was discovered on nearby Rota in October 1991, but no snakes have been noted on Rota since the 1991 observation. Saipan and Tinian may support brown-tree snake populations, as sightings in shipments and in the wild have increased through the 1990s and early 2000s (Colvin *et al.*, 2005; Frits and Leasman-Tanner, 2001). More recently, a reliable sighting was reported from Saipan in April 2008 (Brooke, 2008).

Other predators on native species include monitor lizards, feral cats, dogs, and rats. Predation of Guam rails by feral cats was found to be a problem on Rota and Guam (Beauprez and Brock, 1999a, b). Reintroduction efforts in Area 50 and the Munitions Storage Area at Andersen AFB all determined that cat predation was a major limiting factor to recovery efforts on Guam (Beauprez and Brock, 1999b). Various species of rats are a major obstacle to recovery of species on Pacific Islands (Atkinson, 1985), although brown tree snake may keep rat numbers reasonably low in forested areas as shown by the relatively high numbers of rats on snake-free Cocos Island. Wiles (1998) reports four species of the Muridae family (Old World rats and mice) on Guam: the Polynesian rat, roof rat, Norway rat, and the common house mouse.

3.11.2.9 Exotic Pest Introductions

Numerous exotic pests have been introduced to the Mariana Islands which either directly affected listed species populations or indirectly affected listed species by reducing habitat quality. The giant African snail (*Achatina fulica*) was introduced to the CNMI under the Japanese mandate sometime between 1936 and 1938 (Mead and Kondo, 1949), and to Guam in 1943 in a Japanese agricultural shipment from Rota (Mead, 1961). The giant African snail was a purposeful introduction to provide a high protein food source for local inhabitants and for the later Japanese military presence (Mead, 1961), and caused widespread damage to the Guam and CNMI agricultural sector. The subsequent introductions after World War II of the Manikowar flatworm (*Platydemus manokwari*) and the rosy wolfsnail (*Euglandia rosea*) were intended to remove or reduce the impact of the giant African snail on Guam and CNMI agriculture. As effective predators, these introduced pest species are recognized as primary threats to land snails in the Pacific (Hopper and Smith, 1992; Cowie, 2006), and are largely responsible for reducing Partulid populations on Guam and CNMI (USFWS, 2005c,d). Extinctions of other Partulid snails in French Polynesia, as well as marked declines of endemic land snail faunas of Hawaii and Mauritius, have been attributed to the rosy wolfsnail.

The Asian cycad scale (*Aulacaspis yasumatsui*), first observed on Guam in late 2003, is an example of an unintended pest introduction to Guam, and has impacted *Cycas micronesica*, a dominant mid-level canopy tree of limestone forests (Moore *et al.*, 2005). The tree is an important food source for the Mariana fruit bat. In areas infested within Andersen AFB, mortality of *Cycas. micronesica* stands can be 100 percent (Lawrence, 2006). In 2007, scale was found at two locations on Rota. A biocontrol program is in effect, using a species of beetle, to manage scale infestations (Moore *et al.*, 2005). There are no surviving juvenile cycads and no recruitment of seedlings due to scale infestation.

More recently, the coconut rhinoceros beetle, *Oryctes rhinoceros*, was first detected on Guam in the Tumon Bay area on September 12, 2007. This large scarab beetle is a serious pest of palm trees, including coconut and betelnut, and also *Pandanus* spp., which is an important component of secondary forests, as well as understory and margins of intact limestone forests. An eradication program has been implemented in 2007, managed under the Incidental Command System with NAVFACMAR as a participating entity (Grimm, 2008). With no known predators on Guam, a quarantine order was enacted on October 5, 2007, to prevent the spread of the beetle out of the Tumon Area. The quarantine order prohibits the transport of all species of palm trees, pandanus, pineapple and banana trees (and seedlings), logs, composting material and other ditritus which could harbor the pest (Guam Department of Agriculture, 2007). A coconut rhinoceros beetle detection was also reported from Saipan within a seaport warehouse in September of 2006 (Moore *et al.,* 2005). The beetle is native to Southern Asia and distributed throughout Asia and the Western Pacific including Sri Lanka, Upolu, Western Samoa, American Samoa, Palau Islands, New Britain, West Irian, New Ireland, Pak Island and Manus Island (New Guinea), Fiji, Cocos (Keeling) Islands, Mauritius, and Reunion. The most likely method of introduction onto Guam was as a hitchhiker with construction material from the Philippines (Moore *et al., 2005*).

3.11.2.10 Invasive Plant Species

The island environments within the MIRC have been and will continue to be susceptible to introductions of invasive plant species. Invasive plant species cause degradation of habitats essential to native vegetation and wildlife by altering species composition and structure and promote wildland fires. Some examples of the invasive plant species within MIRC terrestrial environments include vine species such as alalag (*Operculina ventricosa*), and chain-of-love (*Antigonon leptopus*), and vine scarlet gourd (*Coccinia grandis*). Vine species tend to cover trees and other native vegetation so intensely that the understory vegetation is deprived of sunlight. Species found in relatively open herbaceous areas include lantana (*Lantana* spp.) and Siam weed (*Chromolaena odorata*). Notable examples of species that invade forested areas include tangantangan, papaya, *Triphasia trifolia*, and *Vitex parviflora*.

3.11.3 Environmental Consequences

3.11.3.1 No Action Alternative

3.11.3.1.1 Aircraft Overflights

Overview. Various types of fixed-wing aircraft and helicopters are used in training exercises throughout the MIRC Study Area (see Chapter 2). These aircraft overflights would produce airborne noise and some of this energy would be transmitted onto land. Terrestrial species could be exposed to noise associated with subsonic and supersonic fixed-wing aircraft overflights and helicopter training activities (see Section 3.5 [Noise Environment] for a description of the existing noise environment). In addition to sound, terrestrial species could react to the shadow of a low-flying aircraft and/or, in the case of helicopters, surface disturbance from the downdraft.

Wildlife exposure to fixed-wing aircraft noise would be brief (seconds) as an aircraft quickly passes overhead. Longer exposures would be expected near airfields (Andersen AFB). Exposures in other areas would be infrequent based on the transitory and dispersed nature of the overflights; repeated exposure of individual animals over a short period of time (hours or days) is extremely unlikely. Furthermore, the sound exposure levels would be relatively low. Animals could be exposed to noise levels ranging from just above ambient to approximately 97 dBA (based on an F/A-18E/F at 2,000 ft [610 m] above surface level, at 360 knots indicated air speed). However, most sound exposure levels would be lower than 97 dBA (less than 91.3 dBA for subsonic and less than 116 dBA for supersonic at the sea surface) because a majority of the subsonic overflights would occur above 3,000 ft (914 m) and supersonic flights would occur above 30,000 ft (9,144 m).

Unlike fixed-wing aircraft, helicopter training activities often occur at low altitudes (75 to 100 ft [23 to 30 m]), which increases the likelihood that animals would respond to helicopter overflights. In addition, some studies have suggested that animals respond more to disturbance from helicopters than from that of fixed-wing aircraft (Plumpton, 2006). Noise from low-altitude helicopter overflights would be expected to elicit short-term behavioral or physiological responses (*e.g.*, alert response, startle response, temporary increase in heart rate). Repeated exposure of individual animals or groups of animals (nesting colonies or bat roosts) is unlikely based on the dispersed nature of the overflights. The general health of individual animals would not be compromised.

Aircraft overflights are relevant to the following areas within the MIRC: (1) Andersen AFB (helicopters, fixed wing), (2) Ordnance Annex (helicopters), (3) Tinian MLA (helicopters), and (4) FDM (helicopters, fixed wing).

Andersen AFB. Aircraft training activities of the No Action Alternative for biological effects to listed species were analyzed on a prior consultation with USFWS and incorporated into the *Environmental Assessment, Beddown of Training and Support Initiatives at Northwest Field, Andersen AFB, Guam* (USAF, 2006) and the *EIS for the Establishment of ISR/Strike Capability at Andersen AFB, Guam* (USAF, 2007). The primary source of noise at Andersen AFB is from aircraft training activities at the main base airfield. During periods of no flying activity, noise results primarily from ground traffic movement, occasional construction, and similar sources. Noise sources in and around Northwest Field include surface traffic and other ground training activities.

Restrictions on flight altitude for air operations over Andersen AFB include: (1) limiting fixed-wing and helicopter overflights and landings at Northwest Field to the South Runway (6R/24L), (2) restricting fixed-wing and helicopter landing approaches and departures to straight in and out patterns aligned on the runway centerline extended out to 2 nm from the runway threshold, (3) prohibiting overflights north of Northwest Field’s South Runway below 1,600 MSL, and (4) prohibiting overflights within 3,000 ft (914 m) of Pati Point below 1,600 ft (487 m) MSL.

The south runway at Northwest Field is used for fixed-wing aircraft training activities and airmobile or airborne training activities, which include airdrop training at a drop zone on the eastern end of the runway. The north runway is used for helicopter practice landings. During periods of no flying activity, noise results primarily from bivouac and maneuver training by Army National Guard and Army Reserve personnel (Andersen AFB, 2000).

Aircraft training activities and ground training activities at Northwest Field are infrequent. Noise modeling for aircraft activities is not required by Air Force directives if the noise contours do not extend beyond the installation boundary, or if there are fewer than 10 jet or 25 propeller-driven aircraft activities per day. The level of aircraft activities at Northwest Field is well below these thresholds (Andersen AFB, 2000). The 4.6-mi (7.4-km) distance between the Main Base airfield and Northwest Field naturally attenuates aircraft-generated noise at the main base airfield. Existing ambient noise conditions at and around Northwest Field include aircraft overflight from main base activities, shotgun firing associated with the public hunting program, vehicle traffic on unimproved access roads, and thunderclaps during thunderstorms. The noise environment at Northwest Field and the immediately adjacent off-Base area is estimated to be typical for a quiet urban daytime (USAF, 2007).

Mariana fruit bats and Mariana crows are sensitive to human disturbances, and may be particularly sensitive to noise generated from aircraft (Morton, 1996). Aircraft overflights would occur over areas that contain suitable habitat for nesting and foraging. Morton (1996) demonstrated that Mariana crows react negatively to aircraft overflight noise and other human disturbances in some cases, but not always. Noise disturbance of the Mariana crow can cause distress in the birds, cause them to flush from the nest and disrupt nest building, incubation, and nest attendance at least temporarily. However, if the Mariana crow nests are abandoned due to disturbance or predation, the pairs generally attempt to re-nest (Morton, 1996). In addition, crows may respond to visual stimuli as well as noise stimuli (*e.g.*, aircraft outlines, pedestrians). Other studies demonstrate that birds are likely to hear loud noises (*e.g.*, sonic booms), and stop the activity in which they are engaged (Higgins, 1974), but a *Corvus* species study showed the birds rapidly returned to normal activities after the noise event (Davis, 1967).

There is some indication that Mariana crows can be tolerant of disturbances, much like related species of crows throughout the world. The fact that Morton (1996) observed some pairs renesting after nest disturbances may indicate their tenacity. This tolerance can lead to habituation of disturbances that are not threatening to the individuals. Habituation is a process many species of animals undergo to cope with or tolerate environmental stimuli inconsequential to their livelihood or well-being. Animals like those discussed in the Morton (1996) study responded to visual and acoustic stimuli potentially harmful to them. Typically, this is because of their innate predator-prey response mechanism, which causes an increase in alertness or flushing or fleeing from the impending threat. There are many studies showing that recurring events without consequence cause animals to eventually ignore those stimuli. Busnel (1978) observed that many species are able to habituate to noise disturbance. Andersen *et al.* (1989) concluded that Red-tailed hawks could have habituated to aircraft noise. Becker (2002) suspected roosting bald eagles were habituated to disturbances when exposed to a large industrial construction project. Delaney *et al.* (1999) found that endangered Mexican spotted owls become habituated to disturbances like chainsaw noise and helicopter noise. Observations of Mariana crows and Mariana fruit bats by Morton (1996) during aircraft flyover events demonstrated there were reactions in some cases where some observed individuals responded to the noise or visual stimuli and others did not. This could be due to the experience level of the animals, where resident crows or bats were habituated to the aircraft events, and non-resident or young were not accustomed to the intrusions.

Aircraft altitudes in areas where Mariana crows have established nests in the past (Morton 1996) would be 984 ft (300 m) AGL and greater. Noise modeling was accomplished to determine the maximum sound level at two of the 10 analysis points (*i.e.*, Pati Point and Tarague Channel) selected for noise analysis and four biological resources analysis points in the area north and northwest of the airfield where there is suitable habitat for Mariana crow nesting activities. Sound levels from noise modeling were compared to information from the Morton (1996) study to determine the potential for effect.

Based on noise modeling, the maximum sound level produced by any of the ISR/Strike aircraft would be 108 dBA by B-1 aircraft at Pati Point, and 87 dBA by F-22 aircraft at Tarague Channel. The maximum sound level at any of the four other points in the area north and northwest of the airfield would be 109 dBA from F-22 aircraft.

Noise modeling indicated that the maximum sound levels (L_{max}) produced under the Proposed Action (*i.e.*, 108 dBA by the B-1 aircraft at Pati Point) would be 2 dBA less than the maximum noise from the Morton (1996) study (*i.e.*, 110 dBA). Additionally, the maximum sound level at any of the four other points north and northwest of the airfield where the Mariana crow is known to occur would be 109 dBA, which is 1 dBA less than the Morton (1996) study. Noise from aircraft overflights did not cause nest abandonment for at least one pair of Mariana crows when aircraft were restricted to altitudes greater than 984 ft (300 m) AGL (Morton, 1996). Based on the similarities of the maximum noise levels and AGL when comparing the Morton (1996) study and the proposed action, Mariana crow reaction to noise would be expected to be similar or less than that found in the Morton study; that is, some crows might flush from the nest, while others show no negative effects. Additionally, there is a possibility that Mariana crows habituate to aircraft noise since there is no negative reinforcement to cause nest abandonment.

The majority of the Mariana fruit bat population on Guam is located in one colony at Pati Point below the north runway of Andersen AFB. No-Action flight training activities over this area account for 54 daily activities. In addition to the 1996 Morton noise study, Wiles (1991, 1993, and 1994) offers anecdotal observations of Mariana fruit bat behavioral responses to aircraft activities. As much as 42% of the colony at Pati Point flushed from their roosts and flew for approximately five minutes in response to heavy aircraft, such as B-1, C-5, C-141, KC-135, and Boeing 747 aircraft. Mariana fruit bats also respond to fighter craft engine noise (Wiles, 1991; 1994).

Andersen AFB has been an active airfield since 1945, and Mariana fruit bats at the Pati Point colony have been exposed to aircraft overflights, suggesting that fruit bats may be habituated to some degree to aircraft engine noise. However, episodic flushing of roosts also suggests that the Pati Point colony may be abandoned in the future as aircraft training activities of the No Action Alternative increase. Mariana fruit bats have abandoned the Pati Point colony in the past for various reasons and a former roost site may have been abandoned to the east of the current colony site in response to aircraft noise (Morton, 1996). Colony abandonment would potentially increase exposure of Mariana fruit bats to poaching on other sites on Guam or Rota.

Noise from aircraft overflights are expected to affect Mariana crow behavior and affect Mariana fruit bats under the No Action Alternative. Conservation measures to reduce, minimize, or avoid adverse effects to Mariana fruit bats and Mariana crows are discussed at the end of this subsection.

Ordnance Annex. Within the Ordnance Annex, Mariana fruit bats are also known to inhabit and forage in relatively intact forests, Mariana swiftlets inhabit three known caves, and Mariana common moorhens nest and forage at Fena Reservoir. Although no noise modeling has been accomplished within the Ordnance Annex, the noise stress to Mariana fruit bats is expected to be lower relative to portions of Andersen AFB. Temporary behavioral responses are expected from helicopter training activities, but no mortality of fruit bats would occur due to aircraft training activities. Since the previous 1999 consultation between the USFWS and the Navy, the Mariana swiftlet has colonized an additional third cave within the Ordnance Annex. The most recent survey at the three monitored caves provides the current population estimate of 800 to 900 birds (Brooke, 2007). Therefore, it is reasonable to assume that the swiftlet is able to expand its Guam population despite ongoing training within the Ordnance Annex. Moorhen numbers have declined at Fena Reservoir, which is most likely explained by the disappearance or reduction of hydrilla within the reservoir which benefited moorhens (Brooke, 2008).

Although aircraft overflights may cause temporary behavioral changes (cessation of foraging, calling, increased awareness) or even physiological stress, it is unlikely that such events would result in direct or indirect mortality.

Tinian MLA. Mariana fruit bats, Micronesian megapodes, Mariana moorhens, and Tinian monarchs are all species found within the EMUA and LBA on Tinian. Aircraft overflights are not expected to affect Mariana moorhens because the Hagoi area is not subject to disturbance from training activities. The Mariana fruit bat and Micronesian megapode, however may be affected by aircraft overflights. Noise events may induce temporary behavioral responses in these species; however, no direct mortality attributable to helicopter overflights would occur. Flight altitude restrictions for the Tinian MLA include: (1) maintaining an altitude of at least 1,000 ft (305 m) AGL over Hagoi, (2) avoiding flights over Mahalang and Beteha wetland areas, and (3) helicopter gunships remain at 1,000 ft (305) AGL, except in the immediate vicinity of designated helicopter landing zones.

No noise studies have been conducted on the Tinian monarch; however, noise studies have been conducted on the effects of military noise on similar species in the Pacific. VanderWerf (2000) studied the effects of military noise on the ‘elepaio (*Chasiempis sandwichensis),* another endangered Pacific flycatcher (Family *Monarachae*) with various subspecies on Oahu, Kauai, and Hawaii Island. ‘Elepaio on Oahu (*C. s. ibidis*) were studied for the effects of noise live-fire activities and helicopter overflights. VanderWerf concluded that noise associated with live-fire exercises and helicopter overflights do not adversely affect the ‘elepaio (VanderWerf, 2000). Therefore, Tinian monarchs may be affected by aircraft training activities, but no long-term impacts are expected that may necessitate the re-listing of this species due to aircraft overflights.

FDM. Helicopter and fixed wing overflights at FDM may also induce temporary behavioral responses to Micronesian megapodes. Megapodes on FDM may be habituated to these noise events, as FDM is under occasional high intensity bombardment and an estimated population of 42 birds persists on the island.

Summary. In summary, aircraft noise under the No Action Alternative could elicit short-term behavioral or physiological responses in exposed species. Helicopter overflights are more likely to elicit responses than fixed-wing aircraft, but the general health of individual animals would not be compromised. In accordance with NEPA, aircraft noise over territorial waters would have no significant impact on terrestrial species or habitats.

3.11.3.1.2 Explosive Ordnance and Practice Munitions

Under the No Action Alternative, land-based explosive ordnance training would occur at (1) Northwest Field, (2) Ordnance Annex, (3) within the EMUA on Tinian, and aerial delivery of ordnance training would occur at FDM.

Northwest Field. Mariana crows and Mariana fruit bats are known to nest, roost, or forage within the Northwest Field area. Under the No Action Alternative, Northwest Field training activities involve the use of ground burst simulations, smoke grenades, small arms blank ammunition, and 40-lb (18-kg) cratering charges. The 40-lb (18-kg) cratering charges are detonated in the same area along an existing taxiway of Northwest Field (one hardstand location), and scheduled to not exceed one cratering charge per 15-day period. The Mariana crow and Mariana fruit bat are expected to experience auditory disturbance during training activities that simulate combat. These activities within the Northwest Field are expected to affect the Mariana crows and Mariana fruit bats that are within the Northwest Field training areas; however, no mortality is expected resulting from the use of explosive ordnance and practice munitions. Conservation measures in place to reduce, minimize, or avoid adverse impacts are discussed at the end of this subsection.

Tinian MLA. Mariana fruit bats, Micronesian megapodes, Mariana moorhens, and Tinian monarchs are all species found within the EMUA and LBA portions of the Tinian MLA. Explosive noise events are not expected to affect Mariana moorhens because the Hagoi area is not subject to disturbance from training activities. The Mariana fruit bat and Micronesian megapode, however, may be affected by explosive noise and the use of practice munitions. Noise events may induce temporary behavioral responses in these species, similar to Northwest Field; however, no direct mortality would occur attributed to explosive noise events.

The VanderWerf (2000) study on the effects of military noise on the ‘elepaio (discussed above), analyzed explosive noise effects. ‘Elepaio on Oahu were studied for the effects of noise live-fire activities and helicopter overflights. VanderWerf concluded that noise associated with live fire exercises do not adversely affect the ‘elepaio (VanderWerf, 2000); however, indirect effects of wildland fires ignited by military training activities are a serious long-term threat to `elepaio and have reduced the amount of suitable habitat for the species, including areas designated as critical habitat for the O`ahu `elepaio at Schofield Barracks and Mākua Military Reservation (VanderWerf, 2000). Live-fire exercises on newly constructed ranges on Tinian may similarly affect Tinian monarchs within suitable habitats. Other noise studies related to behavioral responses to detonations have been conducted on the endangered red-cockaded woodpecker and the bald eagle. These studies indicate that impacts are minimal if the disturbance is a sufficient distance away and the species has previous exposure to the disturbance events (Delaney *et al.*, 1999). For example, Delaney *et al.* (1999) reported that red-cockaded woodpeckers on Fort Stewart, Georgia, did not flush from the nest when noise sources were 450 ft (150 m) away from the nest. Tinian monarchs may be affected by explosive detonations and use of practice munitions, but no long term impacts are expected that may necessitate the re-listing of this species due to episodic noise events associated with military training.

FDM. As shown in Table 2-8, the existing ordnance use at FDM includes the following:

- Bombs (HE) ≤ 500 lb: 400 rounds
- Bombs (HE) 750 / 1000 /2000 lb: 1,600 rounds
- Inert Bomb Training Rounds ≤ 2000 lb: 1,800 rounds
- Missiles [Maverick; Hellfire; TOW; Rockets ≤ 5 inch: 30 rockets
- Cannon Shells (20 or 25 mm): 16,500 rounds
- 5-inch Gun Shells: 400 rounds
- Small Arms [5.56mm; 7.62mm; .50 cal; 40mm]: 2,000 rounds.

Micronesian Megapode. Micronesian megapodes persist on FDM, despite the intensive use of the island as a live-fire range. Megapode densities in portions of the FDM no-fire zone are analogous to densities on other uninhabited islands considered to be refugia for this species, such as Sarigan and Guguan (NAVFACPAC, 2008a). The primary concern for megapodes on FDM is not behavioral responses to noise associated with explosions, but mortality associated with direct strikes. Megapodes may also be impacted by wildland fires ignited by explosive ordnance. Fruit bats on FDM would also be subject to potential direct strikes from explosive ordnance. The Navy is currently permitted by USFWS to take one megapode nest per year on FDM associated with direct strikes of munitions.

Vegetation Communities. Periodic typhoon events limit the stature of the vegetation on the raised and exposed plateau. Vegetation communities, although stunted, have recovered north of the “no fire line” (NAVPACFAC, 2008d) to a low to mid successional state. Height of vegetation within impact areas is smaller relative to vegetation north of the “no fire line.” Vegetation communities also recover in the high explosive impact area when usage of FDM is low. Explosive ordnance delivery at FDM will maintain a low to mid-successional state of the vegetation communities that persist on the island. Individual plants may be destroyed or incinerated by ordnance, and wildfires may impact vegetation on a community level. Photographs of vegetation community impacts and recovery are shown in Figure 3.11-10.

3.11.3.1.3 Bivouac and Land Navigation

Under the No Action Alternative, bivouac and land-based navigation training would occur within Northwest Field, Ordnance Annex, Orote Point, Finegayan Communications Annex, within the MLA on Tinian, and would occur during infrequent USAR training on non-DoD lands on Saipan. Fires are restricted to hardtop surfaces, such as airfields, during bivouac training. Bivouac activities and troop movements may induce temporary behavioral responses to Mariana fruit bats within the Northwest Field, Ordnance Annex, and within the EMUA and LBA areas of the Tinian MLA; Mariana crows within the Northwest Field, and Micronesian megapodes within the EMUA and LBA of the Tinian MLA. As megapodes are ground nesting birds, nest disturbance and mortality is a potential consequence of inadvertent trampling during troop movements. The Navy is currently permitted for one megapode nest to be taken per year during troop movements on Tinian.

3.11.3.1.4 Conservation Measures

The conservation measures that the Navy and Air Force have agreed to in prior consultations are still valid for MIRC training activities. These conservation measures are considered part of the No Action Alternative.

Existing Conservation Measures on Navy Lands: Land Use Constraints. The abundance of biological resources within terrestrial habitats within the MIRC Study Area requires that basic land use constraints be established in potentially sensitive areas. These constraints are readily depicted on training overlays to assist military training planners, matching training activities to training sites, and to limit maneuver or certain training activities as necessary. Prior consultations referenced "No Training" and "No Wildlife Disturbance Areas" on various Navy properties (Waterfront Annex, Ordnance Annex, and MLA on Tinian, as well as targeting restrictions on FDM). Some of the training constraints on these properties were not designated based on habitat and species distributions. The only training restrictions that meet ecological criteria and do not conflict with baseline current training activities include (1) the establishment of no training buffers around the three known swiftlet caves within the Ordnance Annex, and (2) the establishment of a no training buffer around Hagoi on Tinian within the MLA. Under the "No Training" land-use constraint, entry into the area is prohibited, except for specifically authorized troop and vehicle movements on existing designated trails.

Table 3.11-6: Andersen AFB Natural Resource Land Use Constraint Categories

Activity Limitations	No Wildlife Disturbance	No Training
No cross-country, off-road vehicle travel; vehicle parking permitted on cleared shoulders of existing roads and trails	X	X
No pyrotechnics	X	X
No demolitions	X	X
No digging or excavation without prior approval	X	X
No training demolition or breaching charges	X	X
No open fires	X	X
No mechanical vegetation clearing	X	X
No live ammunition	X	X
No firing blanks	X	X
No flights below 1,000 ft (305 m) above ground level	X	X
No helicopter landings, except in designated landing zones	X	X
No entry or training whatsoever, except specifically authorized administrative troop and vehicle movement on designated trails		X

Existing Conservation Measures on Andersen AFB. The conservation measures developed by the Air Force were designed to compensate and minimize the potential impacts from implementation and operation of the ISR/Strike action to the Mariana fruit bat, Mariana crow, Micronesian kingfisher, and the Guam rail. The conservation measures correspond to recovery actions outlined in various USFWS recovery plans for these species. Overall goals of the conservation measures contribute to important habitat and species management objectives on Guam, and may be grouped into the following categories: (1) habitat improvement measures, (2) studies and research, (3) brown tree snake interdiction and control, and (4) adaptive management and avoidance/minimization measures. These measures are shown on Figure 3.11-12.

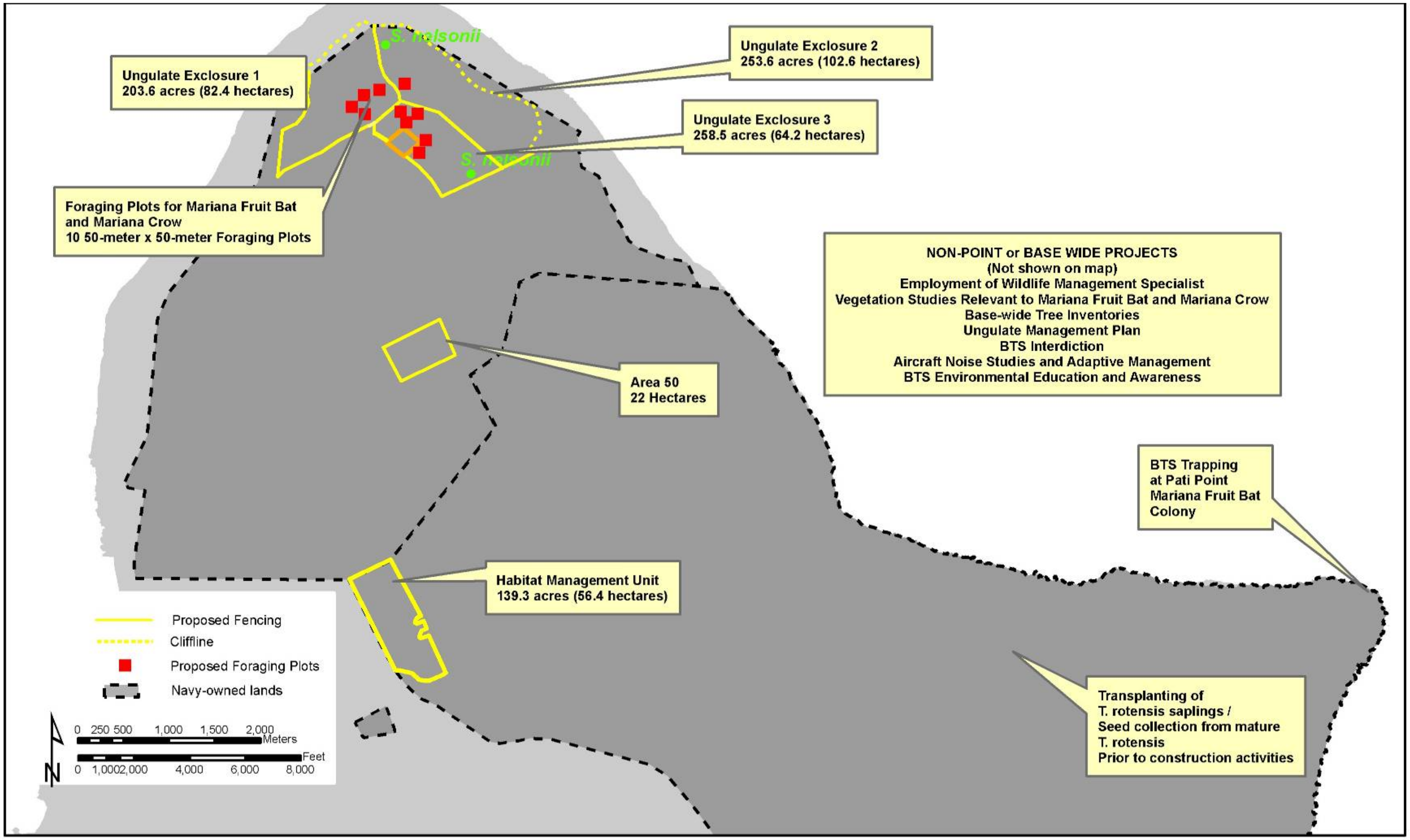

Figure 3.11-12: Conservation Measures on Andersen AFB

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3.11.3.2 Alternative 1

3.11.3.2.1 All Stressors

Under Alternative 1, no new training activities in terrestrial habitats that may affect species, relative to the No Action Alternative, would occur; however, the number of training activities would increase (Table 2-7 and Table 2-8). Training activities within Northwest Field and aircraft overflights impacting the Pati Point Mariana fruit bat colony would not increase over the thresholds analyzed as part of the No Action Alternative. The increase in training activities associated with Alternative 1 is the subject of training activities included in Section 7 consultation with the USFWS Pacific Islands Field Office.

The three plant species (*Nesogenes rotensis*, *Osmoxylon mariannense*, and *Serianthes nelsonii*) considered for analysis are not expected to be affected by increased training activities. The Mariana common moorhen may be affected by the increase in training; however, the effects are not expected to reach the threshold for take. Mariana common moorhens may experience temporary behavioral responses during aircraft overflights, most notably at Fena Reservoir. Mariana swiftlets and Mariana common moorhens within the Ordnance Annex may also experience behavioral changes, but are expected to be temporary resulting in harassment or harm. In addition, the two remaining male Mariana crows within the MSA area of Andersen AFB, Nightingale reed warblers, and Rota bridled white-eyes are not expected to be affected by the increase in training activities, as training will not occur in areas occupied by these species. The Guam rail and the Micronesian kingfisher are extirpated from Guam and by consequence, the MIRC Study Area. Effects for these two species were evaluated against the potential for the increased training activities to affect future recovery efforts. MIRC associated training activities will not affect these efforts, which primarily concern future re-introductions within Area 50 on the Northwest Field portion of Andersen AFB.

3.11.3.2.2 Conservation Measures

The Navy proposes to include the following additional conservation measures to minimize, avoid, or offset adverse effects associated with the proposed increase in training activities as part of Alternative 1. The conservation measures outlined below would supplement existing conservation measures described in Section 3.11.1 for the No Action Alternative.

BTS Conservation Measures. The ongoing Section 7 ESA consultation discussions between the Navy and USFWS for activities associated with this EIS/OEIS will result in a Brown Treesnake procedures plan specific to MIRC activities. Both the Navy and USFWS agree that brown treesnake-specific conservation measures are necessary for the additional training levels. Increases in multiple large and small unit level training activities may increase the risk of unintentional transport and introduction of brown treesnake to CNMI terrestrial habitats and unintentional transport and introductions to sites outside of the MIRC, such as the Hawaiian Islands. Training activities that present potential brown treesnake introduction pathways include amphibious assaults and raids, MOUT, and other activities that require cargo or personnel to move through Guam to other MIRC training locations within the MIRC. The Navy, working in partnership with the USFWS, and USDA –Wildlife Services (USDA-WS) and Animal and Plant Health Inspection Service (APHIS) will decide how best to implement the Brown Treesnake Control Plan relevant to MIRC activities. The Navy strategy will involve three components: (1) avoidance, (2) minimization, and (3) offsetting measures. Specific aspects of these strategies are still in development and will be included in the USFWS Biological Opinion; however, the overall strategies are outlined below:

- *100% Interdiction:* The Navy is committed to implementing 100 percent inspection of all outgoing vessels and aircraft with dog detection teams, which could be supplemented by other pest control expertise (with appropriate USDA-Wildlife Service brown treesnake detection training and oversight) to meet 100 percent inspection goals for large scale training activities.

- *BTS Minimization Measures:* The Navy will support actions to assist with rapid response to brown treesnake sighting within the CNMI and locations outside of the MIRC, specifically Hawaii.
- *BTS Offsetting Measures:* The Navy will fund additional project within the BTS Control Plan.
- *BTS awareness training for all personnel involved in training activities.*

Ungulate Management Planning on Navy Lands. An ungulate management plan and an Environmental Assessment currently in development that will provide a long-term program and methods for a sustained reduction of ungulates on Navy lands (Brooke, 2007).

Rat eradication on FDM. The rodenticide diphacinone has recently been approved for field use by USEPA for rat eradications. Successful rat eradications on pacific islands have been accomplished on Mokapu (off Molokai), Campbell Island (New Zealand), and San Jorge (Solomon Islands), as well as successful application within portions of Hawaii Volcanoes National Park. Given the small size of FDM, island wide eradication is possible (NAVFACPAC, 2008a). This action will provide direct benefits to nesting seabirds (eggs and nesting substrate) and indirect benefits to Micronesian megapodes by increasing vegetation on certain portions of the island.

Quarterly seabird population monitoring at FDM. The Navy proposes to conduct quarterly surveys using the same protocols as the monthly monitoring surveys for seabirds and other resources at FDM (aerial surveys). NAVFACPAC biologists have over 10 years of monitoring data at FDM for seabird populations on FDM, which show no significant changes in the population indices. Therefore, the Navy concludes that quarterly monitoring of FDM seabird populations would be sufficient to meet monitoring goals at FDM.

Life History Studies of the Micronesian megapode. The Navy proposes to conduct a study on the Micronesian megapode life history on Tinian and Sarigan.

Fire management on Navy lands within the MIRC. The Navy is developing fire management protocols for training activities within the MIRC.

Maintain buffers around sensitive ecological features. The Navy will maintain already identified buffers around such features as Mariana swiftlet caves and wetland areas. The intent of the buffers is to protect ecological resources from potential impacts associated with training activities, while not interfering with facility operations.

3.11.3.3 Alternative 2

3.11.3.3.1 All Stressors

As detailed in Chapter 2 and Table 2-6, implementation of Alternative 2 would include all the actions proposed for MIRC, including the No Action Alternative and Alternative 1, and additional major exercises.

The stressors that would increase by implementing Alternative 2 would include an increase in explosive munitions use on FDM, as well as aircraft training activities within the Ordnance Annex, Tinian MLA, and FDM.

Terrestrial species would be affected by the increases in exposure to the various stressors considered for analysis; however, mitigation measures will reduce the likelihood of significant impacts. In accordance with NEPA, the increased exposure to stressors will have no significant impact on terrestrial natural resources under Alternative 2 relative to that of Alternative 1.

3.11.3.3.2 Conservation Measures

Conservation measures for Alternative 2 are the same as for Alternative 1. It should be noted that the interdiction regime currently managed by USDA-WS would likely not meet inspection goals outlined in the Draft Brown Treesnake Control Plan (Brown Treesnake Technical Working Group, 2008) during major exercises proposed under Alternative 2.

3.11.4 Unavoidable Significant Environmental Effects

The analysis presented above indicates that Alternatives 1 and 2 would necessitate a modification of existing take permits from the No Action Alternative. Other than the modification of the take thresholds, the No-Action and Action Alternatives would not result in unavoidable significant environmental effects.

3.11.5 Summary of Environmental Effects

3.11.5.1 Endangered Species Act

The Navy is consulting with USFWS regarding its determination of effect for Federally listed terrestrial species. The analyses presented above indicate that Alternative 1 (Preferred Alternative) and Alternative 2 may affect ESA-listed animal species in the MIRC Study Area. ESA-listed plant species are not expected to be affected. Training activities will not result in the adverse modification of critical habitat designations on Guam or Rota. Table 3.11-7 is a summary table of effects for each species considered for analysis.

Table 3.11-7: Summary of Effects to ESA-Listed Species

Scientific Name	English Name	Effects Determination
Plants		
Nesogenes rotensis	-	No Effect
Osmoxylon mariannense	-	No Effect
Serianthes nelsonii	Fire tree	No Effect
Birds		
Acrocephalus luscinia	Nightingale reed-warbler	No Effect
Aerodramus bartschi	Mariana swiftlet	May Affect
Corvus kubaryi	Mariana crow	May Affect
Gallinula chloropus guami	Mariana common moorhen	May Affect
Halcyon cinnamomina cinnamomina	Micronesian kingfisher (Guam subspecies)	No Effect
Megapodius laperous	Micronesian megapode	May Affect
Rallus owstoni	Guam rail	No Effect
Zosterops rotensis	Rota bridled white-eye	No Effect
Mammals		
Pteropus mariannus mariannus	Mariana fruit bat	May Affect

3.11.5.2 National Environmental Policy Act and Executive Order 12114

As summarized in Table 3.11-8, the No Action Alternative would have no significant impact on terrestrial species and habitats in accordance with NEPA; however, implementation of the Action Alternatives would necessitate the modification of existing incidental take permits. Furthermore, EO 12114 is not applicable because by definition, terrestrial species occur in terrestrial habitats and not in open ocean outside the 12 nm (22.2 km) limit.

Table 3.11-8: Summary of Environmental Effects of the Alternatives on Terrestrial Species and Habitats in the MIRC Study Area

Summary of Effects and Impact Conclusion		
Alternative and Stressor	**NEPA (Land and Territorial Waters, 0 to 12 nm [0 to 22.2 km])**	**Executive Order 12114 (Non-Territorial Waters, >12 nm [22.2 km])**
No Action Alternative, Alternative 1, and Alternative 2		
Aircraft Overflights	Potential exposure to aircraft noise inducing short-term behavior changes. Mariana fruit bats may be harassed to the point of abandoning Pati Point Colony due to aircraft training activities at Andersen AFB. No adverse modifications to critical habitat designations on Guam or Rota.	Not Applicable.
Weapons Firing/Non-Explosive Ordnance / Explosive Ordnance Use	Short-term behavioral responses from weapons firing and explosive ordnance use on FDM. Possible direct mortality to Micronesian megapodes south of the no fire line on FDM. Vegetation on FDM will maintain low to mid-successional stature. No adverse modifications to critical habitat designations on Guam or Rota.	Not Applicable.
Land-based Movements	Potential for short-term behavioral responses. Potential for nest mortality of Micronesian megapodes on Tinian. No adverse modifications to critical habitat designations on Guam or Rota.	Not Applicable.
Impact Conclusion	The Navy and other Services have entered into various Section 7 ESA consultations to minimize adverse impacts to listed species considered in the No Action Alternative, Alternative 1, and Alternative 2. No significant impact to critical habitat designations on Guam or Rota. No significant impact to vegetation communities.	Not Applicable.

3.12 LAND USE

3.12.1 Introduction and Methods

Land use is the classification of either natural or human-modified activities occurring at a given location. It is the policy of the Navy to observe every possible precaution in the planning and execution of all training activities that occur onshore or offshore to prevent injury to people or damage to property (DoN 2006a).

3.12.1.1 Regulatory Framework

Section 3.12 was prepared in accordance with the National Environmental Policy Act (NEPA) and Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*, as described in Chapter 1. Territory and Commonwealths' jurisdictional boundaries extend 3 nm offshore (OC 2004). Impacts of training evaluated under NEPA are further distinguished by state regulatory authorities where applicable.

Congress ceded title to the submerged lands to the governments of Guam, the Virgin Islands, and American Samoa under Public Law 93–435, § 1, Oct. 5, 1974 (LII 2008). Presidential Proclamation 4347 (Feb. 1, 1975) exempted some submerged lands from being returned to the government of Guam, including submerged land of inner and outer Apra Harbor (Woolley and Peters unknown). U.S. Code (USC) Title 48 § 1705 [2006] describes submerged land whose jurisdiction has remained under the United States (LII 2008).

The United States acquired rights to submerged lands of the Commonwealth of the Northern Mariana Islands (CNMI) pursuant to Article I, § 101 of *The Covenant to Establish a Commonwealth of the Northern Mariana Islands* (*CNMI v. U.S*, 2002). The jurisdiction over submerged lands has been disputed in the past, but in *CNMI v U.S.* (2002) it was concluded that "The United States possesses paramount rights in and powers over the waters extending seaward of the ordinary water mark on the Commonwealth coast and the lands, minerals and other things of value underlying the waters…"

3.12.1.2 Assessment Methods and Data Used

The assessment of land use in the Mariana Islands Range Complex (MIRC) was conducted by reviewing available literature including previously published NEPA documents for actions in the MIRC and surrounding area. In addition, integrated natural resources management plans and integrated cultural resource management plans were reviewed. Additional research obtained from the MIRC Range Complex Management Plan provided information regarding the real estate and agreements, range infrastructure, and affected environment.

3.12.1.3 Warfare Areas and Associated Environmental Stressors

Impacts to land use are assessed in terms of a Proposed Action's compatibility with existing land use and continued consistency with existing land use plans and policies. Land use impacts would be considered significant if implementation of the Proposed Action would result in:

- Inconsistent or noncompliant use of the area with applicable land use plans and policies;
- Affected viability of the land use, changed continued use or occupation of the area; or
- Incompatibility with adjacent land uses to the extent that public health or safety is threatened.

Stressors were reviewed by conducting a detailed analysis of the warfare areas, training, and specific activities affecting land use that were included in the alternatives. There were no stressors identified that would be expected to potentially impact land use activities.

3.12.2 Affected Environment

The Mariana Islands geographic region offers prime strategic locations for military installations, ranges, and training areas. Guam, a U.S. territory located in the Western Pacific (WestPac), is the southernmost and largest island of the Mariana Islands archipelago. It is situated approximately 3,700 miles (mi.) west-southwest of Hawaii and 1,560 mi. southeast of Japan. The island is approximately 30 mi. long by 4 to 8 mi. wide. Guam has had a U.S. military presence since the 1898 Spanish-American War, except during the World War II Japanese occupation. The Japanese invaded and occupied Guam on December 10, 1941. The U.S. liberation commenced on July 21, 1944 with the island declared secure on August 10, 1944. U.S. military forces invaded Saipan on June 15 and Tinian on August 24 of the same year.

The United States developed major air bases on all three islands. These air bases served as launching points for World War II bombing raids on Japan. During the Korean War and Vietnam War, the United States. sent additional air forces to Guam to conduct long-distance reconnaissance and combat missions. During the Vietnam War, B-52 Stratofortresses launched a series of heavy bombing campaigns from the island to include support of the Marine Corps' Operation Harvest Moon, and Linebacker I and II. To keep a strong presence in the Pacific and Asia, the U.S. military has continued to maintain several bases on Guam. The bases currently have fewer permanently stationed personnel than in the past and primarily perform supporting roles for transient military forces deployed to the Pacific Theater for training and contingency activities. Personnel, force structure, and training are anticipated to increase through the year 2014.

The Air Force (36th Wing) and the Navy (Naval Forces Marianas) both operate bases on Guam that include under-developed areas for training, weapons training ranges, ordnance storage, training facilities, and fuel storage and distribution. Military property comprises approximately 29 percent of Guam's land area. A major initiative affecting the military use of Guam land is the Guam Land Use Plan Update (GLUP '94) published in June 1995. The plan reviewed all Department of Defense (DoD) land requirements on Guam, considered the rationale for military holdings, combined the Military Services' use of real property, and the environmental effects of military land use. The plan identified 8,081 acres of land that are considered releasable to the Government of Guam (GovGuam) and another 126 acres as potentially releasable. Obtaining development controls was recommended for approximately 133 acres.

The Base Realignment and Closure (BRAC) program has also affected military lands on Guam. BRAC is a Congressional program that has decreased the number of bases operated by the U.S. military at home and abroad. The former Naval Air Station (NAS) Agana was closed in 1995 as a result of a BRAC recommendation. The NAS lands were transferred or leased to the GovGuam or other government agencies. As a result of BRAC 1995, business reuse plans were also prepared for the former U.S. Naval Ship Repair Facility (SRF) and the Navy transferred the SRF equipment and facilities in Apra Harbor to the GovGuam. The GovGuam awarded the shipyard a 10-year lease with a 5-year renewable option to operate as a private ship-repair facility.

The U.S. military also used Guam in recent years to support humanitarian missions in the region; to include the Pacific Partnership in 2007, the USNS Mercy Deployments to the WestPac and Southeast Asia, USS Boxer Amphibious Ready Group Missions in East Timor, Operation United Assistance, and many other activities through the Asia Pacific Regional Initiative.

The U.S. military does not have permanently stationed personnel on any island of the CNMI. Lands for military training are leased from CNMI. These training lands include approximately the northern two thirds of Tinian Island (the Military Leased Area or [MLA]) and all of Farallon de Medinilla (FDM) island. The MLA on Tinian is split into the Exclusive Military Use Area (EMUA) on the northern third of Tinian, and the Lease Back Area (LBA) on the center third of Tinian. On Tinian, use of military land is affected by the terms of various lease agreements and the allocation of a portion of the EMUA to the Voice of America—International Broadcasting Bureau (VoA-IBB) for its transmitting facility. Certain exercise maneuver training is permitted in the LBA, provided that the U.S. military notify CNMI Government in writing prior to a given exercise. Training on the VOA-IBB parcel is not permitted, to ensure military personnel and activities do not disturb the antenna fields (DoN 2005a).

FDM is used for live-fire and inert ordnance training. No maneuver training is permitted on FDM and personnel may not land on FDM without permission of Commander, United States Naval Forces Marianas (COMNAVMAR) and without an escort by COMNAVMAR Explosive Ordnance Disposal (EOD) personnel.

3.12.2.1 Navy Lands on Guam

The island of Guam is strategically located at the boundary between the Pacific Ocean and the Philippine Sea, central to some of the most militarily strategic areas of the WestPac and Asia. Commander Navy Region (COMNAVREG) Marianas has jurisdiction or control of roughly 17,808 acres of land in noncontiguous properties on Guam. Since 1990, the Navy on Guam has reorganized to meet military operating requirements. Eight separate command installations were reorganized into a single COMNAVREG Marianas. Prior to reorganization, Navy-owned lands included Naval Station (NAVSTA), Guam; Naval Magazine (NAVMAG), Guam; Naval SRF, Guam; Public Works Center (PWC), Guam; Fleet and Industrial Supply Center (FISC), Guam; NAS, Agana; Naval Hospital, Guam; and Naval Communications Area Master Station (NCTAMS), WestPac. Reorganization created five properties under COMNAVREG Marianas control. These incorporate the previous commands except for the Naval SRF, which was officially closed in 1997, and NAS, Agana, which was closed in 1995. The Navy consolidated the remaining Navy-retained lands into five annexes: Main Base (which includes Tenjo Vista and Sasa Valley Tank Farms); Ordnance Annex; Hospital Annex/Nimitz Hill; Communications Annex, Finegayan; and Communications Annex, Barrigada.

3.12.2.1.1 Main Base

Main Base. The Main Base at Apra Harbor covers approximately 6,200 acres. Main Base is the site of headquarters for supply, maintenance, public works, housing, and operational commands. It incorporates landholdings of the former NAVSTA, Guam and PWC, and the portion of FISC that included administrative offices and wharves. Main Base also encompasses Camp Covington. Main Base lies along the southern and inland sides of Apra Harbor, which is divided into inner and outer harbors. Inner Harbor, which includes about 650 acres, is situated in the southeastern portion of the embayment. The mouth of Inner Harbor is defined by the eastern end of Orote Peninsula and Polaris Point. The Outer Harbor is formed by Cabras Island and the 2.8-mile long Glass breakwater on the north and northern shore of Orote Peninsula. Orote Peninsula, which forms the southern edge of Apra Harbor, comprises about 860 acres of the Main Base. It contains personnel housing, administration, and maintenance, ordnance, and support facilities. Firing ranges and an ammunition wharf (Kilo Wharf) are located on Orote Peninsula.

Tenjo Vista and Sasa Valley. Tenjo Vista and Sasa Valley Tank Farms are former FISC holdings inland of Apra Harbor and east of Marine Drive covering approximately 400 acres. The Navy maintains fuel storage facilities consisting of 27 underground tanks in these two areas. A small portion of this area is also used for petroleum, oil, and lubricant (POL) storage. FISC now operates as the COMNAVREG Marianas Supply Department.

3.12.2.1.2 Ordnance Annex

The Ordnance Annex is the former Naval Magazine, Guam. It is the largest installation on Guam, located on mountainous terrain in south-central Guam. The Ordnance Annex includes approximately 8,840 acres, of which 75 percent is defined as explosives safety zones. The Ordnance Annex is the westernmost ammunition supply point on U.S. territorial soil and a vital link in the ammunition logistics system supporting the Seventh Fleet. Located within the Ordnance Annex is the Fena Dam, which was built in 1951 by the Navy. The Fena Reservoir is the largest freshwater body of water on Guam with a maximum storage capacity of about 7,500 acre-feet. The protected watershed of the Fena Reservoir takes up about half of the total Ordnance Annex area.

3.12.2.1.3 Hospital Annex/Nimitz Hill

The Hospital Annex and Nimitz Hill occupy two land parcels that are centrally located on the island, between the Main Base and the capital city of Agana (Hagatña). The Hospital Annex incorporates the lands of the former Naval Hospital, Guam. It is the site of a 250,000-square-ft (ft^2) hospital and related facilities. The installation includes two neighborhoods for officer and enlisted family housing and community support facilities. The Hospital Annex operates as a tenant of COMNAVREG Marianas. Nimitz Hill encompasses slightly less than 400 acres east of Apra Harbor, on and around a high limestone ridge. Nimitz Hill is used primarily for officer housing.

3.12.2.1.4 Communications Annex, Finegayan

The Communications Annex, Finegayan, is part of the former Naval Communications Area Master Station, WestPac, now operating as the Naval Computers and Telecommunications Station (NCTS). The Communications Annex, Finegayan, is operated under a tenant arrangement with COMNAVREG Marianas.

Finegayan, which covers approximately 2,952 acres, comprises two land parcels located on the northwestern cliff line of the island. The northern parcel is used to support headquarters and communications center activities for NCTS Guam and communications receiving operations for Navy and other Services on the island. The southern parcel is used for family housing.

The two Finegayan land parcels are separated by a separate land parcel (GLUP ‘77) that was identified as releasable to the GovGuam under the 1994 GLUP. Prior to GLUP ‘77, the Federal Aviation Administration (FAA) used this land.

3.12.2.1.5 Communications Annex, Barrigada

The Communications Annex, Barrigada, is part of the former Naval Communications Area Master Station, WestPac, now operating as the NCTS. The Communications Annex, Barrigada, is operated under a tenant arrangement with COMNAVREG Marianas.

Barrigada, which includes approximately 1,848 acres, is located in north-central Guam. The Annex supports a large antenna field developed around an active transmitter facility. Barrigada is also the site of the only Navy-owned golf course on the island.

3.12.2.2 DoD Leased, Navy Managed Lands on CNMI

Tinian and FDM are used by the U.S Military Services for training only. No DoD personnel are stationed on these islands. The Tinian MLA is used for military support, land maneuver, and aviation training. FDM is an aerial bombardment and naval gunfire range that has been used as such since 1971. The types of permitted military training on Tinian and FDM are described in the *Mariana Islands Range Complex Management Plan, 31 October 2007*, and the *Marianas Training Handbook, 5 June 2000*. In addition to DoD activities within the MLA, there are a VoA-IBB relay station and agricultural outleases.

There are portions of Tinian and Rota that are not leased by the DoD; however, the CNMI Government authorizes DoD use of discrete areas of these islands for specified training support activities. On Tinian, DoD uses the commercial harbor, Tinian International Airport, and a staging area near San Jose Village. A right-of-entry agreement was granted for Navy SEAL training (NSWU-1) on Rota. The area of use is limited to West Harbor in Song Song Village and the adjacent Angyuta Island, which is used for initiating bivouac training. No maneuver training occurs on Rota.

3.12.2.2.1 FDM

FDM is the DoD's only U.S.-controlled range in the WestPac, available to forward-deployed forces for live-fire and inert training. For this reason, it plays a unique role in National Defense. FDM's location is ideal for access and availability and its relative isolation facilitates a variety of attack profiles. FDM supports strategic and attack bombing, close air support bombing, naval gunfire, and strafing and special operations training. Annual ordnance expenditures must remain within an authorized amount. The land mass (approximately 182 acres), is approximately 1.7 mi. long and 0.3 mi. wide.

DoD live-fire training is the only land use permitted on FDM. The Navy has leased FDM from CNMI since 1971 and in 1983 negotiated a 50-year lease with an option to renew for another 50 years. Impact areas are restricted to the interior mesic flat ecosystem in the northern two thirds of the island and most of the southern peninsula, including the western cliffline ecosystem. No live-fire training is allowed in the coastal ecosystem.

Public access to FDM is strictly prohibited and there are no commercial or recreational activities on or near the island. During training exercises, marine vessels are restricted within a 3-nm (5-km) radius, although published Notices to Mariners (NOTMARs) may advise restrictions from 3 to 30 nm (5 to 56 km) or greater radius for certain training events. These increased advisory restrictions are used in an effort to ensure better protection to the military and the public during some training sessions. For these specific exercises, NOTMARs and Notices to Airmen (NOTAMs) are issued for up to 30-nm (56-km) or greater radius at least 72 hours in advance (DoN 2005b).

The U.S. Army Corps of Engineers (USACE) may promulgate regulations to establish a permanent danger zone or restricted area that establishes an exclusion zone or safety zone 10-nm (18-km) around FDM as an additional safety measure beyond the present NOTMARS advisory system. Pursuant to its authorities in Section 7 of the Rivers and Harbors Act of 1917 (40 Stat. 266; 33 U.S. Code [USC] 1) and Chapter XIX of the Army Appropriations Act of 1919 (40 Stat.892; 33 USC 3) the USACE is able to amend the regulations in 33 Code of Federal Regulations (CFR) Part 334 by establishing danger zone and restricted areas regulations. As usage of FDM increases under implementation of either Alternative 1 or Alternative 2, a permanent safety zone or restricted area would be established to restrict all private and commercial vessels from entering the area to minimize danger from the hazardous activity in the area. The present safety zones, which are activated by NOTAMS and NOTMARS, rely on the general public to actively pursue information concerning the restrictions. Establishment of a 10-nm (18-km) permanent restricted zone in accordance with 33 CFR would reduce the potential for missed information by the public resulting in public safety concerns. The 10-nm safety restricted zone would be a permanent restriction supplemented by temporary advisory notices as required. There would be continued use of the existing NOTMARs for training events requiring an extension of the safety zone from 10 nm to 30 nm or greater.

3.12.2.2.2 Tinian

The DoD leases approximately 15,347 contiguous acres of northern Tinian for field training. This MLA provides the largest maneuver area for field training in the Marianas. The largely forested area provides a realistic combat environment for jungle-like maneuvers and amphibious landings. In support of training activities within the MLA, DoD Services are permitted to use areas outside the MLA, including Tinian Harbor, Tinian International Airport, and a staging area near San Jose for logistical support. There is a recently closed live-fire mortar range on the northeast coast.

Tinian is largely public land with an estimated 10 percent privately owned. A significant portion of the public property is the MLA, leased to DoD for military training. Other uses include tourism, agriculture, commerce, recreation, and communication. There are no CNMI Land Use zoning regulations. Various land uses overlap to some extent. For example, civilian recreational uses are allowed within the MLA agreements. Designated natural and cultural conservation areas and health and safety considerations dictate land use constraints.

The Tinian MLA generally consists of the area north of the Tinian International Airport (also known as West Field) to the northernmost point of the island, Puntan Tahgong. The MLA is divided into the EMUA (approximately 7,577 acres) located in the north, and the LBA (approximately 7,770 acres) centrally located on the island. The EMUA is the primary training area, and civilian access is prohibited during exercises, except for VoA relay station staff. The LBA is used primarily for agricultural outleases; however, there is a proposed agricultural and conservation park west of Broadway. The boundaries between the land use areas are not secured, except for a fence around VoA operations.

3.12.2.2.3 Rota

The DoD has no leases for land on Rota.

3.12.2.3 Air Force Lands on Guam

Andersen AFB (AAFB), one of the largest airfields in the U.S. Air Force, is located in the northern portion of the island of Guam. The main base of AAFB covers 24.5 square miles, or about 15,460 acres. Main base is situated on a relatively flat, uplifted limestone plateau at the northern end of the island. To the north, west, and east of the plateau, steep cliffs drop 500 to 600 feet to a coastal terrace that extends 300 to 900 ft to a rocky shoreline. The Tarague embayment is a small coastal flat along the north shore. Tarague offers the only direct access to the ocean. The main training area is in the eastern third of the main base and includes the active airfield and an array of training, maintenance, and community support facilities. The central third of AAFB is a Munitions Storage Area (MSA). The western third is Northwest Field, a World War II (WWII) era airfield. Northwest Field is used for fixed-wing aircraft and helicopter training and various field exercises and bivouacs.

Non-contiguous properties of AAFB include Andersen Communication Annex No. 2 at Barrigada (122 acres); Andersen Petroleum Products Storage Annex No. 2, also known as the Tumon Tank Farm (64 acres); Andersen Water Supply Annex, also known as Tumon Maui (55 acres); Andersen Air Force Station at Mt. Santa Rosa (32 acres); and the Andersen South Annex (1922 acres).

3.12.2.3.1 Andersen Main Base

The AAFB Main Base comprises about 11,500 acres. The base is used for aviation training activities and small arms and EOD training. As a large working airfield, the base has a full array of training activities, maintenance, and community support facilities. The 36th Wing supports all U.S. military aircraft and personnel transiting the Mariana Islands. Facilities are available for cargo staging and inspection. Undeveloped terrain consists of open and forested land. The AAFB main base coastline consists of high cliffs and a long, narrow recreation beach (Tarague Beach). There is a small arms range in the Tarague Beach area and an EOD site to the northeast. Multiple exposed coral pillars negate use of Tarague Beach for amphibious landings by landing craft or amphibious vehicles.

Most of AAFB main base is dedicated to its primary airfield mission. The airfield, which comprises roughly 1,750 acres, is the predominant land use. The base's airfield is bordered by aircraft training activities, maintenance, and industrial facilities and infrastructure and open spaces. Airfield facilities, infrastructure, and open spaces are compatible land uses. The *2001 Air Installations Compatible Use Zones (AICUZ) Report* indicates there is no off-base incompatible land use resulting from aircraft noise (Andersen AFB 1998).

AAFB main base area lies in the southern half of the installation. The main base is bordered by a golf course and a high cliff line to the southeast and the village of Yigo along the boundary to the west and the south. The airfield and munitions storage area separate the main base from Northwest Field. The principal land uses in the cantonment include housing (both accompanied and unaccompanied), administration, medical, outdoor recreation, and community commercial services. The family housing neighborhoods consist of low-density, detached units. Higher density, multi-story dormitories for unaccompanied personnel are concentrated closer to administrative areas and the airfield. Most industrial and all airfield and aircraft training activities and maintenance functions are separated from residential areas by other land uses. The developed portion of the base is characterized by low-density development consisting of individual buildings with substantial setbacks.

The main base land use categories include administrative, aircraft training activities and maintenance, airfield, community, housing (unaccompanied), housing (accompanied), industrial, medical, open space, outdoor recreation, and water.

3.12.2.3.2 Northwest Field

Northwest Field is one of the many major complexes constructed during WWII. One of its runways remains active for fixed-wing aircraft training to include airborne and airmobile training activities. Helicopter units use other paved surfaces for Confined Area Landing (CAL), simulated amphibious ship helicopter deck landings, and insertions and extractions of small maneuver teams. About 3,562 acres in Northwest Field are the primary maneuver training areas available at AAFB for field exercises and bivouacs.

Northwest Field occupies the northern tip of Guam and the northwest third of AAFB. Northwest Field is bounded on the south by the Guam communities of Yigo and Dededo, the Pacific Ocean to the north and east, and the Philippine Sea to the west. Adjacent military property includes the Communications Annex, Finegayan, to the southwest and the AAFB MSA 1 to the southeast. The majority of residents in Guam reside on the northern half of the island. Most of the civilian land use in the vicinity is considered low density residential. Satellite tracking station antenna domes are the only structures visible above the Northwest Field tree line from an adjacent highway. Non-DoD lands are between Northwest Field and the offshore waters. To the southwest is the NCTS at Finegayan.

A narrow strip of non-Air Force land lies between Northwest Field and the Pacific Ocean and the Philippine Sea to the north, northeast, and northwest of the base boundary. Private land to the northeast is accessed by owners under an agreement between the land owners and the Air Force.

The Guam National Wildlife Refuge consists of eight administrative units, five of which are noncontiguous, under two different legal authorities. The refuge is composed of 771 acres (371 acres of coral reefs and 400 acres of terrestrial habitat) owned by the U.S. Fish and Wildlife Service (USFWS), and 22,456 acres (mostly of forest) of refuge overlay owned by the DoD in Air Force and Navy installations. The Ritidian Unit, which is owned by the USFWS, was created from a small decommissioned, specialized naval installation (Figure 3.12-1) (USFWS 2008). It should be noted that portions of what is known as the former FAA property, which was determined to be surplus property to DoD requirements in 1997, have been removed from the description of the overlay refuge in accordance with the overlay refuge agreement (Memorandum of Understanding [MOU] between USFWS and Navy and Air Force) that provides that federally controlled, DoD lands would be included in areas of the refuge commonly referred to as “overlay refuge.”

Northwest Field land use categories are administrative, aircraft training activities and maintenance, airfield, community, housing (unaccompanied), housing (accompanied), industrial, medical, open space, outdoor recreation, and water.

Explosives handling and storage are conducted in MSA 1 to the southeast of Northwest Field. The Air Force follows guidance in DoD 6055.9-STD (Ammunition and Explosives Safety Standard), Air Force Policy Directive 91-2 (Safety Programs), and Air Force Manual 91-201 (Explosives Safety Standards) to manage explosives at the base. These directives affect training activities and safety within the MSA and the areas surrounding it. The explosive safety quantity distance (ESQD) arc for MSA 1 extends nearly to the eastern end of the south runway at Northwest Field. The ESQD does not include any proposed Northwest Field project areas. The ESQD restricts construction of occupied structures (less those required for ordnance functions) and all other nonordnance-related activities.

Source: EDAW, Inc.

Figure 3.12-1: Guam National Wildlife Refuge

3.12.2.3.3 Andersen South

Andersen South consists of 1,922 acres. Open fields, wooded areas, vacant single-family housing, and vacant dormitories have been available in the past for staging, bivouac, equipment inspection, and small-unit tactics prior to aerial movement to other islands.

Military Operations on Urban Terrain (MOUT) training events are conducted in the abandoned housing areas. The current state of the buildings will need repairs to be suitable for continual training use.

No additional training infrastructure exists on Andersen South. Fresh water well heads exist along the perimeter. Fresh water wells provide water to Andersen AFB and the local community.

Andersen South facilities were heavily damaged during Typhoon Paka (December 1998), eliminating the use of single-family and multi-family units as residences and use of the barracks as contingency support facilities for training units. Utilities include an inactive wastewater pump station, water booster pump station, water tank, and an electrical substation that serves as a backup generator.

Directly south of Andersen South is former military-owned land that has been transferred to GovGuam. To the east is the Guam International Raceway. An adjacent cliff-line south and east of Route 15 drops to the Pacific Ocean.

Land uses to the east, north, and west of Andersen South include residential communities, schools, park and conservation areas, and golf courses. Additional land area is considered to be rural with little development of single-family houses and/or agricultural uses.

Military-owned land within a 3-mi. radius of Andersen South is a mix of Navy and Air Force properties. The Naval Communications Annex and Andersen Communications Annex, both located in Barrigada, are radio antenna fields for the respective commands. The Naval Communications Annex, located in Finegayan, northwest of Andersen South, is military land with low development density consisting of housing units and communications equipment and facilities. AAFB main base, located northeast of Andersen South, has airfield, fuel storage, munitions storage, family housing, and community support facilities.

3.12.2.4 Real Estate Use and Agreements

The following section was extracted from the 2006 Range Complex Management Plan (DoN 2006b) and summarizes those real estate instruments that might have relevance in the MIRC.

3.12.2.4.1 Air Installations Compatible Use Zones (AICUZ)

The purpose of the AICUZ program is to promote compatible land development in areas subject to aircraft noise and accident potential. The objective of the AICUZ program is to assist local, regional, state, and Federal land use planning organizations in developing land use strategies that are compatible with military airfield training activities and public health, safety, and welfare. AICUZ documents are developed using either historical and/or anticipated flight training activities to estimate sound levels associated with air training activities. They provide useful noise information to the localities for use in allowing compatible land uses.

3.12.2.4.2 Andersen Air Force Base

The Andersen AFB AICUZ Report, 1998 (Volume I, II, and III) delineates the noise contours, the Accident Potential Zones (APZs) and land use compatibility assessment for AAFB, Guam, based on existing flight training activities and training. The Air Force AICUZ land use guidelines reflect land use recommendations for Clear Zones (CZs), APZs I and II, and four Noise Zones (NZs). The AICUZ includes APZs and CZs based on past Air Force aircraft accidents and installation operational data; NZs, produced by the computerized Day-Night Average A-Weighted Sound Level (DNL) metric; and the area designated by the FAA and the Air Force for purposes of height limitations in the approach and departure zones of the base.

The three basic types of constraints that affect or result from flight activities are height limitations identified by FAA and DoD, NZs produced by the DNL metric and DoD noise map program, and APZs based on statistical analysis of past DoD aircraft accidents.

There are two airfields at AAFB, the main AAFB airfield (North Field), and Northwest Field. At both North Field and Northwest Field, aircrafts use the following flight pattern: straight-out departure, straight-in approach, overhead landing pattern, Instrument Flight Rules (IFR) or radar closed pattern, Visual Flight Rules (VFR) pattern, and circling approach. Takeoff patterns are routed to avoid heavily populated areas as much as possible. Air Force criteria were considered governing speed, rate of climb, and turning radius for each type of aircraft. Efforts are being taken to control and schedule missions to keep noise levels low especially at night, and to coordinate with the FAA to minimize conflict with civilian aircraft training activities. CZs and APZs are established for each runway. There are two parallel runways at North Field and one runway at Northwest Field.

According to the 1998 Andersen AFB AICUZ Report, the only aircraft currently assigned to AAFB is the Boeing HH-46D Sea Knight helicopter flown by the Navy Helicopter Combat Support Squadron 5 (HC-5). In addition to the HH-46D helicopter, other transient aircraft (such as F-18, C-130, C-141, C-5, C-9, and P-3) from other military installations and aircraft carriers land and take off from AAFB. The existing average number of daily training activities is 108 training activities for HH-46D, 4 training activities for F-18, 3 training activities for C-130, 2 training activities for C-141, and 1 operation for C-5, C-9, and P-3.

HC-5 has been redesignated as HSC-25, flying exclusively HH-60S helicopters. In addition, C-141s are no longer in the Air Force aircraft inventory, having been replaced by C-17s.

Because there are two parallel runways, CZs and APZs overlap at AAFB and increase the area affected by the AICUZ zones. Each CZ is 3,000 feet wide by 3,000 feet long. Each APZ I is 3,000 feet wide by 5,000 feet long and each APZ II is 3,000 feet wide by 7,000 feet long. Approximately 718 acres of land to the southwest of AAFB in the Village of Yigo is APZ II, consisting of the 65 DNL noise contour. The affected area in Yigo is primarily open space, natural conservation area, and low to moderate density residential development. Of the 718 acres of APZ II off-base acres, 140 acres are single-family units, from two to four acres per unit, on the approach to Runway 06, which is considered incompatible. Approximately 171 acres of land are affected by the DNL 65 noise contour. There is no current incompatible use in the DNL 65 noise contour that would affect the viability of continued flight training activities (Figure 3.12-2).

Northwest Field is an auxiliary airfield utilized currently by the Navy's HSC-25 helicopters homeported at AAFB and Special Operations C-130 aircraft from Kadena AB, Japan for contingency and training activities. According to the 1998 Andersen AFB AICUZ Report, the average number of daily training activities at Northwest Field was 4 training activities for HH-46D and 25 training activities for C-130.

Northwest Field has only one active runway. The contingency and training activities that occur at Northwest Field do not generate noise contours that extend beyond the boundaries of AAFB. However, approximately 103 acres of private property, located on the southwest end of the field, are within the CZ and APZ I. Also on the southwest end, approximately 23 acres of GovGuam property are affected by APZ I. On the northeast end of the runway, approximately 72 acres of private property is affected by APZ I. Since there are no residential dwellings within the CZ and APZ for Northwest Field, there are no incompatible land uses around Northwest Field.

The cliffs to the north and east of Main Base are preserved in the Pati Point Natural Area while the offshore waters from Tarague Beach to Anao Point are preserved in the Pati Point Marine Preserve. There are also extensive Chamorro cultural resources on base, especially in the Tarague Embayment.

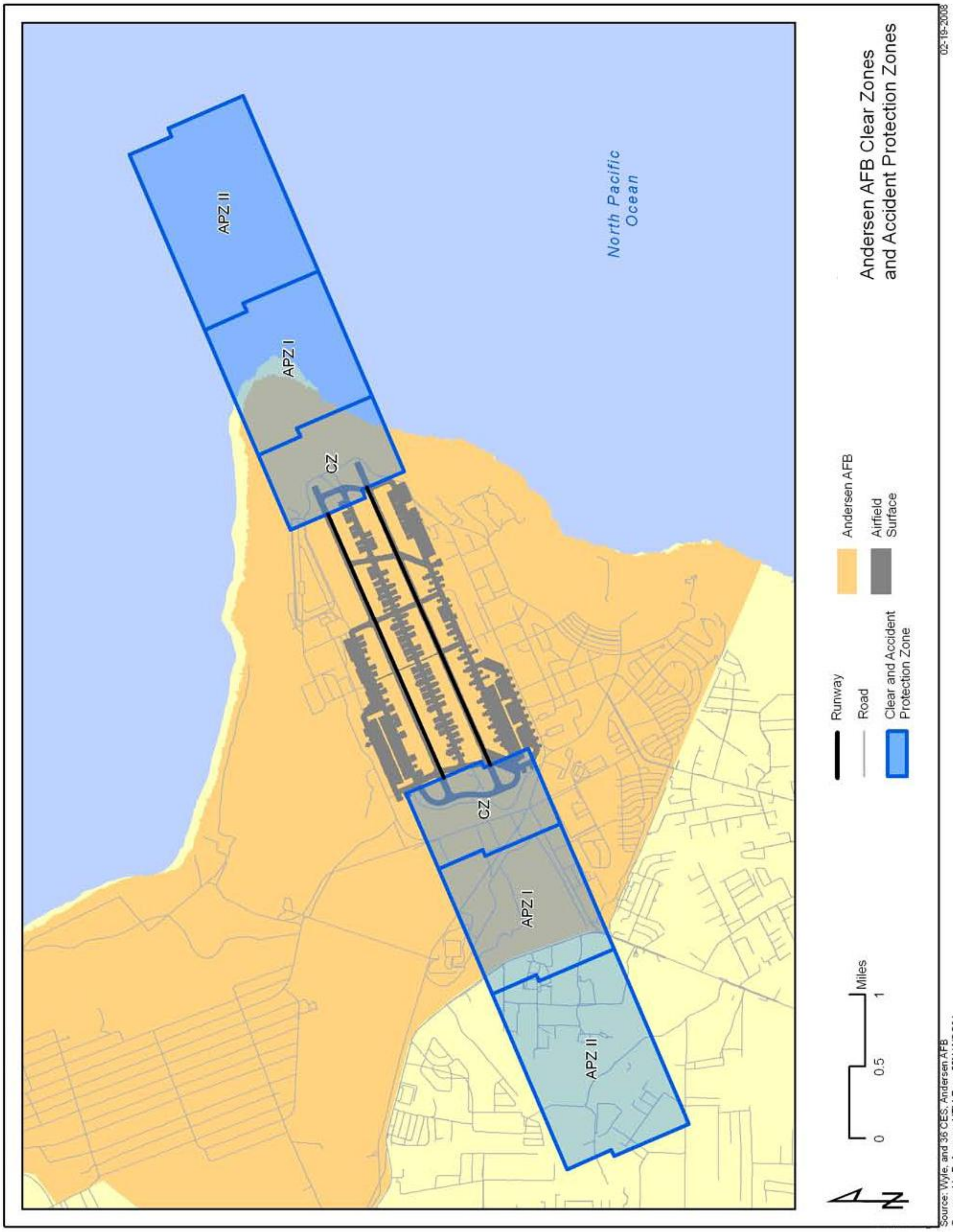
The future land use for Guam does not protect the off-base CZ and APZ areas of North Field and the areas around Northwest Field from future encroachment. There are no restrictions on higher residential densities and various, more intense land uses or height restrictions. On the southwest end of the Northwest Field runway, lands have been rezoned allowing hotels and resorts in the CZ and APZ I. On the northeast end of the Northwest Field runway, the area was rezoned low intensity development. On both ends of the Northwest Field runway, there is a possibility of exposing a large number of people to the risk of an aircraft accident.

To minimize noise impacts to surrounding communities, the following mitigation measures are included in the plan and implemented:

- Restricted nighttime flying activities and flight tracks routed to avoid populated areas;
- Practice takeoffs/landings and instrument approaches, and base maintenance runup activities conducted during normal waking hours (scheduled between 0600 and 2200) only;
- Only mission-essential aircraft arrivals and departures, high-priority missions allowed between 2200 and 0600; and
- Whenever possible, traffic patterns to be located away from the populated areas, both on and off base.

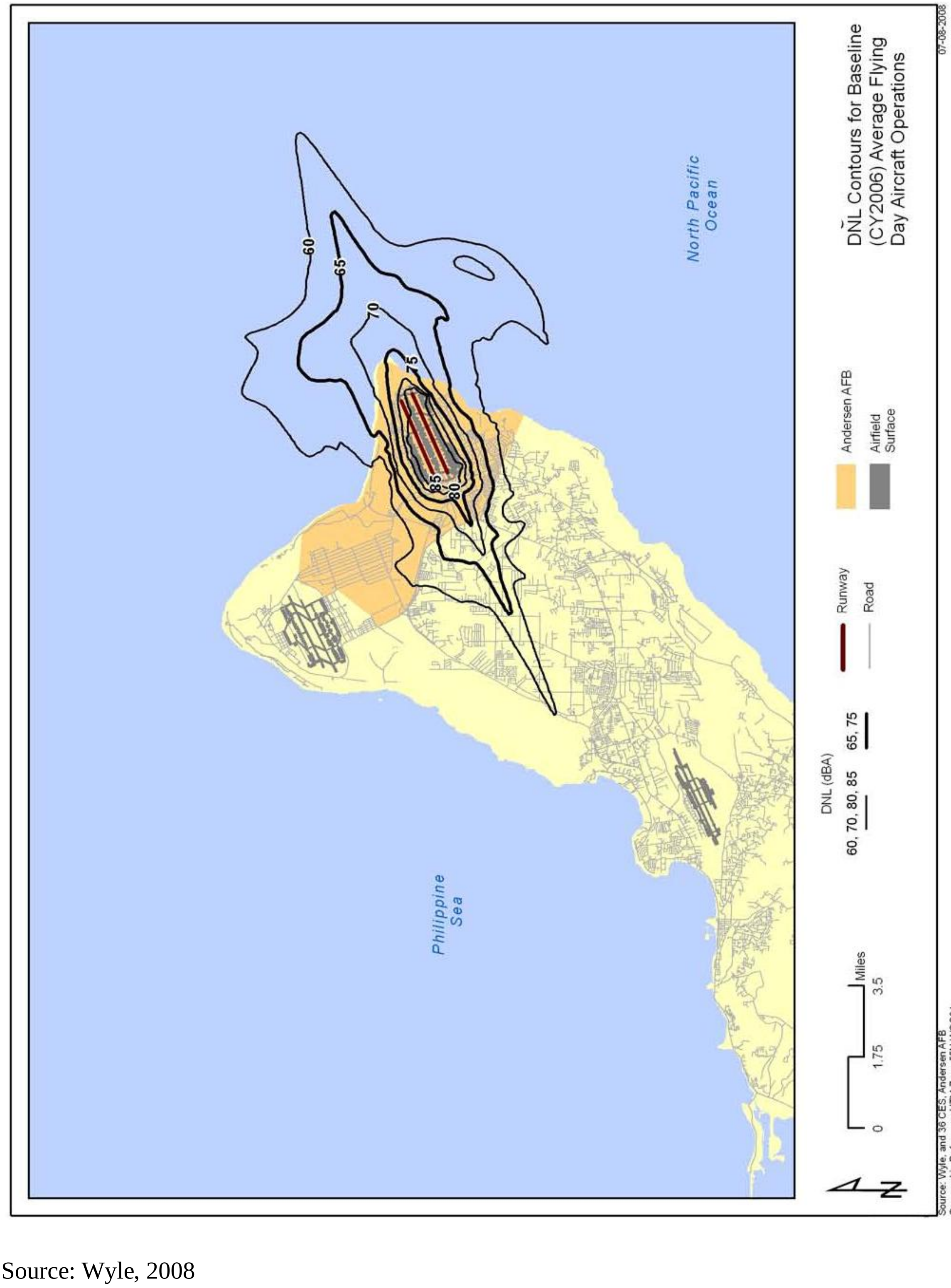
3.12.2.4.3 Aircraft Noise Study for Anderson AFB, Guam

An Aircraft Noise Study conducted in 2008 calculated and plotted the 60 dB through 85 dB DNL contours for the operations for AAFB and concluded that the overland portion of the 60 dB DNL contour extended along the runway heading approximately 5 statute mi. southwest of the base boundary. The off-base overland portion of the 65 dB DNL contour extends approximately 2.5 mi. southwest of the AFB boundary. The highest off-base overland DNL exposure outside AAFB property is between 75 dB and 80 dB DNL as shown in Figure 3.12-3, which shows the 75 dB DNL contour extending approximately 600 ft past the southwest base boundary (Wyle 2008).



Source: Wyle, 2008

Figure 3.12-2: Andersen AFB Clear Zones and Accident Protection Zones



Source: Wyle, 2008

Figure 3.12-3: DNL 60-85 dB Aircraft Noise Contours for Anderson AFB (2006 Baseline)

3.12.2.4.4 Range Air Installations Compatible Use Zones (RAICUZ)

The RAICUZ Program is similar to the AICUZ Program. The RAICUZ Plan provides land use recommendations that are compatible with range safety zones and noise levels associated with air-to-ground range installation and their training activities.

A RAICUZ Plan does not exist for the MIRC. According to NAVFAC Pacific and COMNAVMAR, a RAICUZ Plan was not required for Navy ranges in the Marianas because most of the ranges are in or near uninhabited areas.

3.12.2.4.5 Regional Shore Infrastructure Plan (RSIP)

The RSIP for COMNAVMAR, completed in January 2001, presents an overview of shore infrastructure and assesses present facility needs as well as future needs that arise from Navy operational or home porting changes. The RSIP addresses regional land requirements from a functional perspective, thus the RSIP is a regional overview plan supported by detailed functional plans and implementation strategies. The RSIP states that "…all lands on Guam, Tinian, and FDM are needed to meet current Navy requirements and provide flexibility for unforeseen mission changes in the future."

Chapter C, Functional Analysis, of the RSIP provides a summary of functional areas that include mission critical, mission support, and quality of life functions. Training is identified as a functional area under mission critical activities, along with waterfront and airfields. The RSIP, by reference, adopts the Marianas Training Plan as the detailed functional plan for training. Land and facilities currently used for training will be retained and upgraded to provide adequate facilities for future training activities.

3.12.2.4.6 General Plan

The Andersen AFB General Plan (October 2005) provides the framework for siting, programming, designing, and constructing the facilities required for the Intelligence, Surveillance, and Reconnaissance (ISR)/Strike Task Force beddown as well as those needed to support other ongoing or new missions. The 36th Wing is the host unit at AAFB with the mission to provide peacetime and wartime support to project global power and reach from the Pacific Theater.

One of the goals associated with the General Plan is to "…ensure that facilities and land uses are adaptable and can expand to accommodate new missions, weapons systems, and training." Since AAFB is home to several partner units belonging to other Air Force commands, the Guam Air National Guard, and the Navy, the General Plan recommends "early and frequent coordination with partner units to ensure their future development plans are incorporated into the overall plan for base development."

The General Plan summarizes the finding and recommendations of four component plans—Constraints and Opportunities, Infrastructure, Land Use and Circulation, and Capital Improvements Program (CIP). The Constraints and Opportunities component integrates natural and cultural resources information; environmental quality issues; and airspace, operational, and safety requirements. The Infrastructure component of the General Plan looks at utility supply and delivery systems and their capacity to accommodate growth. The Land Use and Circulation component assesses future development and the functional relationships that influence land use. The CIP identifies the construction projects needed to repair, upgrade, or replace facilities and infrastructure that support the ISR/Strike Task Force beddown and ongoing priorities.

Future land use planning objectives that may affect training include:

- Expand Northwest Field's capability to support unit training in a manner compatible with the natural environment
- Preserve the mission capability of Northwest Field's runways and aircraft Operating Areas (OPAREAs)
- Provide additional land on the South Ramp and North Ramp (of Northwest Field) for aircraft training activities and maintenance buildings required to support mission growth (includes the relocation of the existing Navy HSC-25 helicopter hangar)
- Designate land at Northwest Field for long-range aircraft maintenance and training activities

The Northwest Field Final Environmental Assessment (FEA), June 2006 identifies six general land use categories:

- Administrative
- Industrial
- Air Field
- Open Space
- Training Area
- Aircraft Operations and Maintenance

3.12.2.4.7 CNMI Covenant

The Covenant to Establish a Commonwealth of the Northern Mariana Islands in Political Union with the United States of America (Covenant) defines the relationship between the Northern Mariana Islands and the United States, recognizing sovereignty of the United States, but limiting, in some respects, the applicability of Federal law. The Covenant was approved by vote by Northern Mariana Islands voters on June 17, 1975, and after approval by the U.S. House of Representatives and the Senate, then President Ford signed Public Law 94-281 enacting the Covenant on 24 March 1976.

Article VIII, Property, of the Covenant "made available to the United States by lease to enable it to carry out its defense responsibilities" the following property:

- On Tinian Island, approximately 17,799 acres (7,203 hectares) and the waters immediately adjacent thereto
- On Saipan Island, approximately 177 acres (72 hectares) on Tanapag Harbor
- On FDM, approximately 206 acres (83 hectares) encompassing the entire island, and the waters immediately adjacent thereto

Article VIII also defined the initial lease period as 50 years, with an option to renew the lease for another 50 years for all or part of the property at the end of the first term. Total cost of the lease, including the second 50-year term if renewed, is $19,520,600 determined as follows:

- For that property on Tinian Island, $17.5 million
- For that property at Tanapag Harbor on Saipan Island, $2 million
- For that property known as Farallon de Medinilla, $20,600 (to be adjusted by the percentage change in the U.S. Department of Commerce composite price index from the date of the signing of the Covenant)

A separate Technical Agreement Regarding Use of Land to Be Leased by the United States in the Northern Mariana Islands (Technical Agreement) was simultaneously executed with the Covenant which provided for the leaseback of property and joint use arrangements for San Jose Harbor and West Field on Tinian Island. The Technical Agreement allowed for the leaseback of 6,458 acres (2,614 hectares) on Tinian for a sum of one dollar per acre per year and approximately 44 acres (18 hectares) at Tanapag Harbor on Saipan, to be used for land uses compatible with military use. The Technical Agreement also allowed the leaseback of the remaining leased property on Saipan at no cost for use as a memorial park to honor those who died in the World War II Marianas campaign.

On 6 January 1983, a lease agreement covering the above lands was signed and the Navy assumed control and possession. Under the terms of the lease agreement, none of the leased lands may be privately owned, nor are any CNMI residents allowed to live or develop there. Any nonmilitary uses within the leased areas must be approved by the Navy. It should be noted that Article 9, Improvements; Restoration of the Lease Agreement provides specifically for Saipan and Tinian, the "…removal of unexploded ordnance and exploded ordnance fragments introduced or uncovered by the United States during the term of this Lease Agreement." With regards to FDM, "…upon identification by the Lessors of a project for use of a specific area and notification to the United States of such intended use, the United States shall, to the extent practicable, remove all unexploded ordnance and exploded ordnance fragments from that area."

The entire area on Tinian leased to the United States is known as the MLA and is divided into the LBA and the EMUA.

North Field, encompassing about 2,500 acres in the EMUA, is listed on the National Register of Historic Places (NRHP) as an historic district and has been designated a National Historic Landmark (NHL). This NHL is formally known as the Tinian Landing Beaches, Ushi Point Field, and North Field, Tinian Island National Historic Landmark and will be referred to as the North Field NHL, herein after. In 1999, Tinian officials called for North Field to become a national historical park administered by the National Park Service (NPS). In 2000, the Navy stated that its long-term strategic needs were to continue using the North Field area for military training and that this use precluded its consideration for use as a national park. The Navy has cleared roads and trails, produced and installed interpretive signs, and printed an interpretive guide for North Field that describes North Field's historic resources through funding from the DoD Legacy Resource Management Program.

3.12.3 Environmental Consequences

The assessment of environmental consequences was made using an ecosystem management approach. Ecosystem management is defined as the process of restoring, creating, enhancing, and preserving habitat and other ecosystem features in conjunction with or in advance of projects in areas where environmental needs and the potential environmental contributions have been determined to be greatest.

3.12.3.1 No Action Alternative

No changes to existing real estate use or agreements are proposed as a result of implementation of the No Action Alternative. None of the offshore events associated with the proposed activities are associated with land encroachment, or land forms and soil. Land-based modes of transportation and utility systems are not associated with offshore events. Additionally, the scenic quality of the offshore area is not affected by proposed activities. Therefore, the proposed activities associated with the No Action Alternative have a less than significant impact on land use.

3.12.3.2 Alternative 1

Alternative 1 proposes increased operational training, expansion of warfare missions, accommodation of force structure changes, and enhancement of range complex capabilities. Proposed increases are not associated with land encroachment, or land forms and soil. Land-based modes of transportation and utility systems are not expected to change. The scenic quality of the offshore area is not affected by proposed activities. No changes to existing real estate use or agreements are proposed as a result of the implementation of Alternative 1. Therefore, the proposed activities associated with Alternative 1 would have a less than significant impact on land use.

3.12.3.3 Alternative 2

Alternative 2 proposes increased operational training, expansion of warfare missions, accommodation of force structure changes, and enhancement of range complex capabilities beyond that proposed for Alternative 1. Proposed increases are not associated with land encroachment, or land forms and soil. Land-based modes of transportation and utility systems are not anticipated to change. The scenic quality of the offshore area is not affected by proposed activities. No changes to existing real estate use or agreements are proposed as a result of the implementation of Alternative 2. Therefore, the proposed activities associated with Alternative 2 would have a less than significant impact on land use.

3.12.4 Unavoidable Significant Environmental Effects

Based upon the analysis presented in this section, there are no unavoidable significant environmental effects or ecosystem impacts as a result of implementation of the No Action Alternative, Alternative 1, or Alternative 2.

3.12.5 Summary of Environmental Effects (NEPA and EO 12114)

The MIRC EIS proposed actions (No Action Alternative, Alternative 1, and Alternative 2) do not result in impacts on land use or ecosystem management of the MIRC Study Area. There are no Navy training activities proposed that will be incompatible with current land use plans and policies, there are no anticipated changes to current land use, and no incompatibility exists with adjacent land use. Naval activity would have no significant impact on land use activities under the No Action Alternative, Alternative 1, or Alternative 2. Naval activity in non-territorial waters would not cause significant harm to land use activities under the No Action Alternative, Alternative 1, or Alternative 2.

3.13 CULTURAL RESOURCES

3.13.1 Introduction and Methods

Cultural resources are districts, buildings, sites, structures, areas of traditional use, or objects with historical, architectural, archaeological, cultural, or scientific importance. Cultural resources include archaeological resources (prehistoric and historic), historic architectural resources, and traditional cultural resources.

Archaeological resources include prehistoric and historic locations or sites where human actions have resulted in detectable changes. Archaeological resources can have a surface component, a subsurface component, or both. Archaeological resources also include human remains. Historic archaeological resources are those resources dating from after European contact. They may include subsurface features such as wells, cisterns, or privies. Other historic archaeological resources include artifact concentrations and building remnants (e.g., foundations). Submerged cultural resources include historic shipwrecks and other submerged historic materials, such as sunken airplanes and prehistoric cultural remains.

Architectural resources are elements of the built environment. These resources include 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.

Traditional cultural resources are resources associated with beliefs and cultural practices of a living culture, subculture, or community. These beliefs and practices must be rooted in the group's history and must be important in maintaining the cultural identity of the group. Archaeological sites, locations of traditional events, sacred places, and resource collection areas, including hunting or gathering areas, and human remains may be traditional cultural resources.

3.13.1.1 Regulatory Framework

Several federal laws and associated regulations require that potential effects on cultural resources be considered during the planning and implementation of federal undertakings. These laws and regulations stipulate a process of compliance, define the responsibilities of the federal action proponent, and prescribe the relationships among other involved agencies (e.g., State Historic Preservation Officer [SHPO], Advisory Council on Historic Preservation [ACHP]). Although the current undertaking is a federal project and federal laws take precedence, the DoD acknowledges local laws and regulations for cultural resources management, and makes every effort to incorporate them into the consultation process and mitigation effort whenever possible.

3.13.1.1.1 Federal Laws and Regulations

The primary laws that apply to the treatment of cultural resources during environmental analysis are the National Historic Preservation Act (NHPA) (16 United States Code [U.S.C.], Section [§] 470 et seq.), especially Sections 106 and 110; the Archaeological Resources Protection Act (ARPA) of 1979 (16 U.S.C. § 470), which prohibits the excavation and removal of items of archaeological interest from federal lands without a permit; and the Antiquities Act of 1906 (16 U.S.C. § 431).

Cultural resources of particular concern are those properties listed in or eligible for listing in the National Register of Historic Places (NRHP) and National Historic Landmarks (NHLs). Section 106 of the NHPA requires federal agencies to consider the effects of their actions on NRHP-eligible cultural properties. The implementing regulations for Section 106 (36 CFR Part 800) specify a consultation process to assist in satisfying this requirement. Cultural resources must meet one or more of the eligibility criteria established by the National Park Service (NPS) and listed in Department of the Interior regulations (36 CFR Part 60.4). Sites not yet evaluated may be considered to be eligible; potentially eligible resources are afforded the same regulatory consideration as listed properties. In some cases, cultural resources that are not eligible for inclusion in the NRHP may still require some level of management, protection, or mitigation. Whether prehistoric, historic, or traditional, sites listed in the NRHP are referred to as historic properties. NHLs are cultural resources of national historical importance and are automatically listed on the NRHP. Under the implementing regulations for Section 106 of the NHPA (36 CFR Part 800.10), special consideration to minimize harm to NHLs is required and both the ACHP and the Secretary of the Interior are consulted if any adverse effects are likely to occur to such resources.

3.13.1.1.2 Territory and Commonwealth Laws and Regulations

The laws and regulations related to the management and preservation of cultural resources on Guam consist of Title 21 GCA, Chapter 76, Historical Objects and Sites(Public Law 12-126), which established public policy to implement a comprehensive program of historic preservation; Public Law 20-151 which established authority for preservation review of all government permits or licenses and provided authority to stop projects in violation of the preservation requirements; Executive Order 89-9 which required consideration of historic preservation needs for any action needing an approval of the Territorial Land Use Commission (now known as the Guam Land Use Commission); Executive Order 89-24 which established policies for the disposition of archaeologically recovered human remains; and Public Law 21-104 which established a Chamorro shrine to be called *Naftan Mañaina-ta*, dedicated for the entombment of ancestral human remains retrieved from archaeological sites that cannot be reburied in their original locations. Although Public Law 21-104 established a Chamorro shrine, it was repealed in 1999 by Public Law 25-69.The Comprehensive Historic Preservation Plan for Guam (Belt Collins Guam Ltd, 2007) and the Guidelines for Archaeological Burials further define specific procedures and consultation requirements.

Laws related to the management and preservation of cultural resources in the Commonwealth of the Northern Mariana Islands include Public Law 3-39, the Commonwealth Historic Preservation Act of 1982 which promoted the preservation of the historic and cultural heritage of the Northern Mariana Islands and prohibited the removal of historic properties and artifacts from the Islands; Public Law 3-33 which established a permit and penalty process for the excavation and removal of human remains; and Public Law 10-71 which amended the Commonwealth Historic Preservation Act of 1982 to increase the membership of the Review Board and increase the monetary penalty for violations of the Act.

3.13.1.2 Warfare Areas and Associated Environmental Stressors

Aspects of the proposed training likely to act as stressors to cultural resources were identified through analysis of the warfare events and specific activities included in the alternatives. This analysis is presented in Table 3.13-1; impact analysis is discussed in subchapter 3.13.3 Environmental Consequences.

Table 3.13-1: Warfare Training and Potential Stressors to Cultural Resources

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Cultural Resources
Army Training			
Surveillance and Reconnaissance (S & R) / Finegayan Communications Annex, Barrigada Communications Annex, Tinian MLA	Surveillance and Reconnaissance (S & R)	Vehicle Movements Foot Traffic	Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism
Field Training Exercise (FTX) / Polaris Point Field, Orote Point Airfield/Runway, NLNA, Northwest Field, Andersen South, Tinian EMUA	Field Training Exercise (FTX)	Vehicle Movements Foot Traffic	Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism
Live Fire / Tarague Beach Small Arms Range	Live Fire	Weapons Firing	Impact to cultural resources from projectiles
Parachute Insertions and Air Assault / Orote Point Triple Spot, Polaris Point Field, Ordnance Annex Breacher House	Parachute Insertions and Air Assault	Aircraft Disturbance Vehicle Movements Foot Traffic	Audio and vibration disturbance to architectural and traditional resources Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism
Military Operations in Urban Terrain (MOUT) / Orote Point CQC Facility, Ordnance Annex Breacher House, Barrigada Communications Annex, Andersen South	Military Operations in Urban Terrain (MOUT)	Vehicle Movements Foot Traffic Building Modification	Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism Damage to integrity of historic buildings and structures

Table 3.13-1: Warfare Training and Potential Stressors to Cultural Resources (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Cultural Resources
Marine Corps Training			
Ship to Objective Maneuver (STOM)/ Tinian EMUA	Ship to Objective Maneuver (STOM)	Aircraft Operations Foot Traffic	Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism
Operational Maneuver / NLNA, SLNA	Operational Maneuver	Vehicle Movements Foot Traffic	Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism
Non-Combatant Evacuation Order (NEO) / Tinian EMUA	Non-Combatant Evacuation Order (NEO)	Aircraft Disturbance Vehicle Movement Foot Traffic	Audio and vibration disturbance to architectural and traditional resources Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism
Assault Support (AS) / Polaris Point Field, Orote Point KD Range, Tinian EMUA	Assault Support (AS)	Aircraft Disturbance Vehicle Movement Foot Traffic	Audio and vibration disturbance to architectural and traditional resources Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism
Reconnaissance and Surveillance (R & S) / Tinian EMUA	Reconnaissance and Surveillance (R & S)	Vehicle Movements Foot Traffic	Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism

Table 3.13-1: Warfare Training and Potential Stressors to Cultural Resources (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Cultural Resources
Marine Corps Training (Continued)			
MOUT / Ordnance Annex Breacher House, Andersen South	MOUT	Vehicle Movements Foot Traffic Building Modification	Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism Damage to integrity of historic buildings and structures
Direct Fires / FDM, Orote Point KD Range, ATCAA 3A	Direct Fires	Weapons Firing Disturbance	Impact to cultural resources from projectiles
Exercise Command and Control (C2) / Andersen AFB	Exercise Command and Control (C2)	None	None
Protect and Secure Area of Operations / Northwest Field	Protect and Secure Area of Operations	Vehicle Movements Foot Traffic	Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism

Table 3.13-1: Warfare Training and Potential Stressors to Cultural Resources (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Cultural Resources
Navy Training			
Anti-Submarine Warfare (ASW) / Open Ocean	Anti-Submarine Warfare (ASW)	Sonar	Audio and vibration disturbance to possible archaeological resources
Mine Warfare (MIW) / Agat Bay, Inner Apra Harbor	Mine Warfare (MIW)	Underwater Detonations	Impact to submerged cultural resources from projectiles and shock waves
Air Warfare (AW)/ Open Ocean	Anti-Air Warfare (AAW)	None	None
Surface Warfare (SUW)/ Open Ocean	Surface to Surface Gunnery Exercise (GUNEX)	None	None
	Air to Surface Gunnery Exercise	None	None
	Visit Board Search and Seizure (VBSS)	None	None

Table 3.13-1: Warfare Training and Potential Stressors to Cultural Resources (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Cultural Resources
Navy Training (Continued)			
Strike Warfare (STW) / FDM	Air to Ground Bombing Exercises (Land)(BOMBEX -Land)	Land Detonations Underwater Detonations	Impact to cultural resources from projectiles Impact to submerged cultural resources from projectiles and shock waves
	Air to Ground Missile Exercises (MISSELEX)	Land Detonations	Impact to cultural resources from projectiles
Naval Special Warfare (NSW))/ Orote Point (Airfield/Runway, CQC Facility, Small Arms Range/Known Distance Range, Triple Spot), Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field	Naval Special Warfare Operations (NSW OPS)	Vehicle Movements Foot Traffic Amphibious Landings Weapons Firing Disturbance	Impact to cultural resources from projectiles Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Impact to cultural resources from projectiles Damage to integrity of cultural place Vandalism
	Insertion/ Extraction	Vessel Disturbance Aircraft Disturbance Foot Traffic Amphibious Landings	Audio and vibration disturbance to architectural and traditional resources Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Impact to cultural resources from projectiles Damage to integrity of cultural place Vandalism

Table 3.13-1: Warfare Training and Potential Stressors to Cultural Resources (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Cultural Resources
Navy Training (Continued)			
Naval Special Warfare (NSW))/ Orote Point (Airfield/Runway, CQC Facility, Small Arms Range/Known Distance Range, Triple Spot), Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field (Continued)	Direct Action	Aircraft Disturbance Amphibious Landings Foot Traffic Weapons Firing Disturbance	Audio and vibration disturbance to architectural and traditional resources Impact to cultural resources from projectiles Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Impact to cultural resources from projectiles Damage to integrity of cultural place Vandalism Impact to cultural resources from projectiles
	MOUT	Vehicle Movements Foot Traffic	Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism
	Airfield Seizure	Aircraft Disturbance Foot Traffic	Audio and vibration disturbance to architectural and traditional resources Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism

Table 3.13-1: Warfare Training and Potential Stressors to Cultural Resources (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Cultural Resources
Navy Training (Continued)			
Naval Special Warfare (NSW))/ Orote Point (Airfield/Runway, CQC Facility, Small Arms Range/Known Distance Range, Triple Spot), Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field (Continued)	Over the Beach (OTB)	Aircraft Disturbance Amphibious Landings Foot Traffic	Audio and vibration disturbance to architectural and traditional resources Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism
	Breaching	Explosive Ordnance	Disturbance/destruction to archaeological sites, traditional places and cultural landscapes from ordnance detonations

Table 3.13-1: Warfare Training and Potential Stressors to Cultural Resources (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Cultural Resources
Navy Training (Continued)			
Amphibious Warfare (AMW) / FDM, Orote Point Small Arms/ Known Distance Range, Finegayan Communications Annex, Reserve Craft Beach, Outer Apra Harbor, Tipalao Cove, Tinian EMUA	Naval Surface Fire Support (FIREX Land)	Land Detonations	Impact to cultural resources from projectiles
	Marksmanship	Weapons Firing	Impact to cultural resources from projectiles
	Expeditionary Raid	Amphibious Landings Vehicle Movement Foot Traffic	Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Impact to cultural resources from projectiles Damage to integrity of cultural place Vandalism
	Hydrographic Surveys	Amphibious Landings Foot Traffic	Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Impact to cultural resources from projectiles Damage to integrity of cultural place Vandalism

Table 3.13-1: Warfare Training and Potential Stressors to Cultural Resources (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Cultural Resources
Navy Training (Continued)			
Explosive Ordnance Disposal (EOD) / (refer to specific events)	Land Demolition / Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point (Airfield/Runway, CQC Facility, Small Arms Range/Known Distance Range, Triple Spot), Ordnance Annex Breacher House, Ordnance Annex Emergency Detonation Site, NLNA, SLNA, Barrigada Communications Annex	Vehicle Movements Foot Traffic Land Detonations	Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Impact to cultural resources from projectiles Damage to integrity of cultural place Vandalism
	Underwater Demolition / Outer Apra Harbor, Piti Floating Mine Neutralization areas Area, Agat Bay	Underwater Detonations	Impact to submerged cultural resources from projectiles and shock waves

Table 3.13-1: Warfare Training and Potential Stressors to Cultural Resources (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Cultural Resources
Navy Training (Continued)			
Logistics and Combat Services Support / Orote Point Airfield/ Runway, Reserve Craft Beach	Combat Mission Area	Vehicle Movements Foot Traffic Amphibious Landings	Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism
	Command and Control (C2)	None	
Combat Search and Rescue (CSAR) / Tinian EMUA	Embassy Reinforcement	Vehicle Movements Foot Traffic Building Modification	Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism Damage to integrity of historic buildings and structures
	Anti-Terrorism (AT)	None	None

Table 3.13-1: Warfare Training and Potential Stressors to Cultural Resources (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Cultural Resources
Air Force Training			
Airlift / Northwest Field	Airlift	Aircraft Disturbance Vehicle Movements Foot Traffic	Audio and vibration disturbance to architectural and traditional resources Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism
Air Expeditionary / Northwest Field	Air Expeditionary	Aircraft Disturbance Vehicle Movements Foot Traffic	Audio and vibration disturbance to architectural and traditional resources Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism
Counter Land / FDM, ATCAA 3	Counter Land	Land Detonations	Impact to cultural resources from projectiles
Counter Sea (Chaff)	Counter Sea (Chaff)	None	None
Airlift / Northwest Field	Airlift	Aircraft Disturbance Vehicle Movements Foot Traffic	Audio and vibration disturbance to architectural and traditional resources Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism

Table 3.13-1: Warfare Training and Potential Stressors to Cultural Resources (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Cultural Resources
Air Force Training (Continued)			
Air Expeditionary / Northwest Field	Air Expeditionary	Aircraft Disturbance Vehicle Movements Foot Traffic	Audio and vibration disturbance to architectural and traditional resources Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism
Force Protection / Andersen AFB Main Base, Northwest Field, Tarague Beach Small Arms Range	Force Protection	Vehicle Movements Foot Traffic	Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism
Intelligence, Surveillance, Reconnaissance (ISR) and Strike Capacity / R-7201, FDM, Andersen AFB	Air-to-Air Training	None	None
	Air-to-Ground Training	Land Detonations	Impact to cultural resources from projectiles

Table 3.13-1: Warfare Training and Potential Stressors to Cultural Resources (Continued)

Training Event Type/ Location	Training Event Name	Potential Stressor	Potential Activity Effect on Cultural Resources
Air Force Training (Continued)			
Rapid Engineer Deployment Heavy Operational Repair Squadron Engineer (RED HORSE) / Northwest Field	Silver Flag Training	Aircraft Disturbance Vehicle Movements Foot Traffic	Audio and vibration disturbance to architectural and traditional resources Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism
	Commando Warrior Training	Aircraft Disturbance Vehicle Movements Foot Traffic	Audio and vibration disturbance to architectural and traditional resources Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance Damage to integrity of cultural place Vandalism
	Combat Communications	• Aircraft Disturbance • Vehicle Movements • Foot Traffic	• Audio and vibration disturbance to architectural and traditional resources • Unintentional disturbance by individuals who are unaware of cultural resource and/or its significance • Damage to integrity of cultural place • Vandalism

3.13.2 Affected Environment

Cultural resources information was obtained from Naval Facilities Engineering Command Pacific (NAVFAC PAC) cultural resources personnel, Pearl Harbor, Hawai'i, the National Register of Historic Places (National Register Information System [NRIS]), Guam Register of Historic Places, and Commonwealth of the Northern Mariana Islands (CNMI) listings for NRHP resources on Rota, Saipan, and Tinian. Primary summary information on cultural resources was derived from the *Updated Cultural Resources Management Plan for the Tinian Military Lease Area (MLA)* (DoN 2003); the *Regional Integrated Cultural Resources Management Plan for COMNAVREG Marianas Lands, Volume I: Guam* (DoN 2005b); the *Integrated Cultural Resources Management Plan for Andersen Air Force Base, Guam, 2003 Update* (USAF, 2003), the *Cultural Resources Synthesis for COMNAVREG Marianas Lands, Guam* (DoN 2005a*); the Results of Cultural Resource Inventories for Establishment and Operation of An Intelligence, Surveillance, Reconnaissance, and Strike Capability and the Deployment of Red Horse Squadron, Andersen Air Force Base, Guam* (USAF 2007); and the *Work Plan for Archaeological Surveys and Cultural Resources Studies on Guam and the Commonwealth of the Northern Marianas Islands in Support of the Joint Guam Build-up Environmental Impact Statement* (DoN 2007).

The Study Area for cultural resources includes the footprint of all MIRC military facilities on Guam, Rota, Saipan, Tinian, and FDM (Figures 2-2 through 2-9, Figure 2-11) as well as the open waters beneath the W-517 (Figure 2-1), R-7201, and the seven ATCAA locations (Figure 2-10).

The chronology or historical sequence for the Mariana Islands is detailed in the Integrated Cultural Resource Management Plan (ICRMP) for Guam (DoN 2005b) and Tinian (DoN 2003) as well as in the cultural resources synthesis for Guam (DoN 2005a*)* and *The Archaeology of Micronesia* (Rainbird 2004). The pre-*Latte* period (1500 B.C.-A.D. 1000) consists of the Early, Middle, and Late Unai phases and the Huyong phase. The Early Unai phase (1500-900 B.C.) is characterized by the highly decorated Lapita pottery which represents the earliest evidence of occupation in the Mariana Islands (Rainbird 2004). The Early Unai phase sites are located on the sandy beaches along the coastlines on Tinian and Saipan. The Middle Unai phase (900-400 B.C.) is characterized by a simpler bold-line decoration on the ceramics. Middle Unai phase sites are located at several sandy and rocky beaches, coastal rockshelters, and a few inland caves in the islands of Guam, Rota, Tinian, and Saipan. The Late Unai phase (400 B.C.-A.D. 400) is characterized by large thick-walled shallow pan-like ceramic vessels. Late Unai sites occur throughout coastal and inland areas of Guam, Rota, Tinian, and Saipan and include both surface and subsurface scatters of artifacts and midden in diverse settings. The Huyong phase (A.D. 400-1000) exhibits a continuation of large flat-bottomed pans which declines in frequency as pots with rounded bases and slightly incurved rims become more common. Surface and subsurface scatters of pottery and midden have been reported in both coastal and inland settings of Guam, Rota, Tinian, and Saipan.

The *Latte* Period (A.D.1000-1668) is characterized by *latte* which are quarried and shaped columns and capstones that once supported house structures. Nearly all of these columns and capstones were made from quarried limestone, but some (especially in the farthest northern islands) include basalt elements. *Latte* sets include paired rows of upright slab-like columns, arranged in rectangles. *Lusong* (grinding mortars in basalt or limestone) and *lummok* (stone pounders) are common during this time indicating an increased reliance of pounded food processing. Rice agriculture most likely occurred during this period as evidenced by the presence of rice impressions in ceramic pottery. The latter part of the *Latte* Period coincides with the early Spanish period. The early Spanish period refers to an extended period of Spanish contact with minimized direct impact on native Chamorro culture. This period begins with Magellan's arrival in the region in 1521, and it ends with the arrival of Spanish missionaries and soldiers intent on making radical changes and a long-term Spanish colony, in 1668.

In the Spanish Period (A.D. 1668-1898), the nature of contact between Chamorro and Spanish populations changed radically after the arrival of Father Diego Luis de Sanvitores and his party. The missionaries quickly began converting the Chamorro people to the Christian religion, also bringing many other social changes. The Spanish efforts that began in 1668 quickly led to conflict and violence, and the following few decades involved rapid and devastating impacts on the Chamorro people. Under Spanish influence, maize was introduced, and it soon became the staple food crop. Maize processing implements (*manos* and *metates*) replaced older food-pounders and mortars. Cattle, carabao (water buffalo), pigs, goats, and deer were also introduced and created new economic opportunities. In the early 1800s, the Manila galleons stopped their annual circuit across the Pacific, as the Spanish colonies in the Americas gained independence from Spain. The Philippines assumed Spanish administrative control of the Mariana Islands in 1817. Whaling ships were common at Guam between 1823 and 1853. During this time, approximately 30 ships provisioned at Guam each year. Between 1815 and 1820, canoe-loads of Carolinian Islander refugees requested permission from the Spanish governor to resettle in the Mariana Islands. In exchange for services rendered to the government, many of these refugees were allowed to settle in Saipan. In the 1880s, more Carolinian Islanders immigrated to the Mariana Islands. Carolinian communities were established throughout the islands.

The Pre-War Naval Administration (A.D.1898-1941) as defined on Guam and the Japanese Colonial/Pre-War Period as defined for the Northern Mariana Islands reflects early United States, German, and then Japanese control of the northern Marianas. In June 1898, during the Spanish-American War, the U.S. cruiser *Charleston* arrived at Apra Harbor to take control of Guam from Spain. Spain ceded Guam to the U.S. in 1899, and the Navy was given responsibility of administration of Guam. Under U.S. rule before 1941, Guam served as a fueling station for ships between the U.S. and Asia, the site of the trans-Pacific cable station, the base of a strategic Naval radio station, and a landing place for the Pan American trans-Pacific air clippers flying between San Francisco and Hong Kong.

As part of an agreement at the end of the Spanish-American War, Spain decided to dispose of all remaining colonies in the Pacific and sold the Mariana Islands north of Guam along with the Caroline Islands to Germany. The end of the Spanish-American War resulted in the political separation of the Mariana Islands and the islands' inhabitants that still continues today. These colonial and political decisions, except for the CNMI covenant, were not made by the inhabitants of the islands. The Germans were interested in developing an agricultural cash crop economy in the Northern Marianas, based on copra production. Vast coconut plantations were started, but two typhoons in 1905 devastated the young coconut trees. In October 1914, a Japanese naval squadron seized control of Saipan and other German possessions in Micronesia. Saipan was placed under military jurisdiction, and German nationals were expelled. In 1921, the League of Nations awarded the Mariana Islands, except Guam, officially to Japan. The Japanese Mandated Islands included more than the Northern Mariana Islands. A separate treaty included the non-fortification provision (these islands would not be fortified for military use) which applied to both Japanese and U.S. occupations on Guam. In 1922, the Nan'yō Kōhatsu Kabushiki Kaisha/Nankō (NKK, the South Seas Development Company) was established in Saipan to develop large-scale sugarcane production. Extensive plantations and settlements were developed in Saipan, Tinian, Rota, and Aguijan, vastly transforming the landscapes of these islands. Smaller-scale Japanese land use occurred at the various smaller islands in the Northern Marianas.

The World War II (A.D.1941-1945) period covers Japanese occupation and U.S. liberation of the Mariana Islands. On December 8, 1941, Japanese planes attacked Guam, a few hours after the attack at Pearl Harbor in O`ahu Island of Hawai'i. The Navy administration in Guam had not engaged in any substantial military build-up, despite being surrounded by Japanese-controlled islands of the Japanese Mandate. After just two days, Japanese forces landed at Guam, and the Navy commander surrendered just two hours later. Throughout 1942 and 1943, Japanese Navy forces occupied Guam and brutalized the native population. Beginning in March 1944, with the increased threat of a U.S. military invasion, Japanese reinforcements landed at Guam. The Japanese Army assumed control of Guam and began to fortify the likely invasion landing beaches. The local population was forced to provide labor and eventually forced into internment camps. During just a few years, large-scale Japanese defensive constructions had greatly transformed sections of Guam and Saipan, and less extensive transformations occurred in Rota and Tinian. Camouflaged bunkers, carved tunnels, and various gun emplacements were numerous. The U.S. began its attack on Japanese-controlled Saipan on June 15, 1944, with air strikes that destroyed 150 Japanese planes. The U.S. Liberation of Guam commenced on July 21, 1944. From Saipan, U.S. forces began a bombardment of Tinian ending with a landing invasion on July 24. Guam, Saipan, and Tinian then served as the staging base for B-29 bombers (Twentieth Air Force) on missions to the Japanese mainland, including the atomic bombing of Hiroshima and Nagasaki that effectively ended World War II.

The U.S. Post-War (A.D. 1945-present) Period represents Continued administration of the Mariana Islands by the United States. Guam was established as a U.S. flag territory and was governed separately under the Navy administration. A civilian government was established in 1949, and Guam was made a U.S. territory in 1950. Still, the U.S. military presence has remained significant in Guam. Many of the World War II facilities Continued to be used, and additional facilities were added in response to military needs associated with the Cold War, Korean War, and Vietnam War.

In 1947, a congressional resolution established the Trust Territory of the Pacific Islands and was signed into law by President Truman who then officially handed control over Micronesia to the Navy. The Northern Mariana Islands became part of the post-World War II United Nations' Trust Territory of the Pacific Islands. The United States became the administering authority under the terms of a trusteeship agreement (first under the Navy in 1947 and then under the Department of Interior in 1951). In 1976, Congress approved the mutually negotiated Covenant to Establish a Commonwealth of the Northern Mariana Islands (CNMI) in Political Union with the United States. The CNMI Government adopted its own constitution in 1977, and the constitutional government took office in January 1978.

3.13.2.1 Airspace

Nine different airspace locations are associated with the Mariana Island Range Complex (MIRC) Training areas: special use airspace W-517, located 50 miles (80 km) south-southwest of Guam; restricted airspace R-7201, surrounding FDM bombing range, and seven FAA assigned airspace locations (Figure 2-10).

Existing Conditions. Although no field surveys for cultural resources have been conducted in deep water, an extensive literature review of all known submerged cultural resources in Micronesia was conducted by the Submerged Cultural Resources Unit of the National Park Service (NPS) (Carrell et al. 1991a). In addition, several shallow-waters areas in the Mariana Islands, including Guam, Saipan, and Tinian, were surveyed for cultural resources by the NPS and U.S. Navy divers. No cultural resources surveys have been conducted in open waters, although several WWII submerged cultural resources are likely to occur in the open ocean areas beneath W-517, R-7201, or the seven Air Traffic Control Assigned Airspace (ATCAA) locations. No known cultural resources occur under the nine different airspace locations.

Current Protective Measures. None currently identified.

3.13.2.2 Guam Offshore

Three general areas are considered as Guam Offshore locations: Agat Bay including the Agat Bay DZ and Floating Mine Neutralization Area, Tipalao Cove, and the Piti Floating Mine Neutralization Area (Figure 2-3).

Existing Conditions. An extensive literature review of all known submerged cultural resources in Micronesia was conducted by the Submerged Cultural Resources Unit of the National Park Service (NPS) (Carrell et al. 1991a). In addition, several areas in the Mariana Islands, including Guam, Saipan, and Tinian, were surveyed for cultural resources by the NPS and U.S. Navy divers. No known submerged cultural resources occur under Agat Bay, Tipalao Cove, or in the Piti Floating Mine Neutralization Area (Carrell et al., 1991b, 1991c).

Current Protective Measures. None currently identified.

3.13.2.3 Guam Commercial Harbor

Guam commercial harbor is defined as the Outer Apra Harbor and includes Kilo Wharf. Apra Harbor is a former natural lagoon defined on the north side by the 1.7 mile (2.7 km) long Cabras Island, the 1.6 mile (2.6 km) long Luminao Reef that extends west of the island, and the submerged coral Calalan Bank, west of the reef extending to the mouth of the lagoon; Orote Peninsula marked the southern edge of the lagoon (Figure 2-3). At the inner end of the lagoon, a lobe of the bay extended south to form a smaller protected embayment and the Tepungan and Piti Channels offer access to the open ocean to the north (between Cabras Island and the mainland).

Construction during World War II and immediately after greatly altered the character of Apra Harbor. In 1944 until sometime after the end of the war, the Inner Apra Harbor was dredged, a few shoals were eliminated, and the berthing facilities in the Outer Harbor and the Glass Breakwater were constructed. The Breakwater is generally not considered to connect Cabras Island to mainland Guam. The engineering design of the Glass Breakwater is considerably different than the causeway between Cabras Island and mainland Guam, which extends west across Luminao Reef and Calalan Bank to the Spanish Rocks. Dredge material was used to create additional land along the shoreline of the inner lagoon, forming what is now called the Inner Harbor.

Existing Conditions. Thirty-one submerged resource locations occur in Outer Apra Harbor consisting of 29 shipwreck locations with 28 wrecks extant, and two plane crash locations containing three planes. The British passenger ship, “Caribia”, was salvaged and scrapped in the 1970s through a U.S. Army Corps of Engineers contract. Submerged resources include work and fishing boats, two 1976 American yachts (“Ondine” and “Whisper”), barges, tugs, landing craft utility vessels, a British passenger ships (“C S Scotia”), WWII Japanese freighters or transport ships (“Kitsugawa Maru” and “Nichiyu Maru”) and three Japanese planes from WWII commonly referred to as Val, Jake, and Hufe (Carrell et al. 1991a; Lotz, 1994). It is likely that about 80 percent of the submerged resources will not be considered eligible for the NRHP. The SMS Cormoran and the Tokai Maru are listed on both the Guam Register (Guam Register of Historic Places, 2008) and the NRHP (NRIS, 2008a). The SMS Cormoran was a German ship anchored in Apra Harbor near the beginning of World War I. When the United States joined the war in 1917, the SMS Cormoran’s crew was ordered to turn over the ship; they destroyed it instead with nine crewmen dying in the incident. The Tokai Maru, a Japanese passenger-cargo freighter built in 1930, was used to transport military supplies during WWII. The Tokai Maru was sunk in Apra Harbor in 1943 by a U.S. submarine.

Current Protective Measures. A Memorandum of Agreement (MOA) regarding the implementation of military training on Guam was signed and executed in 1999 (Commander In Chief, U.S. Pacific Command Representative Guam and the Commonwealth of the Northern Mariana Islands [USCINCPAC REP GUAM/CNMI], 1999a). The 1999 restrictions on training exercises correspond to mapped constrained areas designated as No Training (NT) or No Cultural Resource Damage (NCRD). NT areas designate complete avoidance with no training exercises. NCRD areas indicate limited military training activities with no vehicular travel off-road, no pyrotechnic, no demolition, and no digging without prior written approval from the USCINCPAC REP. Two areas within Outer Apra Harbor are designated as NT areas; seven additional areas within the harbor are designated as NCRD (USCINCPAC REP GUAM/CNMI, 1999a). Based on current consultations with the Guam SHPO, CNMI HPO, ACHP, and the NPS, a new Programmatic Agreement (PA) is currently being negotiated for all military training activities proposed under the Preferred Alternative and will include additional mitigation measures and procedures. The PA is scheduled for signature in July 2009 prior to the release of the FEIS and the signed PA will be incorporated into the FEIS.

A Regional Integrated Cultural Resources Management Plan (RICRMP) was prepared in 2005 (DoN 2005b) for Navy lands on Guam, including the Outer Apra Harbor, to ensure that cultural resources are managed in a planned and coordinated manner. The RICRMP established protective measures through standard operating procedures (SOPs) for new undertakings; inadvertent discovery of archaeological resources; inadvertent discovery of human remains; inadvertent disturbance to historic properties; during emergency situations; in the event of natural disasters; for permits, leases, and contracts; and permits for archaeological investigations.

3.13.2.4 Apra Harbor Naval Complex (Main Base)

Apra Harbor Naval Complex, also referred to as the Main Base, comprises 4,500 acres (1,821 hectares) located on Orote Peninsula, a Mariana limestone formation that marks the southern edge of the harbor. This raised limestone plateau rises to about 200 ft (61 m) above sea level (ASL); sheer cliffs mark its northern and southern sides (Figure 2-4). Tipalao Bay and Dadi Beach on the south shore, and Gab Gab Beach on the north shore are narrow coastal shelves that offer access to the sea. Just off the tip of Orote Peninsula is Orote Island, a small limestone rock with an elevation of about 140 ft (43 m) ASL.

Existing Conditions. Twenty-one cultural resources investigations have been conducted around the Apra Harbor Naval Complex and include overviews and assessments, Phase I survey, and Phase II testing (Figure 3.13-1) (DoN 2005b: 107, Table III-2). Approximately 150 acres (60 hectares) will be tested for subsurface deposits at Dadi and Tipalao Beach in fall 2008 for the Joint Guam Program Office actions (DoN 2007a).

Cultural resources identified at the Apra Harbor Naval Complex (Main Base) include prehistoric, historic, and multicomponent archaeological sites, historic buildings and structures, monument and memorials, objects, a cemetery, and a paleoenvironmental site (DoN 2005b: Table ES-1). One hundred twenty-two resources are listed, considered eligible or currently unevaluated for the NRHP (DoN 2005b: Table ES-1). Six resources, the Cable Station Remains, the Japanese Midget Submarine, Orote Airfield, Orote Historical Complex, and Sumay Cemetery are listed on the Guam Register (Guam Register of Historic Places, 2008); the Cable Station Remains, Orote Airfield, and the Orote Historical Complex are also listed on the NRHP (NRIS 2008a).

Prehistoric Archaeological Resources. Sixteen prehistoric and ten multicomponent (prehistoric and historic) resources considered NRHP-eligible occur on the Apra Harbor Naval Complex. Middle and Late Unai occupations have been recorded at Orote Point Cave on the shore of Apra Harbor. Huyong occupations occur at Sumay Village on Orote Peninsula and a rockshelter at Dadi Beach. Limited remains of the *Latte* period are present and include one *latte* set at the Piti site near the Apra Bay coast. Orote, Sumay, and Tipalao villages on Orote Peninsula are known from early historical records and must have been occupied during the Late *Latte* Phase, if not earlier, but only limited remains from the Tipalao site have been recorded. The Orote Historical Complex consists of a prehistoric rockshelter, fort, steps, and well complex. The archaeological component consists of Orote Point Cave and associated midden deposits covering approximately 10 acres (4 hectares) of the rugged coastal plain beneath the Orote escarpment near the entrance to Apra Harbor. Two petroglyphs, one of a stick figure with upraised arms and one of a fish, are found in the rockshelter.

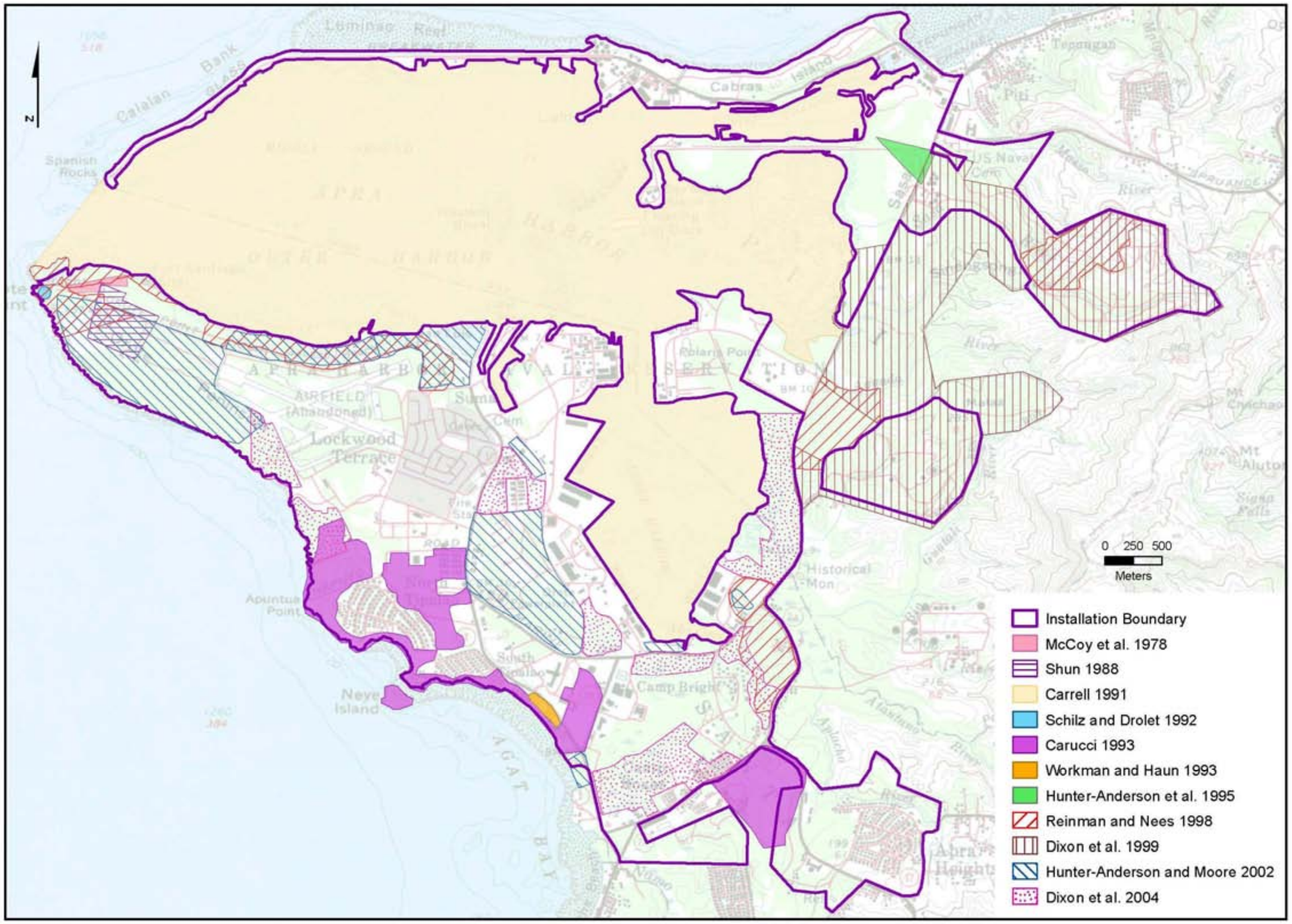


Figure 3.13-1: Major Cultural Resource Surveys Conducted at Waterfront Annex. (Source: DoN 2005a)

Historic Archaeological Resources. Fifty-five historic resources considered NRHP-eligible are located on the Apra Harbor Naval Complex. The only Spanish period site is the remains of Fort San Luis. The Cable Station Superintendent's Building, the one still partly standing, was a two-story concrete building constructed in a style identical to other cable station buildings in the Pacific, and represents the Pre-War Naval Administration period. The Sumay Village Cemetery once contained 157 grave markers dating from 1910 with inscriptions in Chamorro, Spanish, and English. During World War II, the Japanese built an elaborate defensive system across the neck of Orote Peninsula, consisting of trenches, foxholes, and a large number of pillboxes and heavy caliber weapons. During the battle for Guam in July 1944, Marines counted approximately 250 pillboxes and emplacements in this area. At least 13 Japanese fortifications around Agat Bay are considered NRHP-eligible.

Historic Architectural Resources. Twelve buildings and twenty-one structures considered NRHP-eligible include Orote Airfield, administration, shop, and office buildings, fallout shelter, Quonset hut, sheds, floating dry docks, piers, breakwater, wharves, beach fortifications, Japanese bunkers, seaplane ramp, bridge, and reservoir. During their World War II occupation, the Japanese built an airstrip on Orote. The Orote Airfield was captured by the U.S. and the peninsula declared secured on July 29, eight days after the 1944 invasion began.

Traditional Cultural Resources. No traditional cultural resources have yet been identified by the Chamorro or other ethnic groups. However, concerns over the possible disturbance and disposition of prehistoric human remains are likely, and the presence of petroglyphs and pictographs may indicate past or present ceremonial or religious activities. Prehistoric human remains have been recovered from caves and rockshelters as well as near *latte* sites. Two petroglyphs are associated with a rockshelter in the Orote Historical Complex.

Current Protective Measures. A Memorandum of Agreement (MOA) regarding the implementation of military training on Guam was signed and executed in 1999 (USCINCPAC REP GUAM/CNMI 1999a). The 1999 restrictions on training exercises correspond to mapped constrained areas designated as NT or NCRD. One area in the Apra Harbor Naval Complex (Main base) is designated as an NT area; four additional areas within the annex are designated as NCRD (USCINCPAC REP GUAM/CNMI 1999a). Based on current consultations with the Guam SHPO, CNMI HPO, ACHP, and the NPS, a new PA is currently being negotiated for all military training activities proposed under the Preferred Alternative and will include additional mitigation measures and procedures. The PA is scheduled for signature in July 2009 prior to the release of the FEIS and the signed PA will be incorporated into the FEIS.

A RICRMP was prepared in 2005 (DoN 2005b) for Navy lands on Guam, including the Main base, to ensure that cultural resources are managed in a planned and coordinated manner. The RICRMP established SOPs for new undertakings; inadvertent discovery of archaeological resources; inadvertent discovery of human remains; inadvertent disturbance to historic properties; during emergency situations; in the event of natural disasters; for permits, leases, and contracts; and permits for archaeological investigations.

3.13.2.5 Navy Munitions Site (Ordnance Annex)

The Navy Munitions Site (Ordnance Annex) comprises approximately 8,800 acres (3,561 hectares) and is situated within the inland volcanic hills, valleys, and mountains of southern Guam (Figure 2-5). The terrain in the Annex is mountainous and rugged. A 700 to 900 ft (213 to 274 m) high ridge line defines the western boundary of the Annex, connecting Mount Alifan in the northwest corner of the Annex to Mount Lamlam just outside the southwest corner of the Annex. The ridge line overlooks the west coast of the island from about Facpi Point to Agat; to the east, the ridge forms the headwaters of eight river drainages that flow eastward into the Talafofo River basin. The Bonya, Talisay, and Maemong Rivers drain the northern half of the Navy Munitions Site; the Imong, Sadog Gago, Almagosa, and Maulap Rivers flow into the Fena Reservoir in the southeast portion of the Navy Munitions Site. The complex of rivers and reservoir then drains into the Maagas River, a tributary of the Talafofo River. This area has been physically isolated and therefore more protected from historic construction and destruction than any of the other Navy areas. The modern landscape retains many elements of native forest and in the more remote sections has only been lightly modified by twentieth century introductions.

Existing Conditions. Thirteen cultural resources investigations have been conducted on the Navy Munitions Site and include overviews and assessments, Phase I survey and Phase II testing (Figure 3.13-2) (DoN 2005b: 108, Table III-3).

Cultural resources identified in the Navy Munitions Site include prehistoric, historic, and multicomponent archaeological sites, historic buildings and structures, a monument, and objects (DoN 2005b: Table ES-2). Three hundred and eighty-seven resources are listed, considered eligible or currently unevaluated for the NRHP (DoN 2005b: Table ES-2). At least 146 *latte* sites, containing over 350 *latte* sets, have been identified in the Navy Munitions Site, ranging from single, isolated *latte* structures to complexes of multiple *latte* sets combined with other features. Where identifiable, *latte* sets in complexes exhibit 6, 8, 10, and 12 pillars each in two paired rows. Also found in the Navy Munitions Site are quarries, cliff overhangs (some of which have stratified occupations of two to four episodes), caves, artifact scatters, and isolated objects such as slingstones, stone tools, mortars, and a grooved boulder. Unusual sites include a crevice with a nearby scatter of prehistoric pottery, a set of steps chiseled into a steep basalt outcrop next to a river, and a stretch of exposed bedrock along the Imong River that exhibits a cluster of shallow holes or depressions. Three resources, the Bona Site, the Fena Massacre Site and the West Bona Site are listed on the Guam Register (Guam Register of Historic Places, 2008); the West Bona site is also listed on the NRHP (NRIS 2008a).

Prehistoric Archaeological Resources. Two hundred sixty-five prehistoric and 28 multicomponent (prehistoric and historic) resources considered NRHP-eligible occur on the Navy Munitions Site. Middle Unai occupations have been recorded at two caves, one in the Bonya Stream valley and one at the base of Mount Lamlam at the Navy Munitions Site. An anthropomorphic pictograph was drawn on one of the cave walls. Near the end of the Late Unai Phase, settlement of the interior of Guam becomes increasingly evident and apparently more intensive and permanent than before, suggesting the beginnings of cultivation in favorable upland areas. Expansion seems to have followed the major river valleys into the interior uplands. A cave on a ridge south of Dobo Springs, was first occupied near the end of this phase and produced a human burial. Huyong phase occupations represent Continued use of many of the rockshelters and caves in the Navy Munitions Site utilized during earlier phases. Over 270 *Latte* Period sites have been noted in the Navy Munitions Site and include large *latte* complexes, smaller *latte* complexes, artifact scatters, caves, and rockshelters.

The Bona site is a complex consisting of a cave and three rockshelters on a ridge south of the Bonya River northwest of Fena Reservoir, each containing prehistoric pottery and marine shell from the Middle Unai Phase. This site also contains two sets of eight *latte* pillars each and four other broken or bulldozed sets.

Two caves near Fena contained *Latte* period deposits and were the site of Japanese atrocities and a massacre of young Chamorro men and girls just before the American invasion. These caves are the site of annual commemoration ceremonies.

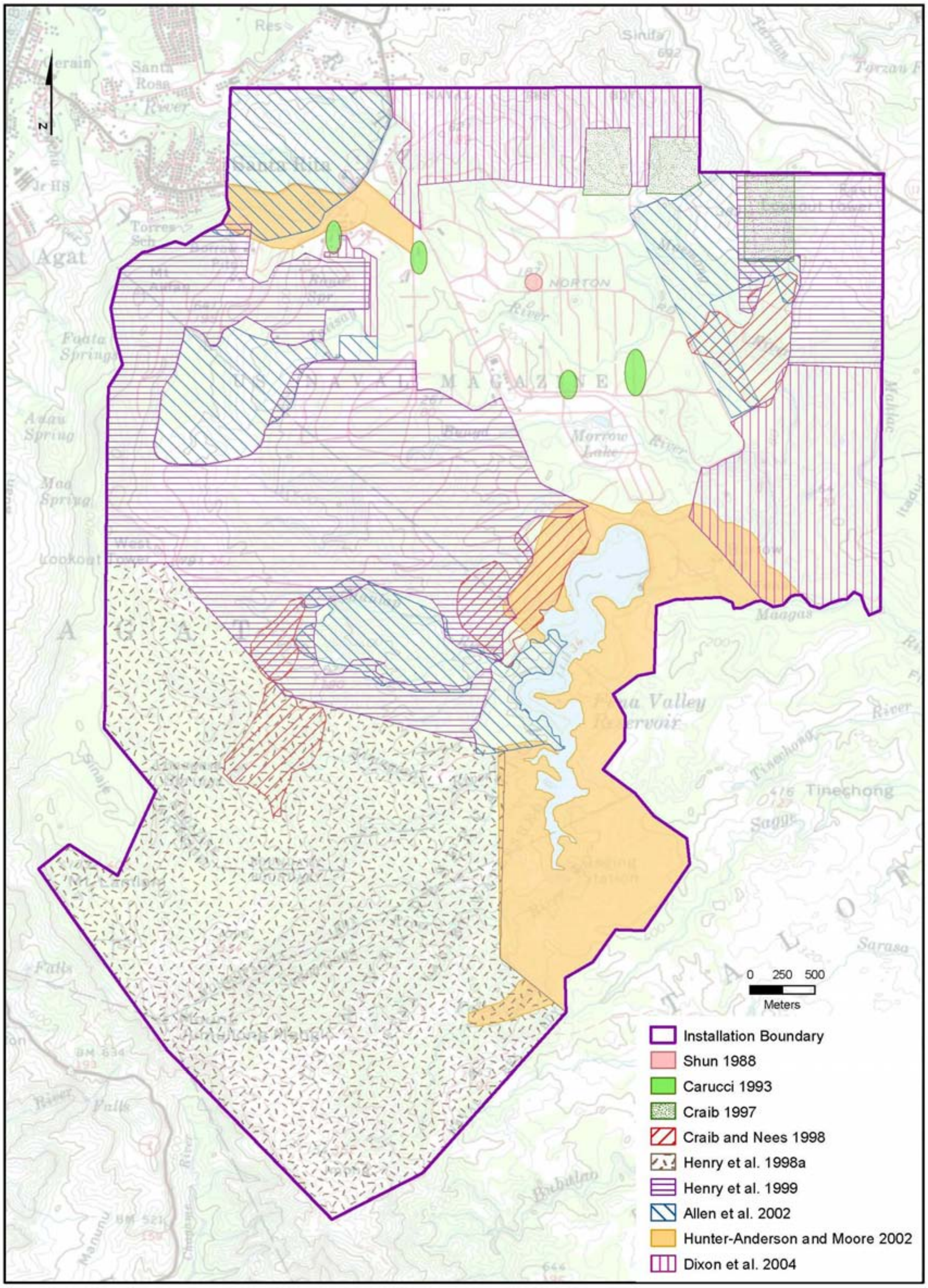


Figure 3.13-2: Major Cultural Resource Surveys Conducted at Navy Munitions Site (Source: DoN 2005a)

The West Bona Site consists of three caves and six rockshelters occupied during the pre-*Latte* period, located on a ridge south of the Bonya River. The West Bonya *latte* complex contains a 12-pillar *latte* set with four *lusong* and two adzes. The site also includes two sets of ten pillars each, one with a possible *metate*, and the other having two mortars and two artifact scatters.

Historic Archaeological Resources. Forty-six historic resources considered NRHP-eligible are located on the Navy Munitions Site and include air plane crash location, a baseball field, depressions, concrete blocks, and artifact scatters. Spanish period resources are identified by the presence of Spanish or western/European artifacts such as pottery, glass beads and stone *metates*. Prior to World War II, the U.S. military used the Navy Munitions Site area only for water supply, tapping Agat and Alamagosa springs and building the Maanot reservoir. Water was gravity-fed to Sumay and Agat at the coast. The Japanese occupation is represented by tunnels excavated into the slopes of Mount Alifan and historic artifact scatters. Post World War II resources include caves with evidence of use by Japanese military personnel hiding from the American forces following the invasion of the island.

Historic Architectural Resources. Five buildings and 39 structures considered NRHP-eligible include ARMCO buildings, abandoned magazines, storehouses, revetments, reservoirs, and bridges.

Traditional Cultural Resources. Only one traditional cultural resource has been identified. The Fena Massacre caves are the location of annual commemoration ceremonies by the Chamorro. Additional traditional cultural resources may yet be identified including locations of prehistoric human remains and the presence of petroglyphs and pictographs which may indicate past or present ceremonial or religious activities. Prehistoric human remains have been recovered from caves and rockshelters as well as near *latte* sites. One cave on the Navy Munitions Site yielded a human burial. An anthropomorphic pictograph has been identified at one cave location.

Current Protective Measures. A MOA regarding the implementation of military training on Guam was signed and executed in 1999 ([USCINCPAC REP GUAM/CNMI 1999a). The 1999 restrictions on training exercises correspond to mapped constrained areas designated as NT or NCRD. The MOA also stipulates cultural resources monitoring of placement of pop-up targets for the Sniper Range so that the ballistic trajectory does not affect historic properties. Four areas in the Navy Munitions Site are designated as NT areas; the eastern and southern portions of the annex are designated as NCRD (USCINCPAC REP GUAM/CNMI 1999a). Based on current consultations with the Guam SHPO, CNMI HPO, ACHP, and the NPS, a new PA is currently being negotiated for all military training activities proposed under the Preferred Alternative and will include additional mitigation measures and procedures. The PA is scheduled for signature in July 2009 prior to the release of the FEIS and the signed PA will be incorporated into the FEIS.

A RICRMP was prepared in 2005 (DoN 2005b) for Navy lands on Guam, including the Navy Munitions Site, to ensure that cultural resources are managed in a planned and coordinated manner. The RICRMP established SOPs for new undertakings; inadvertent discovery of archaeological resources; inadvertent discovery of human remains; inadvertent disturbance to historic properties; during emergency situations; in the event of natural disasters; for permits, leases, and contracts; and permits for archaeological investigations.

3.13.2.6 Communications Annex

The Communications Annex is comprised of approximately 3,000 acres (1,214 hectares) at Finegayan and 1,800 acres (720 hectares) at Barrigada (Figures 2-6 and 2-7).

Finegayan Communications Annex. The Finegayan Communications Annex is located in northwestern Guam. It occupies two parcels, North Finegayan and South Finegayan. Both parcels stretch from the shoreline of the west coast, inland over a line of limestone cliffs, onto the northern plateau of the island. Rain falling on this northern limestone plateau is quickly absorbed, leaving no surface drainages. Most of North Finegayan is located on top of the plateau, but the property extends seaward to include the narrow coastal strip at the base of a 100 ft (30 m) high sea cliff. At two places, the sea cliff is slightly indented to form small coves or larger areas of the coastal flat: Pugua and Haputo. South Finegayan is entirely situated on top of the limestone plateau that characterizes the northern half of the island. The plateau is generally flat with a slight slope to the south and west.

Existing Conditions. Ten cultural resources investigations have been conducted on the Finegayan Communications Annex and include overviews and assessments, Phase I survey and Phase II testing (Figure 3.13-3) (DoN 2005b: 109, Table III-5). Most of the North Finegayan area has received Phase I archaeological survey; an additional 150 acres (60 hectares) of survey is scheduled for spring 2008 for the Joint Guam Program Office actions (DoN 2007a). Fifty acres (20 hectares) of survey will be conducted on the South Finegayan parcel in 2008, also for the Joint Guam Program Office actions (DoN 2007a).

Cultural resources identified at the Finegayan Communications Annex include prehistoric and historic archaeological sites. Twenty-four resources are listed, considered eligible or currently unevaluated for the NRHP (DoN 2005b: Table ES-4). One twentieth century and 22 prehistoric sites, all between the shoreline and the top of the coastal cliff, have been identified at Haputo and Pugua Point on the North Finegayan parcel and one prehistoric site has been recorded on the plateau on the South Finegayan property. Two resources, Haputo Beach Site and South Finegayan Latte Stone Park are listed on the Guam Register (Guam Register of Historic Places 2008); both resources are also listed on the NRHP (NRIS 2008a).

Prehistoric Archaeological Resources. Twenty-three prehistoric resources considered NRHP-eligible occur on the Finegayan Communications Annex. A Middle Unai occupation has been documented at the Pugua Point 1 rockshelter along the northwest coast on Finegayan Communications Annex. A few Late Unai artifacts have been recovered at Haputo; and Pugua Point 1 rockshelter continues to be occupied during this period. Huyong phase artifacts have been identified at a site at Pugua Point in the Finegayan Communications Annex. At Finegayan Communications Annex in northwest Guam, the Late Unai/Huyong Period sites at Haputo and Pugua Point Continued to be occupied into the *Latte* Period.

Occupation at Haputo occurred as early as the Late Unai Period and the site features area distributed in a semi-circular pattern following the curve of the bay, appears to have been permanently occupied. The well-preserved Haputo site contains 23 *latte* sets, two mounds of destroyed *latte*, rectangular enclosures, two rectangular platforms, seven mortars not associated with *latte*, and three large wells for fresh water. Ceramic, stone, and shell artifacts were found scattered throughout the whole embayment, and one dense cobble scatter is present. Two rockshelters and one artifact scatter are located to the north along the coastal shelf. Except for the platforms and possibly the wells, all the features date to the *Latte* Period (DoN 2005a: 104-105).

The Latte Stone Park Site was recorded as having 10 coral pillars (one of which showed World War II bombing damage) and capstones located on a dry upland plateau. Artifact scatters are found in dispersed locations in the vicinity of the *latte* set (Welch *et al*. 2005: 110). Such *latte* sets are highly unusual on the northern plateau.

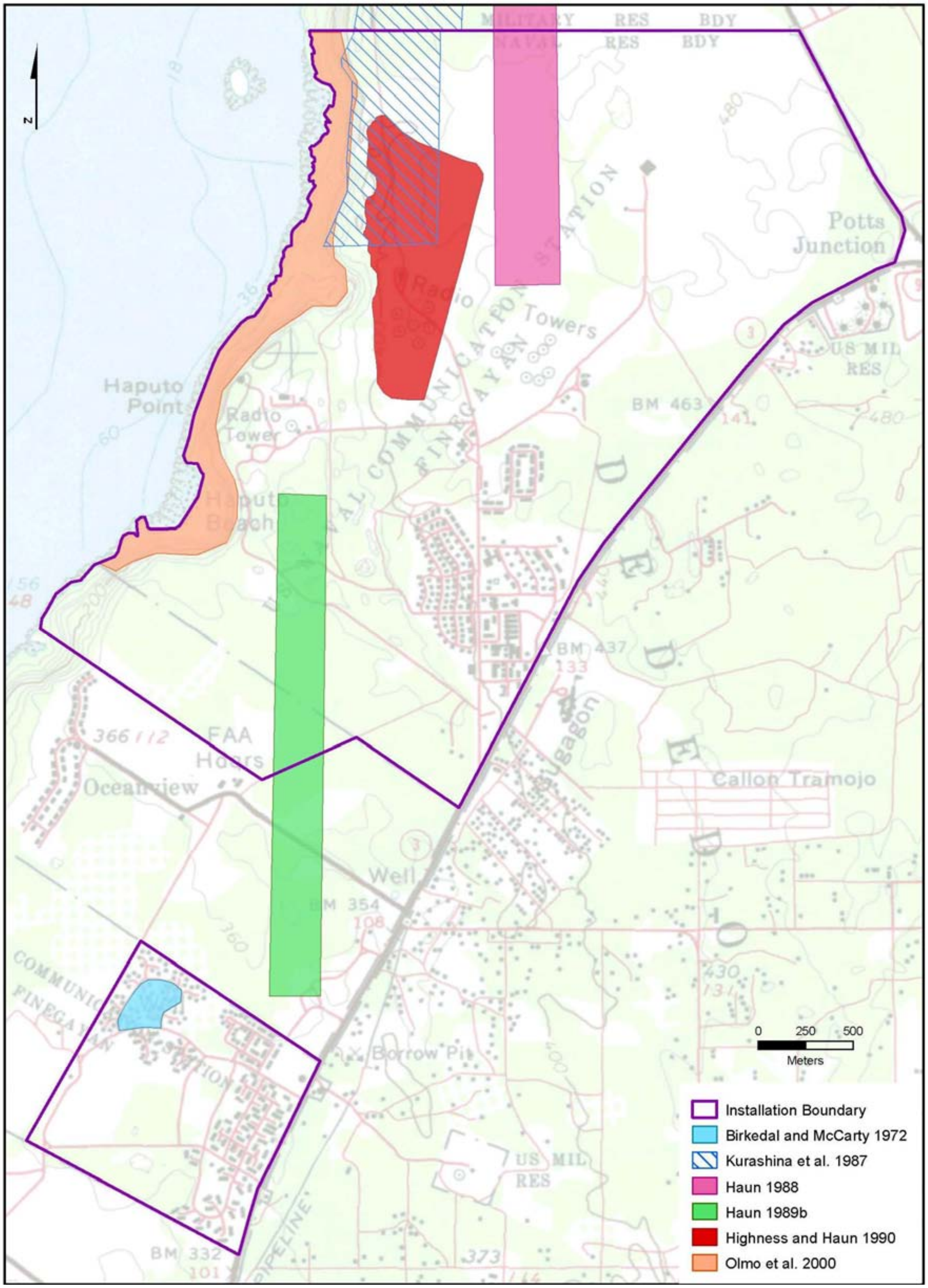


Figure 3.13-3: Major Cultural Resource Surveys Conducted at Finegayan Communications Annex (Source: DoN 2005a)

Historic Archaeological Resources. One historic resource considered NRHP-eligible occurs on the Finegayan Communications Annex. A cave in the Pugua area was used by a Navy radioman during World War II to evade capture by the Japanese (Tweed's Cave).

Historic Architectural Resources. No historic architectural resources have been documented on the Finegayan Communications Annex; however, an architectural survey is presently being conducted.

Traditional Cultural Resources. No traditional cultural resources have yet been identified by the Chamorro or other ethnic groups. However, concerns over the possible disturbance and disposition of prehistoric human remains are likely, and the presence of petroglyphs and pictographs may indicate past or present ceremonial or religious activities. Prehistoric human remains have been recovered from caves and rockshelters as well as near *latte* sites.

Current Protective Measures. A MOA regarding the implementation of military training on Guam was signed and executed in 1999 ([USCINCPAC REP GUAM/CNMI 1999a). The 1999 restrictions on training exercises correspond to mapped constrained areas designated as NT or NCRD; no restrictions were placed on the Communications Annex, Finegayan. Based on current consultations with the Guam SHPO, CNMI HPO, ACHP, and the NPS, a new PA is currently being negotiated for all military training activities proposed under the Preferred Alternative and will include additional mitigation measures and procedures. The PA is scheduled for signature in July 2009 prior to the release of the FEIS and the signed PA will be incorporated into the FEIS.

A RICRMP was prepared in 2005 (DoN 2005b) for Navy lands on Guam, including the Communications Annex, to ensure that cultural resources are managed in a planned and coordinated manner. The RICRMP established SOPs for new undertakings; inadvertent discovery of archaeological resources; inadvertent discovery of human remains; inadvertent disturbance to historic properties; during emergency situations; in the event of natural disasters; for permits, leases, and contracts; and permits for archaeological investigations.

Barrigada Communications Annex. The Barrigada Communications Annex covers about 1,848 acres (748 hectares) on the southeast slope of Mount Barrigada near the center of the island. It is located on the northern limestone plateau in an area with no natural water sources, in either the form of surface drainages or sink holes.

Existing Conditions. Seven cultural resources investigations have been conducted on the Barrigada Communications Annex, and include overviews and assessments, Phase I survey and Phase II testing (Figure 3.13-4) (DoN 2005b: 110, Table III-6). An additional 100 acres (40 hectares) are scheduled for archaeological survey in the spring 2008 for the Joint Guam Program Office actions (DoN 2007a).

Three twentieth century sites had been previously recorded on the Barrigada property. No resources in the Barrigada area are listed on the Guam Register or NRHP.

Prehistoric Archaeological Resources. No prehistoric resources have been documented on the Barrigada Communications Annex.

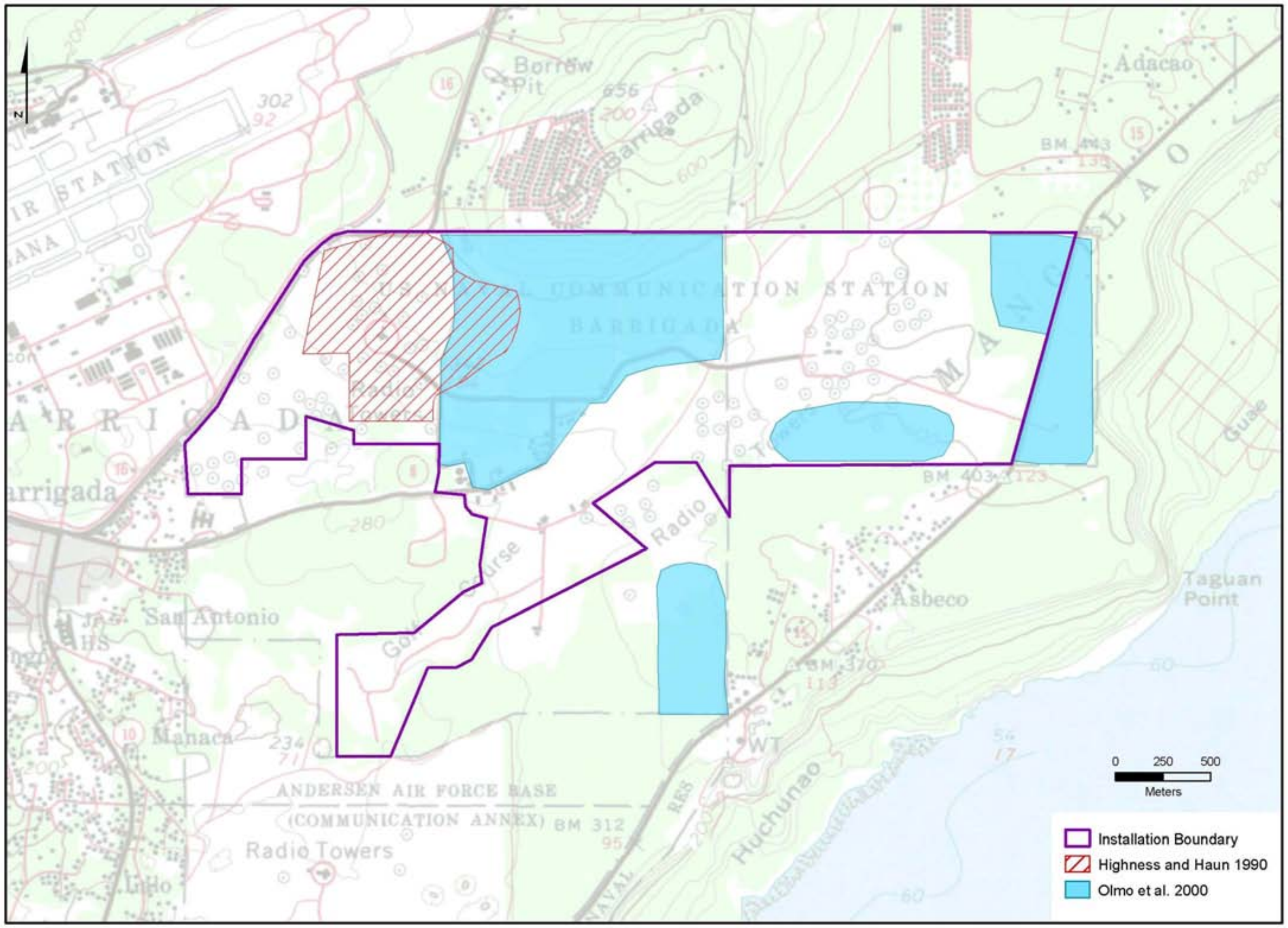


Figure 3.13-4: Major Cultural Resource Surveys Conducted at Barrigada Communications Annex. (Source: DoN 2005a)

Historic Archaeological Resources. Three historic resources considered NRHP-eligible include the Barrigada Battlefield and Well, the Barrigada Golf Course, and Officer Country. A major battle of the American re-capture of the island took place in the Barrigada area. Called the Battle of Barrigada, the focus of this military action was the capture of the Barrigada Well, a critical source of water on the waterless northern plateau of the island. A military camp was established west of the current golf course, probably used for officers' housing. Some foundations remain and two pillars inscribed "Officers Country" mark the entrance.

Historic Architectural Resources. No historic architectural resources have been documented on the Barrigada Communications Annex.

Traditional Cultural Resources. No traditional cultural resources have been identified on the Barrigada Communications Annex.

Current Protective Measures. A MOA regarding the implementation of military training on Guam was signed and executed in 1999 ([USCINCPAC REP GUAM/CNMI 1999a). The 1999 restrictions on training exercises correspond to mapped constrained areas designated as NT or NCRD; no restrictions were placed on the Barrigada Communications Annex. Based on current consultations with the Guam SHPO, CNMI HPO, ACHP, and the NPS, a new PA is currently being negotiated for all military training activities proposed under the Preferred Alternative and will include additional mitigation measures and procedures. The PA is scheduled for signature in July 2009 prior to the release of the FEIS and the signed PA will be incorporated into the FEIS.

A RICRMP was prepared in 2005 (DoN 2005b) for Navy lands on Guam, including the Communications Annex, to ensure that cultural resources are managed in a planned and coordinated manner. The RICRMP established SOPs for new undertakings; inadvertent discovery of archaeological resources; inadvertent discovery of human remains; inadvertent disturbance to historic properties; during emergency situations; in the event of natural disasters; for permits, leases, and contracts; and permits for archaeological investigations.

3.13.2.7 Tinian

The MLA on Tinian consists of 15,644 (6,331 hectares) acres divided into two parcels: the EMUA and the LBA (Figure 2-8). The EMUA is DoD-leased land (7,429 acres [3,006 hectares]) covering the northern third of Tinian. Five limestone terraces formed on an eroded Eocene volcanic base rise in steps from the coastline to maximum height of 554 ft (169 m) above mean sea level. The terraces form level to undulating plains bounded by steep escarpments that occur along fault lines. Sinks and caves occur in the limestone where it is exposed. The key feature is North Field, a large abandoned WWII era airfield and NHL that is still usable as a contingency landing field. The EMUA has two small sandy beaches: Unai Chulu on the northwest coast and Unai Dankulo (Long Beach) on the east coast. The LBA, an 8,415-acre (3,405 hectares) land area covering the central portion of the island, makes up the middle third of Tinian. A key feature is the proximity to the commercial West Field airport on the southern border of the LBA.

Existing Conditions. Forty cultural resources investigations have been conducted on the MLA on Tinian and include overviews and assessments, Phase I survey, Phase II testing, and architectural survey of World War II resources (Figure 3.13-5) (DoN 2003: 60-61, Table III-1). Additional Phase I survey of 4,790 (1,938 hectares) acres and subsurface testing at beach areas, Unai Dankulo (Long Beach) and Unai Chulu, are scheduled in spring 2008 for the Joint Guam Program Office actions (DoN 2007a).

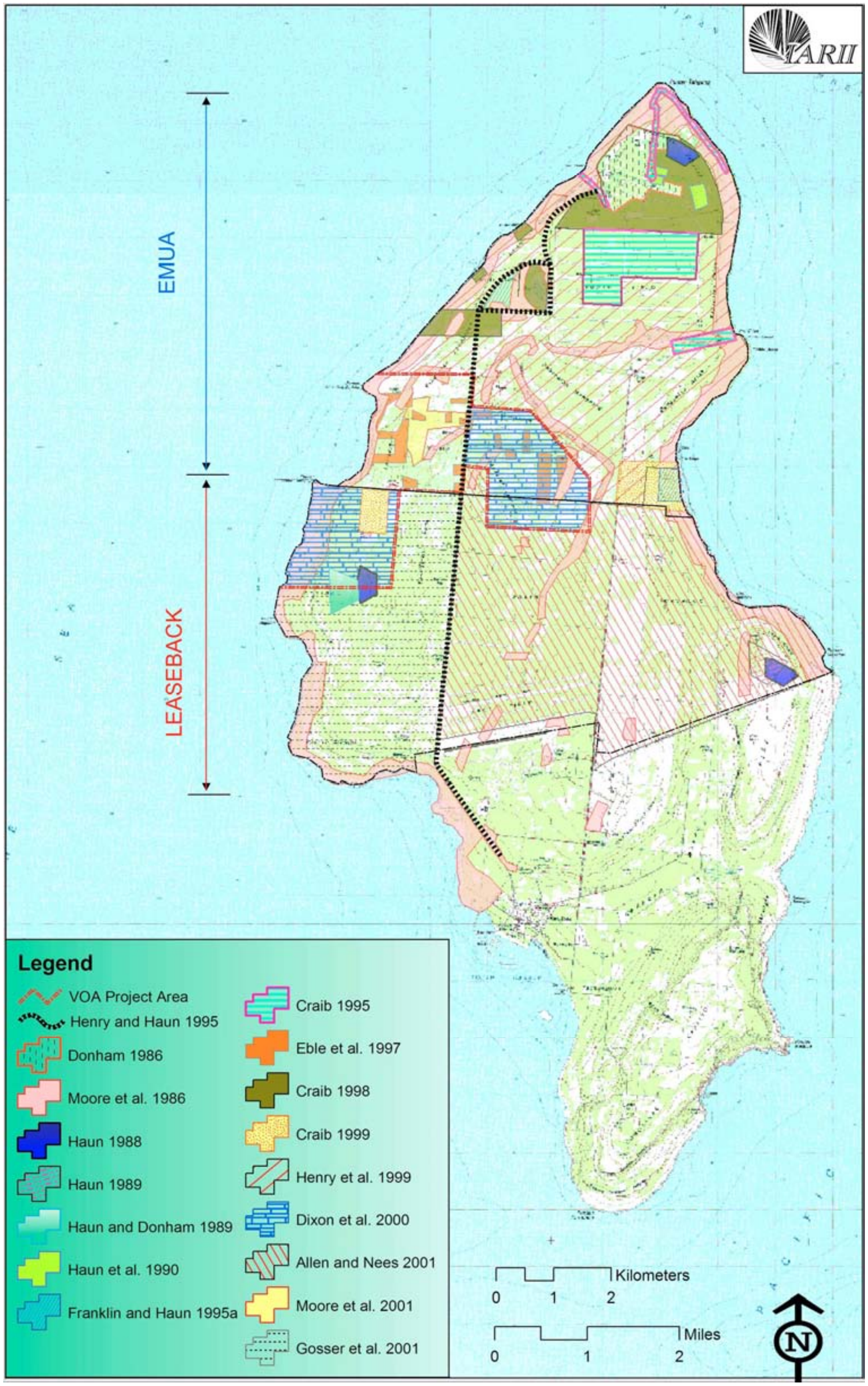


Figure 3.13.-5: Major Cultural Resource Surveys in the Military Lease Area, Tinian. (Source: DoN 2003)

Cultural resources identified on the MLA include the North Field NHL as well as individual resources such as prehistoric and historic archaeological sites, historic buildings and structures, shrines, petroglyphs and pictographs, and objects (DoN 2003: Table ES-1). Over six hundred (n=612) resources are listed, considered eligible or currently unevaluated for the NRHP (DoN 2003: Table ES-1). Two resources, one encompassing the Tinian Landing Beaches, Ushi Point Field, and North Field; and the Unai Dankulo (Long Beach) Petroglyph site are both listed on the CNMI List of Historic Places (CNMI 2008c) and the NRHP (NRIS 2008b). The Tinian Landing Beaches, Ushi Point Field, and North Field resources also comprise a NHL, hereafter referred to at the North Field NHL.

The North Field NHL is located at the north end of the island in the EMUA (Figure 3.13-6). Contributing elements of the North Field NHL include a complex of runways, aprons and parking areas constructed by American forces after the successful invasion of Tinian in 1944. The North Field NHL is primarily significant for its major role during World War II, focusing on the operation of North Field in the bombing of Japan and the deployment of atomic bombs to Hiroshima and Nagasaki. The North Field NHL also commemorates the Japanese military presence on the island, the American invasion, and the effort undertaken to construct the B-29 runways (DoN 2003:13-14).

Prehistoric Archaeological Resources. Ninety prehistoric resources considered NRHP-eligible occur on the MLA; 21 of those sites contain other components related to Japanese civilian and military occupations, and U.S. occupations. One of the seven oldest prehistoric sites in the Mariana Islands is Unai Chulu on the northwest coast of Tinian (Rainbird 2004:84). The site contains early Unai Lapita-style ceramics, indicators of the first wave of occupation in the islands. Ten archaeological sites on the MLA date from the Middle and Late Unai phases and occur along the coast and up to one kilometer inland. Fifteen sites have been identified at Huyong; these sites are located along the coast or on suitable agricultural land on the low terrace just above and behind the coast. *Latte* Period sites include *latte* sites, artifact scatters, isolated mortars, *latte* stone quarries, and caves and rockshelters. Twenty-eight sites with *latte* stones are located on the MLA.

Historic Archaeological Resources. Historic archaeological resources represent Japanese civilian and military occupations, U.S. invasion locations and remnants, and U.S. post invasion occupations, and total 547 resources. Two hundred fifty-seven historic resources related to the Japanese civilian or colonial occupation are considered NRHP-eligible; 17 of those sites contain other components related to prehistoric, post-war Chamorro, Japanese military, and U.S. occupations. The Nan'yo Kohatsu Kaisha (NKK: the South Seas Development Company) developed Tinian for sugar cane production and historic resources include remains of villages, factories, farmsteads, shrines, roads, railroad beds, agricultural remains, cisterns, and refuse dumps. One hundred fifty-two historic resources related to the Japanese military occupation have been identified as NRHP-eligible; 38 of those sites contain other components related to prehistoric, Japanese civilian, and U.S. occupations. Japanese military resources consist of two primary types: concrete structures, ruins, and remnant runways of the Japanese airfields, and defensive positions located in caves, along limestone cliffs, and at anticipated amphibious beach landings. Five U.S. invasion resources include Assault White Beach 2 (Unai Chulu), Assault White Beach 1 (Unai Babui), and three locations of landing craft fragments. One hundred thirty-three U.S. post-invasion resources are considered NRHP-eligible; 21 of those sites contain other components related to prehistoric, post-war Chamorro, and Japanese civilian and military occupations. Historic resources associated with the transformation of Tinian as a U.S. B-29 base include airfield features, building and structural remnants, revetments, A-bomb loading pits, gun positions, refuse dumps, cemeteries, machinery, internment camp features, and roads.

Historic Architectural Resources. No historic architectural resources were specifically identified in the UCRMP (DoN 2003).

Figure 3.13-6: North Field NHL. (Source: DoN 2007a)

Traditional Cultural Resources. No traditional cultural resources have yet been identified by the Chamorro or other ethnic groups. However, concerns over the possible disturbance and disposition of prehistoric human remains are likely, and the presence of petroglyphs and pictographs may indicate past or present ceremonial or religious activities. Prehistoric human remains have been recovered from caves and rockshelters as well as near *latte* sites. Three prehistoric sites exhibit pictographs or petroglyphs; one is a cave and the other two are located at Puntan Laminabot San Hilo and Unai Dankulo (Long Beach). A fourth cave site may also exhibit pictographs or petroglyphs, but has not been documented.

Current Protective Measures. A Programmatic Agreement (PA) regarding the implementation of military training on Tinian was signed and executed in 1999 (USCINCPAC REP GUAM/CNMI 1999b). The 1999 restrictions on training exercises correspond to mapped constrained areas designated as NT or NCRD. NT areas designate complete avoidance with no training exercises. NCRD areas indicate limited military training activities with no vehicular travel off-road, no pyrotechnic, no demolition, and no digging without prior written approval from the USCINCPAC REP. Beach access roads for ingress and egress by military and recreational vehicles are also clearly delineated on the constraints map, particularly in regard to Unai Chulu and Unai Dankulo (Long Beach). The PA also stipulates cultural resources monitoring of specific military training activities by qualified personnel. Three areas in the MLA are designated as NT areas; nine large areas are designated as NCRD (USCINCPAC REP GUAM/CNMI 1999b). Based on current consultations with the Guam SHPO, CNMI HPO, ACHP, and the NPS, a new PA is currently being negotiated for all military training activities proposed under the Preferred Alternative and will include additional mitigation measures and procedures. The PA is scheduled for signature in July 2009 prior to the release of the FEIS and the signed PA will be incorporated into the FEIS.

An Updated Cultural Resources Management Plan (UCRMP) was prepared in 2003 (DoN 2003) for the MLA on Tinian to ensure that cultural resources are managed in a planned and coordinated manner. The UCRMP established SOPs for new projects; inadvertent discovery of archaeological resources; inadvertent discovery of human remains; inadvertent disturbance to historic properties; during emergency situations; in the event of natural disasters; and for permits, leases, and contracts.

3.13.2.8 Other Guam/CNMI

Other Guam/CNMI facilities and locations include FDM and a 10 mi (16 km) safety/exclusionary zone around FDM; the Guam Army Reserve Center; the Guam Army National Guard Center; pier space and Angyuta Island on Rota; and the Saipan Army Reserve Center, pier space; and the east side of north Saipan.

Existing Conditions. FDM is an uninhabited 182-acre (74-hectare) island used since 1976 as a live air-to-ground bombing range (Global Security 2008) (Figure 2-2). A preliminary archaeological field survey of FDM was conducted in 1996 (Welch 1997). No archaeological sites or isolated non-modern artifacts were observed. The only cultural items that were identified were related to the modern military use of the island.

The Guam Army Reserve Center was constructed in 2003 on Barrigada Communications Annex by Dick Pacific Construction Company, Limited (Sommer 2004). The building is not older than 50 years and is not considered a historic architectural resource.

The Guam Army National Guard Center was constructed in 2001 on the Barrigada Communications Annex (Brooks 2001). The building is not older than 50 years and is not considered a historic architectural resource.

Leased pier space on Rota includes the use of Angyuta Island seaward of Song Song's West Harbor as a Forward Staging Base/overnight bivouac site (Figure 2-11). The island is adjacent to the commercial port facility that is used for boat refueling and maintenance. Angyuta Island has not been surveyed for cultural resources and it is unlikely that limited military use of the island as a staging base and bivouac area has destroyed subsurface sites or structures. Intact archaeological sites, some of which may be NRHP eligible, may occur.

The Saipan Army Reserve Center was constructed in 2006 (Donato 2006). The building is not older than 50 years and is not considered a historic architectural resource.

Leased pier space on Saipan consists of approximately 100 acres (40 hectares) in the Wharf area (Figure 2-8). This area is highly developed and it is likely that any previously existing cultural resources have been disturbed or destroyed. No intact cultural resources are likely to occur.

The east side of north Saipan is used by the Army Reserves who conduct land navigation training on non-DoD land.

Archaeological Resources. Archaeological resources, some of which may be NRHP eligible may occur on Angyuta Island off of Rota. No archaeological resources are expected to occur at any of the other Guam/CNMI locations as a result of pre-existing disturbance or development.

Historic Architectural Resources. No historic architectural resources have been identified at any of the other Guam/CNMI locations.

Traditional Cultural Resources. No traditional cultural resources have been identified at any of the other Guam/ CNMI locations.

Current Protective Measures. None.

3.13.2.9 Andersen Air Force Base

The main base of Andersen AFB covers 24.5 square miles (63 km^2), or about 15,460 acres (6,256 hectares), of a relatively flat, uplifted limestone plateau at the northern end of Guam (Figure 2-9). To the north, west, and east of the plateau, steep cliffs drop 500 to 600 ft (152 to 183 m) to a coastal terrace that extends 300 to 900 ft (91 to 274 m) to a rocky shoreline. The Tarague embayment is a small coastal flat along the north shore; it offers the only direct access to the ocean.

Areas on Andersen AFB include Northwest Field, Andersen South, Main Base, and Pati Point (Tarague Beach) CATM Range and EOD Pit. Northwest Field was one of the many major complexes constructed during WW II. One of its runways remains active for fixed-wing aircraft training. About 3,562 acres (1,441 hectares) in Northwest Field are the primary maneuver training areas available at Andersen AFB for field exercises and bivouacs. Andersen South consists of 1,922 acres (778 hectares). Open fields, wooded areas, vacant single family housing and vacant dormitories have been available in the past for staging, bivouac, equipment inspection, and small-unit tactics prior to aerial movement to other locations. Main Base at Andersen AFB is comprised of about 11,500 acres (4,654 hectares. The base is used for aviation, small arms, and Air Force EOD training. As a large working airfield, the base has a full array of operations, maintenance, and community support facilities. The Pati Point (Tarague Beach) consists of 21 acres (8.5 hectares); most training is conducted on the small arms range or the EOD pit.

Existing Conditions. Thirty-three cultural resources surveys and eleven other cultural non-survey related reports have been conducted at Andersen AFB and include overviews and assessments, Phase I survey, Phase II testing, and architectural survey of World War II resources (Figure 3.13-7) (USAF 2003; USAF 2004; Yee et al. 2004; USAF 2007). An additional 180 acres (73 hectares) is scheduled for archaeological survey and limited subsurface testing to identify the spatial extent and character of cultural deposits will be implemented at Tarague Beach in fall 2008 for the Joint Guam Program Office actions (DoN 2007a).

Cultural resources identified on Andersen AFB include prehistoric and historic sites, historic structures, and pictographs (USAF 2003: 25, Table 4). Twenty-four resources are listed, considered eligible, or are currently unevaluated for the NRHP (Yee et al. 2004; DeFant and Guerrero 2006; Hunter-Anderson and Moore 2003). The Pati Point Complex and the Tarague Beach Historic District are listed on the Guam Register (Guam Register of Historic Places 2008).

Prehistoric Archaeological Resources. Twelve prehistoric resources are considered NRHP-eligible and include the Tarague Historic District, the Pati Point Complex, and the Lafac site (USAF 2003). The Tarague Beach Historic District consists of a large set of archaeological sites (of all time periods) in the Tarague embayment. For traditional Chamorro sites (Pre-Contact and early Post-Contact), this is one of the most important areas at Andersen AFB. The extensive coastal dune areas and caves contain remains of Chamorro settlement dating back at least 3000 years. The coastal dunes and caves are also known to have been traditional burial areas and probably contain many unmarked and unrecorded burials (USAF 2003: Appendix F). The Tarague Beach Historic District includes one hundred and thirty nine archaeological localities. Sites included thirty-eight pre-contact complexes and one hundred and one discrete features, including twenty four rock alignments, twenty artifact scatters, sixteen rock shelters, ten rock mounds, seven bedrock mortars, six water bearing caves, four caves/sinks, and three trails (April, 2006). The Pati Point Complex is an ancient Chamorro village site with numerous occupational features, including caves, stone structures, possible latte stones, and dense midden deposits.

Historic Archaeological Resources. Eight historic resources considered NRHP eligible are a Spanish oven and well, a stone pier, North Field, a farmhouse, water catchment features, and a Japanese bunker (USAF, 2003).

Historic Architectural Resources. Northwest Field was determined eligible for the NRHP in 1998. Three historic structures are considered NRHP-eligible: the two reservoirs and a well (USAF 2003). Seven representative buildings (a radome tower building, a munitions support facility, and 5 storage igloos), two potential historic districts (Munitions Storage Areas 1 and 2), and one cultural landscape (North Field) have been recommended as potentially NRHP-eligible (USAF, 2004) but are not listed in the ICRMP. The radome tower building is a twelve-sided building constructed in 1956 and located on Mount Santa Rosa; it is important for its Cold War association and architectural style (Mason Architects 2004). The munitions support facility is an earth covered concrete reinforced building also important for its Cold War association and architectural style (USAF 2004). The igloos and munitions storage areas were built in 1954 when Andersen AFB was becoming the principal Strategic Air Command base in the Pacific during the Cold War. North Field is listed as an NRHP-eligible historic archaeological resource (USAF 2003) but also reflects the post-1956 Cold War landscape.

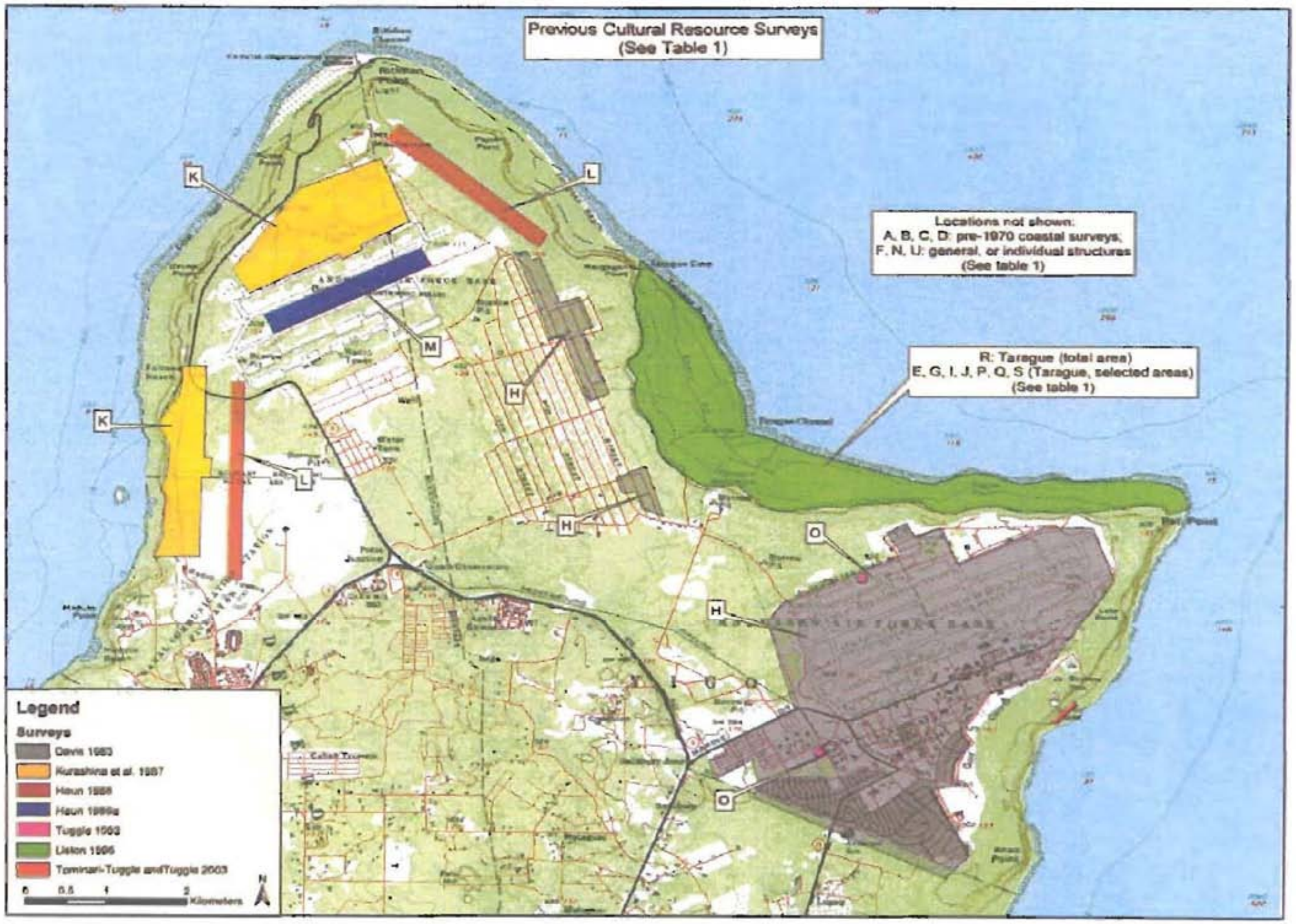


Figure 3.13-7: Major Cultural Resource Surveys Conducted at Andersen Air Force Base (Based on Yee *et al.* 2004)

Traditional Cultural Resources. Traditional cultural practices are known to exist on Andersen AFB and include hunting, fishing and gathering of forest products. No traditional cultural resources (locations or habitats) have yet been identified by the Chamorro or other ethnic groups (Welch et al. 2006). However, concerns over the possible disturbance and disposition of prehistoric human remains are likely, and the presence of petroglyphs and pictographs may indicate past or present ceremonial or religious activities. Prehistoric human remains have been recovered from caves and rockshelters as well as near *latte* sites. The coastal dunes and caves at Tarague Beach are known to have been traditional burial areas and probably contain many unmarked and unrecorded burials. Pictographs have been recorded at caves at Ritidian Point, and at Tarague (April 2006).

Current Protective Measures. A MOA regarding the implementation of military training on Guam was signed and executed in 1999 (USCINCPAC REP GUAM/CNMI 1999a). The 1999 restrictions on training exercises correspond to mapped constrained areas designated as NCRD. The northwest portion of Andersen AFB including Northwest Field is encompassed by a large NCRD zone. The MOA also stipulates an annual commemoration of the last World War II bombing mission that took off from Northwest Field; development of a long-term management plan for Northwest Field; and consultation with the Guam HPO to avoid historic properties during rapid runway repair training. As a result of this MOA, a permanent marker to the last mission of World War II has been established at Northwest Field.

A MOA regarding the RED HORSE Beddown Initiatives at Northwest Field, Andersen AFB was signed and executed in 2006 (USAF, 2006b). The MOA stipulated Historic American Building Survey/Historic American Engineering Record (HABS/HAER) documentation of the Northwest Field runway complex and previously existing facilities; and implementation of cultural resources inventory and evaluation investigations for areas scheduled for ground disturbing activities. As a result of this MOA, a runway repair location has been established at Northwest Field for the RED HORSE Beddown Initiatives.

An ICRMP was prepared in 2003 (USAF 2003) for Andersen AFB to ensure that cultural resources are managed in a planned and coordinated manner. The ICRMP established SOPs for the review of work orders; inadvertent discovery of archaeological resources; inadvertent discovery of human remains; ground disturbing activity in archaeological sensitive areas; request for access by off-base personnel; requests to conduct archaeological studies; during emergency situations; in the event of natural disasters; for permits, leases, and contracts; for enforcement and monitoring; and installation restoration projects.

Based on current consultations with the Guam SHPO, CNMI HPO, ACHP, and the NPS, a new PA is currently being negotiated for all military training activities proposed under the Preferred Alternative and will include additional mitigation measures and procedures. The PA is scheduled for signature in July 2009 prior to the release of the FEIS and the signed PA will be incorporated into the FEIS.

3.13.3 Environmental Consequences

Federal laws and regulations have established the requirements for identifying, evaluating, and mitigating impacts on cultural resources. Pertinent provisions of NHPA and ARPA address management and treatment of cultural resources. Provisions of NHPA will be addressed in more detail below. ARPA provides for site protection through penalties for non-compliance with its statutes and provides for authorizing archaeological investigations.

Under NHPA, historic properties are defined on the basis of NRHP criteria (36 CFR § 60.4) in consultation with SHPO. An undertaking is considered to have an effect on a historic property when the undertaking may alter characteristics of the property that may qualify it for inclusion in the NRHP. An effect is considered adverse when it diminishes the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Adverse effects on historic properties would include, but not be limited to:

- Physical destruction, damage, or alteration of all or part of the property;
- Isolation of the property from or alteration of the character of the property’s setting when that character contributes to the property’s qualification for the NRHP;
- Introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting;
- Neglect of a property resulting in its deterioration or destruction; and
- Transfer, lease, or sale of the property (36 CFR Part 800.9[b]).

Under NHPA, assessing impacts involves identifying activities that could directly or indirectly affect NRHP-eligible resources, identifying known or expected NRHP-eligible resources in the area of potential effects, and determining the level of impacts on the resources. Possible impact determinations include a finding of no effect, no adverse effect, or an adverse effect on significant resources (36 CFR Part 800.4-9).

Under NEPA, impacts on cultural resources are explicitly identified as attributes that must be addressed to determine the significance of a project’s anticipated environmental effect. The potential for adverse effects on cultural resources is considered in this NEPA assessment. An adverse effect on a historic property, however, does not necessarily equate to a significant impact under NEPA. Under NEPA, a significant impact can be mitigated to less than significant through data recovery or other treatment measures. In assessing impacts on cultural resources under NEPA, 40 CFR Part 1508.27 defines significance in terms of context and intensity. These elements include consideration of the impacts on the community, the importance of a site, unique characteristics, and the severity of the impact.

If an NRHP-eligible site would be adversely affected by training activities, appropriate treatment will be identified through consultation with the SHPO and other consulting parties. For archaeological resources, avoidance is preferred. However, when that is not possible, data recovery will be considered.

Impacts on cultural resources can be either direct or indirect. Direct impacts on archaeological resources are usually those from ground disturbance. Architectural resources may be directly impacted by modifications to the structure. Indirect impacts on significant cultural resources can involve alterations in its setting, increased access leading to vandalism, or changes in land status without adequate protection of the resources. Impacts on traditional cultural properties can be determined through consultation with the affected ethnic groups.

3.13.3.1 No Action Alternative

Under the No Action Alternative, the current training events and level of activity in the MIRC would remain the same. Current training activities would continue to be conducted in accordance with existing Section 106 compliance documents: the MOA for Guam (USCINCPAC REP GUAM/CNMI 1999a), the PA for Tinian (USCINCPAC REP GUAM/CNMI 1999b), and the MOA for Northwest Field on Guam (USAF 2006b), to protect NRHP-listed or eligible cultural resources.

In addition to the military training agreement documents, cultural resources will continue to be managed in accordance with procedures identified in the *Updated Cultural Resources Management Plan for the Tinian Military Lease Area (MLA)* (DoN 2003), the *Regional Integrated Cultural Resources Management Plan for COMNAVREG Marianas Lands, Volume I: Guam* (DoN, 2005b), and the *Integrated Cultural Resources Management Plan for Andersen Air Force Base, Guam, 2003 Update* (USAF,2003).

Airspace Use. Nine different airspace locations are associated with the MIRC Training areas: special use airspace W-517, located 50 mi (80 km) south-southwest of Guam; restricted airspace R-7201, surrounding the FDM bombing range, and seven FAA assigned airspace locations. Aircraft overflights and land detonations from Marine Corps, Navy, and Air Force training activities may affect any cultural resources. No known cultural resources have been located under the nine different airspace locations; however, several WWII submerged cultural resources are likely to occur in the open ocean areas beneath the airspace locations. Even though the current training events and level of activity would remain the same, geographical extent may vary and additional submerged resources would be affected (Table 3.13-2).

Guam Offshore. Three areas comprise Guam Offshore locations: Agat Bay including the Agat Bay DZ and Floating Mine Neutralization Area, Tipalao Cove, and the Piti Floating Mine Neutralization Area. An extensive literature review of all known submerged cultural resources in Micronesia was conducted by the Submerged Cultural Resources Unit of the National Park Service (NPS) (Carrell et al. 1991a). In addition, several areas in the Mariana Islands, including Guam, Saipan, and Tinian, were surveyed for cultural resources by the NPS and U.S. Navy divers. No known submerged cultural resources occur under Agat Bay, Tipalao Cove, or in the Piti Floating Mine Neutralization Area (Carrell et al. 1991b. 1991c).. Underwater mine warfare, hydrographic surveys, and underwater demolition activities conducted by the Navy would occur at the same level of activity, however, geographical extent may vary and additional submerged cultural resources would be affected (Table 3.13-3).

Guam Commercial Harbor. Guam commercial harbor is defined as the Outer Apra Harbor. Three submerged resources which are listed, considered eligible, or are currently unevaluated for the NRHP, are located in the Outer Apra Harbor including the World War I era *SMS Cormoran* and WWII *Tokai Maru*. In accordance with the 1999 MOA for the implementation of military training on Guam (USCINCPAC REP GUAM/CNMI, 1999a), two areas within Outer Apra Harbor are designated as NT areas; seven additional areas within the harbor are designated as NCRD (USCINCPAC REP GUAM/CNMI 1999a). Because hydrographic surveys and underwater demolition activities conducted by the Navy would not occur in NT areas and strict guidelines would be followed in NCRD areas, these training activities would not affect any submerged cultural resources (Table 3.13-4).

Apra Harbor Naval Complex (Main Base). Cultural resources identified at the Main Base include prehistoric, historic, and multi-component archaeological sites, historic buildings and structures, monument and memorials, objects, a cemetery, and a paleoenvironmental site. One hundred twenty-two resources are listed, considered eligible or currently unevaluated for the NRHP including the Cable Station Remains, the Japanese Midget Submarine, Orote Airfield, Orote Historical Complex, and Sumay Cemetery.

In accordance with the 1999 MOA for the implementation of military training on Guam (USCINCPAC REP GUAM/CNMI, 1999a), one area in the Main base is designated as an NT area; four additional areas within the annex are designated as NCRD (USCINCPAC REP GUAM/CNMI 1999a). Because Army, Marine Corps and Navy training activities would not occur in NT areas and strict guidelines would be followed in NCRD areas, these training activities would not affect any archaeological resources (Table 3.13-5). NRHP-listed Orote Airfield encompasses training areas consisting of the Orote Point Airfield/Runway, Orote Point Triple Spot, Orote Point CQC House, Orote Point KD Range, and Orote Point Small Arms Range. Architectural resources are also located near Orote Point Radio Tower and on Gab Gab Beach. Current training activities do not involve the alteration or demolition of architectural resources or occur in close enough proximity to create audio or vibration impacts. Current training activities do not affect architectural resources.

Table 3.13-2: Cultural Resources and Protective Measures for the Training Activities Associated with the MIRC Airspace and FDM

Training Event Type	Training Event Name	Location	Training Area	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures
Marine Corps Training							
Direct Fires		FDM		No	No	No	None Required
		Airspace	ATCAA 3A	Possible	No	No	None Currently Identified
Navy Training							
Surface Warfare (SUW)	Surface to Surface Gunnery Exercise	W-517		Possible	No	No	None Currently Identified
	Air to Surface Gunnery Exercise	W-517		Possible	No	No	None Currently Identified
	Visit Board Search & Seizure			No	No	No	None Required
Strike Warfare (STW)	Air to Ground Bombing Exercises	FDM		No	No	No	None Required
	Air to Ground Missile Exercises	FDM		No	No	No	None Required
Amphibious Warfare (AMW)	Naval Surface Fire Support	FDM		No	No	No	None Required
Air Force Training							
Counter Land		FDM		No	No	No	None Required
Counter Sea (Chaff)		Airspace	W-517	Possible	No	No	None Currently Identified
		Airspace	ATCAA 1	Possible	No	No	None Currently Identified

Table 3.13-2: Cultural Resources and Protective Measures for the Training Activities Associated with the MIRC Airspace and FDM (Continued)

Training Event Type	Training Event Name	Location	Training Area	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures
		Airspace	ATCAA 2	Possible	No	No	None Currently Identified
ISR/Strike	Air-to-Ground	FDM		No	No	No	None Required
	Air-to-Air	Airspace	W-517	Possible	No	No	None Currently Identified
		Airspace	ATCAA 1	Possible	No	No	None Currently Identified
		Airspace	ATCAA 2	Possible	No	No	None Currently Identified
		Airspace	ATCAA 3A	Possible	No	No	None Currently Identified
		Airspace	ATCAA 3B	Possible	No	No	None Currently Identified
		Airspace	ATCAA 3C	Possible	No	No	None Currently Identified
		Airspace	ATCAA 5	Possible	No	No	None Currently Identified
		Airspace	ATCAA 6	Possible	No	No	None Currently Identified
		Airspace	R-7201	Possible	No	No	None Currently Identified

Table 3.13-3: Cultural Resources and Protective Measures for the Training Activities Associated with Guam Offshore Locations

Training Event Type	Training Event Name	Location	Training Area	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures
Navy Training							
Mine Warfare (MIW)		Guam Offshore	Agat Bay	Possible	No	No	None Currently Identified
Amphibious Warfare (AMW)	Hydrographic Surveys	Guam Offshore	Tipalao Cove	Possible	No	No	None Currently Identified
Explosive Ordnance Disposal (EOD)	Underwater Demolition	Guam Offshore	Agat Bay	Possible	No	No	None Currently Identified
		Guam Offshore	Piti Floating Mine Neutralization Area	Possible	No	No	None Currently Identified

Table 3.13-4: Cultural Resources and Protective Measures for the Training Activities Associated with Guam Commercial Harbor

Training Event Type	Training Event Name	Location	Training Area	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures
Navy Training							
Amphibious Warfare (AMW)	Hydrographic Surveys	Guam Commercial Harbor	Outer Apra Harbor	Yes	No	No	Avoidance 2 NT zones 7 NCRD zones
Explosive Ordnance Disposal (EOD)	Underwater Demolition	Guam Commercial Harbor	Outer Apra Harbor	Yes	No	No	Avoidance 2 NT zones 7 NCRD zones

Table 3.13-5: Cultural Resources and Protective Measures for the Training Activities Associated with the Apra Harbor Naval Complex

Training Event Type	Training Event Name	Island	Location	Training Area	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures
Army Training								
Field Training Exercise (FTX)		Guam	Main base	Polaris Point Field	No	No	No	None Required
		Guam	Main base	Orote Point Airfield/Runway	No	Yes	No	Avoidance of Architectural Resources
Parachute Insertions and Air Assault		Guam	Main base	Orote Point Triple Spot	No	Yes	No	Avoidance of Architectural Resources
		Guam	Main base	Polaris Point Field	No	No	No	None Required
		Guam	Main base	Orote Point Airfield/Runway	No	Yes	No	Avoidance of Architectural Resources
Military Operations in Urban Terrain (MOUT)		Guam	Main base	Orote Point Close Quarters Combat (CQC) House	No	Yes	No	Avoidance of Architectural Resources
Marine Corps Training								
Assault Support (AS)		Guam	Main base	Polaris Point Field	No	No	No	None Required
		Guam	Main base	Orote Point KD Range	No	Yes	No	Avoidance of Architectural Resources
Direct Fires		Guam	Main base	Orote Point KD Range	No	Yes	No	Avoidance of Architectural Resources

Table 3.13-5: Cultural Resources and Protective Measures for the Training Activities Associated with the Apra Harbor Naval Complex (Continued)

Training Event Type	Training Event Name	Island	Location	Training Area	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures
Navy Training								
Naval Special Warfare (NSW)	Breaching	Guam	Main base	Orote Point CQC House	No	Yes	No	Avoidance of Architectural Resources
Amphibious Warfare (AMW)	Marksmanship	Guam	Main base	Orote Point Small Arms Range	No	Yes	No	Avoidance of Architectural Resources
		Guam	Main base	Orote Point KD	No	Yes	No	Avoidance of Architectural Resources
Explosive Ordnance Disposal (EOD)	Land Demolition	Guam	Main base	Inner Apra Harbor	No	No	No	None Required
		Guam	Main base	Gab Gab Beach	Yes	Yes	Possible	Avoidance 1 NCRD zone
		Guam	Main base	Reserve Craft Beach	No	No	No	None Required
		Guam	Main base	Polaris Point Field	No	No	No	None Required
		Guam	Main base	Orote Point Airfield/Runway	No	Yes	No	Avoidance of Architectural Resources
		Guam	Main base	Orote Point CQC House	No	Yes	No	Avoidance of Architectural Resources

Table 3.13-5: Cultural Resources and Protective Measures for the Training Activities Associated with the Apra Harbor Naval Complex (Continued)

Training Event Type	Training Event Name	Island	Location	Training Area	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures
Navy Training (Continued)								
Logistics and Combat Services Support	Combat Mission Area	Guam	Main base	Orote Pont Airfield/Runway	No	Yes	No	Avoidance of Architectural Resources
	Command and Control (C2)	Guam	Main base	Reserve Craft Beach	No	No	No	None Required
Combat Search and Rescue (CSAR)	Embassy Reinforcement	Guam	Main base	Inner Apra Harbor	No	No	No	None Required
		Guam	Main base	Kilo Wharf	No	No	No	None Required
		Guam	Main base	Reserve Craft Beach	No	No	No	None Required
		Guam	Main base	Orote Point Airfield/Runway	No	Yes	No	Avoidance of Architectural Resources
		Guam	Main base	Orote Point CQC House	No	Yes	No	Avoidance of Architectural Resources
		Guam	Main base	Orote Point Triple Spot	No	Yes	No	Avoidance of Architectural Resources
	Anti-Terrorism (AT)	Guam	Main base	Inner Apra Harbor	No	No	No	None Required
		Guam	Main base	Polaris Point Site III	No	No	No	None Required
		Guam	Main base	Orote Annex Emergency Detonation Site	No	No	No	None Required

Navy Munitions Site. Cultural resources identified in the Navy Munitions Site include prehistoric, historic, and multi-component archaeological sites, historic buildings and structures, a monument, and objects. Three hundred and eighty-seven resources are listed, considered eligible or currently unevaluated for the NRHP including the Bona Site, the Fena Massacre Site and the West Bona Site.

In accordance with the 1999 MOA for the implementation of military training on Guam (USCINCPAC REP GUAM/CNMI 1999a), four areas in the Navy Munitions Site are designated as NT areas; the eastern and southern portions of the annex are designated as NCRD. Because Army, Marine Corps and Navy training activities would not occur in NT areas and strict guidelines would be followed in NCRD areas, these training activities would not affect any archaeological resources (Table 3.13-6). Architectural resources are also located near the Breacher House; however, current training activities do not involve the alteration or demolition of architectural resources or occur in close enough proximity to create audio or vibration impacts. Current training activities do not affect architectural resources.

Communications Annex. Cultural resources identified at the Communications Annex at Finegayan include prehistoric and historic archaeological sites. Twenty-five resources are listed, considered eligible or currently unevaluated for the NRHP. Three twentieth century sites had been previously recorded on the Barrigada property. No resources in the Barrigada area are listed on the Guam Register or NRHP. Army and Navy training activities are not located in areas containing cultural resources (Table 3.13-7). Current training activities do not affect cultural resources in the Communications Annex.

Tinian. Cultural resources identified on the MLA include the North Field NHL as well as individual resources such as prehistoric and historic archaeological sites, historic buildings and structures, shrines, petroglyphs and pictographs, and objects. Over six hundred (n=612) resources are listed, considered eligible, or currently unevaluated for the NRHP including the Unai Dankulo (Long Beach) Petroglyph site.

In accordance with the 1999 PA for military training on Tinian (USCINCPAC REP GUAM/CNMI 1999b), three areas in the MLA are designated as NT areas and nine large areas are designated as NCRD. Beach access roads for ingress and egress by military and recreational vehicles are also clearly delineated on the constraints map, particularly in regard to Unai Chulu and Unai Dankulo (Long Beach). Because Army, Marine Corps and Navy training activities would not occur in NT areas and strict guidelines would be followed in NCRD areas, these training activities would not affect any cultural resources (Table 3.13-8). The PA also stipulates cultural resources monitoring of specific military training activities by qualified personnel (USCINCPAC REP GUAM/CNMI 1999b).

Other Guam/CNMI. Other Guam/CNMI facilities and locations considered assets for this project include FDM, the Guam Army Reserve Center, the Guam Army National Guard Center, pier space and Angyuta Island on Rota, and the Saipan Army Reserve Center, pier space, and the east side of north Saipan. With the exception of Angyuta Island on Rota, no cultural resources have been identified at any of the facilities. Current training activities on Angyuta Island would occur at the same level of activity and no additional cultural resources would be affected.

Table 3.13-6: Cultural Resources and Protective Measures for the Training Activities Associated with the Navy Munitions Site, Guam

Training Event Type	Training Event Name	Island	Location	Training Area	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures
Army Training								
Field Training Exercise (FTX)		Guam	Navy Munitions Site	Northern Land Navigation Area	Yes	No	Possible	Avoidance 1 NCRD zone
Parachute Insertions and Air Assault		Guam	Navy Munitions Site	Breacher House	No	Yes	No	Avoidance of Architectural Resources
MOUT		Guam	Navy Munitions Site	Breacher House	No	Yes	No	Avoidance of Architectural Resources
Marine Corps Training								
Operational Maneuver		Guam	Navy Munitions Site	Northern Land Navigation Area	Yes	No	Possible	Avoidance 1 NCRD zone
		Guam	Navy Munitions Site	Southern Land Navigation Area	Yes	No	Possible	Avoidance 1 NT zone 1 NCRD zone
MOUT		Guam	Navy Munitions Site	Breacher House	No	Yes	No	Avoidance of Architectural Resources

Table 3.13-6: Cultural Resources and Protective Measures for the Training Activities Associated with the Navy Munitions Site, Guam (Continued)

Training Event Type	Training Event Name	Island	Location	Training Area	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures
Navy Training								
Naval Special Warfare (NSW)	Breaching	Guam	Navy Munitions Site	Breacher House	No	Yes	No	Avoidance of Architectural Resources
Explosive Ordnance Disposal (EOD)	Land Demolition	Guam	Navy Munitions Site	Breacher House	No	Yes	No	Avoidance of Architectural Resources
		Guam	Navy Munitions Site	Ordnance Annex Emergency Detonation Site	Yes	No	Possible	Avoidance 1 NCRD zone
		Guam	Navy Munitions Site	Northern Land Navigation Area	Yes	No	Possible	Avoidance 1 NCRD zone
		Guam	Navy Munitions Site	Galley Building 460	No	No	No	None Required
		Guam	Navy Munitions Site	Southern Land Navigation Area	Yes	No	Possible	Avoidance 1 NT zone 1 NCRD zone
Combat Search and Rescue (CSAR)	Anti-Terrorism (AT)	Guam	Navy Munitions Site	Breacher House	No	Yes	No	Avoidance of Architectural Resources

Table 3.13-7: Cultural Resources and Protective Measures for the Training Activities Associated with the Communications Annex

Training Event Type	Training Event Name	Island	Location	Training Area	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures
Army Training								
Surveillance and Reconnaissance (S & R)		Guam	Finegayan Communications Annex	Finegayan House	No	No	No	None Required
		Guam	Barrigada Communications Annex	Barrigada Housing	No	No	No	None Required
Military Operations in Urban Terrain (MOUT)		Guam	Barrigada Communications Annex	Barrigada Housing	No	No	No	None Required
Navy Training								
Amphibious Warfare (AMW)	Marksmanship	Guam	Finegayan Communications Annex	Finegayan Small Arms Range	No	No	No	None Required
Explosive Ordnance Disposal (EOD)	Land Demolition	Guam	Barrigada Communications Annex	Barrigada Housing	No	No	No	None Required

Table 3.13-8: Cultural Resources and Protective Measures for the Training Activities Associated with the Tinian MLA

Training Event Type	Island	Location	Training Area	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures
Army Training							
Surveillance and Reconnaissance (S & R)	Tinian		Exclusive Military Use Area (EMUA)	Yes	Yes	Possible	Avoidance 3 NT zones 9 NCRD zones
	Tinian		Lease Back Area (LBA)	Yes	Yes	Possible	Avoidance
Field Training Exercise (FTX)	Tinian		EMUA	Yes	Yes	Possible	Avoidance 3 NT zones 9 NCRD zones
Marine Corps Training							
Ship to Objective Maneuver (STOM)	Tinian		EMUA	Yes	Yes	Possible	Avoidance 3 NT zones 9 NCRD zones
Non-Combatant Evacuation Order (NEO)	Tinian		EMUA	Yes	Yes	Possible	Avoidance 3 NT zones 9 NCRD zones
Assault Support (AS)	Tinian		EMUA	Yes	Yes	Possible	Avoidance 3 NT zones 9 NCRD zones

Table 3.13-8: Cultural Resources and Protective Measures for the Training Activities Associated with the Tinian MLA (Continued)

Training Event Type	Island	Location	Training Area	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures
Marine Corps Training (Continued)							
Reconnaissance and Surveillance (R & S)	Tinian		EMUA	Yes	Yes	Possible	Avoidance 3 NT zones 9 NCRD zones
Navy Training							
Amphibious Warfare (AMW) **Hydrographic Surveys**	Tinian		EMUA	Yes	Yes	Possible	Avoidance 3 NT zones 9 NCRD zones

Andersen AFB. Cultural resources identified on Andersen AFB include prehistoric and historic sites, historic structures, and pictographs. Twenty-four resources are listed, considered eligible, or are currently unevaluated for the NRHP including the Pati Point Complex, the Tarague Beach Historic District, the Northwest Field runways, the two reservoirs, and a well. Seven representative buildings (a radome tower building, a munitions support facility, and 5 storage igloos), two potential historic districts (Munitions Storage Areas 1 and 2), and one cultural landscape (North Field) have also been recommended as potentially NRHP-eligible (USAF 2004).

In accordance with the 1999 MOA for the implementation of military training on Guam (USCINCPAC REP GUAM/CNMI 1999a), the northwest portion of Andersen AFB including Northwest Field is encompassed by a large NCRD zone. Because Army, Marine Corps, and Air Force training activities follow strict guidelines in the NCRD area, these training activities would not affect any cultural resources at Northwest Field (Table 3.13-9). The MOA also stipulates an annual commemoration of the last World War II bombing mission that took off from Northwest Field; development of a long-term management plan for Northwest Field; and consultation with the Guam HPO to avoid historic properties during rapid runway repair training.

A MOA regarding the Northwest Field Beddown Initiatives at Andersen AFB stipulated HABS/HAER documentation of the Northwest Field runway complex and previously existing facilities; and implementation of cultural resources inventory and evaluation investigations for areas scheduled for ground disturbing activities prior to project construction and implementation (USAF 2006b).

Current training activities include Northwest Field, Andersen South,,Tarague Beach Small Arms Range and specific ingress and egress routes. Current training activities do not affect archaeological resources.

Summary. Under the No Action Alternative, the current training events and level of activity in the MIRC would remain the same. Current training activities would continue to be conducted in accordance with existing Section 106 compliance documents: the MOA for Guam (USCINCPAC REP GUAM/CNMI 1999a), the PA for Tinian (USCINCPAC REP GUAM/CNMI 1999b), and the MOA for Northwest Field on Guam (USAF 2006b), to protect NRHP-listed or eligible cultural resources. Therefore, the No Action Alternative will have no adverse effects on cultural resources.

Table 3.13-9: Cultural Resources and Protective Measures for Training Activities at Andersen AFB

Training Event Type	Training Event Name	Island	Location	Training Area	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures
Army Training								
Field Training Exercise (FTX)		Guam	Andersen AFB	Northwest Field	Yes	Yes	No	Avoidance 1 NCRD zone
		Guam	Andersen AFB	Andersen South Housing	No	No	No	None Required
Live Fire		Guam	Andersen AFB	Tarague Beach Small Arms Range	Yes	No	Possible	Avoidance
Military Operations in Urban Terrain (MOUT)		Guam	Andersen AFB	Andersen South Housing	No	No	No	None Required
Marine Corps Training								
Protect and Secure Area of Operations		Guam	Andersen AFB	Northwest Field	Yes	Yes	No	Avoidance 1 NCRD zone
Air Force Training								
Airlift		Guam	Andersen AFB	Northwest Field	Yes	Yes	No	Avoidance 1 NCRD zone
Air Expeditionary		Guam	Andersen AFB	Northwest Field	Yes	Yes	No	Avoidance 1 NCRD zone
Force Protection		Guam	Andersen AFB	Northwest Field	Yes	Yes	No	Avoidance 1 NCRD zone
		Guam	Andersen AFB	Tarague Beach Small Arms Range	Yes	No	Possible	Avoidance
		Guam	Andersen AFB	Main Base	No	No	No	None Required

Table 3.13-9: Cultural Resources and Protective Measures for Training Activities at Andersen AFB (Continued)

Training Event Type	Training Event Name	Island	Location	Training Area	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures
RED HORSE	Silver Flag Training	Guam	Andersen AFB	Northwest Field	Yes	Yes	No	Avoidance 1 NCRD zone
	Commando Warrior Training	Guam	Andersen AFB	Northwest Field	Yes	Yes	No	Avoidance 1 NCRD zone
	Combat Communications	Guam	Andersen AFB	Northwest Field	Yes	Yes	No	Avoidance 1 NCRD zone

3.13.3.2 Alternative 1

Under Alternative 1, the number of training exercises in the MIRC would increase; however, the nature of the training activities would not change substantially. Increased training activity would result in upgrades and modernization of some existing ranges and training areas, including Anti-Submarine Warfare exercises, Mine Warfare training, upgrade of Combined Arms Warfare ranges, conversion of existing airspace, and placement of portable Electronic Combat (EC) threat emitters on other CNMI islands (Table 3.13-10).

Major Exercises. Although the number of training exercises would increase under Alternative 1 and include multi-Service and Joint exercises, the types of training activities would remain the same. Additional training activities under Alternative 1 may affect WWII submerged cultural resources and unidentified submerged cultural resources offshore of Guam, and cultural resources on Angyuta Island near Rota. Based on current consultations with the Guam SHPO, CNMI HPO, ACHP, and the NPS, a new PA is currently being negotiated for all military training activities proposed under the Preferred Alternative and will include additional mitigation measures and procedures. The development of NT areas and NCRD areas will help mitigate the effects that increased access would have on cultural resources and make people aware of the resources and the repercussions of impacting them. The PA is scheduled for signature in July 2009 prior to the release of the FEIS and the signed PA will be incorporated into the FEIS.. The PA will supercede all previous Section 106 compliance documents for the military training activities in the MIRC.

ISR/Strike. Cultural resources impacts associated with the ISR/Strike have been analyzed in the *2006 Establishment and Operation of an Intelligence, Surveillance and Reconnaissance/Strike, Andersen Air Force Base EIS*. The Air Force completed the Section 106 process with the Guam SHPO and conducted cultural resource surveys in the previously unsurveyed area in which ISR/Strike facilities would be constructed. The Guam SHPO concurred that no further investigations on prehistoric sites would provide additional information. No cultural resources were affected.

Anti-Submarine Warfare (ASW). Submerged cultural resources could occur in areas delineated for an Underwater Training or Tracking Range. Training activities associated with ASW training may affect submerged cultural resources.

Military Operations in Urban Terrain (MOUT). Only repair and maintenance of existing MOUT facilities are proposed under Alternative 1. There would be no impacts to cultural resources.

Summary. Based on current consultations with the Guam SHPO, CNMI HPO, ACHP, and the NPS, a new PA is currently being negotiated for all military training activities proposed under the Preferred Alternative and will include additional mitigation measures and procedures. The PA is scheduled for signature in July 2009 prior to the release of the FEIS and the signed PA will be incorporated into the FEIS. Under Alternative 1, increased training activities in the MIRC would not adversely affect cultural resources because protective measures as identified in the new PA, are in place for sensitive areas. Upgrades of training facilities could affect cultural resources, however, they will be conducted in such a manner as to avoid cultural resources. If avoidance is not possible, consultation with the appropriate Historic Preservation Officer would be initiated and any adverse effect to cultural resources would be resolved prior to upgrading existing training facilities.

Table 3.13-10: Cultural Resources Impacts and Protective Measures for Alternative 1

Activity	Island	Location	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures	Impacts	Mitigation Measures
Training		Open Ocean	Possible	No	No	No protective measures feasible	Potential impacts	Consultation with Appropriate HPO
	Guam	Guam Offshore	Possible	No	No	Cultural Resources Survey	Potential impacts	Consultation with Appropriate HPO
	Guam	Guam Commercial Harbor	Yes	No	No	Avoidance –NT zones Guidelines- NCRD zones	No impacts	
	Guam	Apra Harbor Naval Complex	Yes	Yes	Possible	Avoidance –NT zones Guidelines- NCRD zones	No impacts	
	Guam	Navy Munitions Site	Yes	Yes	Possible	Avoidance –NT zones Guidelines- NCRD zones	No impacts	
	Guam	Finegayan and Barrigada Communications Annexes	No	No	No	None Required	No impacts	
	Tinian	EMUA	Yes	Yes	Possible	Avoidance –NT zones Guidelines- NCRD zones	No impacts	
		LBA	Yes	Yes	Possible		No impacts	
	Other Guam/ CNMI	Saipan, Rota	Yes (Angyuta Island)	No	No	Avoidance	Potential impacts	Consultation with Appropriate HPO

Table 3.13-10: Cultural Resources Impacts and Protective Measures for Alternative 1 (Continued)

Activity	Island	Location	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures	Impacts	Mitigation Measures
	Guam	Andersen AFB	Yes	No	Possible	Avoidance –NT zones Guidelines-NCRD zones	No impacts	
ISR/Strike	Guam	Andersen AFB	No	No	No	None Required	No impacts	
Anti-Submarine Warfare (ASW)			Possible	No	No	Avoidance through siting	Potential impacts	Consultation with Appropriate HPO
Military Operations in Urban Terrain (MOUT)			No	No	No	None Required	No Impacts	

3.13.3.3 Alternative 2

Under Alternative 2, the number of training exercises in the MIRC would further increase in comparison to Alternative 1; however, the nature of the training activities would not change substantially. In addition to upgrades and modernization of some existing ranges and training areas proposed under Alternative 1, additional major at sea exercises would be included (Table 3.13-11).

Major at Sea Exercise. Although the number of training exercises would increase under Alternative 2, the types of training activities would remain the same. Additional training activities under Alternative 2 may affect WWII submerged cultural resources and unidentified submerged cultural resources offshore of Guam and cultural resources on Angyuta Island near Rota. Based on current consultations with the Guam SHPO, CNMI HPO, ACHP, and the NPS, a new PA is currently being negotiated for all military training activities proposed under the Preferred Alternative and will include additional mitigation measures and procedures. The development of NT areas and NCRD areas will help mitigate the effects that increased access would have on cultural resources and make people aware of the resources and the repercussions of impacting them. The PA is scheduled for signature in July 2009 prior to the release of the FEIS and the signed PA will be incorporated into the FEIS. The PA will supersede all previous Section 106 compliance documents for the military training activities in the MIRC.

Summary. Based on current consultations with the Guam SHPO, CNMI HPO, ACHP, and the NPS, a new PA is currently being negotiated for all military training activities proposed under the Preferred Alternative and will include additional mitigation measures and procedures. The PA is scheduled for signature in July 2009 prior to the release of the FEIS and the signed PA will be incorporated into the FEIS. Under Alternative 2, increased major at sea training activities in the MIRC would not adversely affect cultural resources because protective measures as identified in the new PA, are in place for sensitive areas. Upgrades of training facilities and placement of portable training equipment could affect cultural resources, however they would be conducted in such a manner as to avoid cultural resources. If avoidance is not possible, consultation with the appropriate Historic Preservation Officer would be initiated and any adverse effect to cultural resources would be resolved prior to upgrading existing training facilities and the placement of portable training equipment.

Table 3.13-11: Cultural Resources Impacts and Protective Measures for Alternative 2

Activity	Island	Location	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures	Impacts	Mitigation Measures
Training		Open Ocean	Possible	No	No	No protective measures feasible	Potential impacts	Consultation with Appropriate HPO
	Guam	Guam Offshore	Possible	No	No	Cultural Resources Survey	Potential impacts	Consultation with Appropriate HPO
	Guam	Guam Commercial Harbor	Yes	No	No	Avoidance –NT zones Guidelines-NCRD zones	No impacts	
	Guam	Apra Harbor Naval Complex	Yes	Yes	Possible	Avoidance –NT zones Guidelines-NCRD zones	No impacts	
	Guam	Navy Munitions Site	Yes	Yes	Possible	Avoidance –NT zones Guidelines-NCRD zones	No impacts	
	Guam	Finegayan and Barrigada Communications Annexes	No	No	No	None Required	No impacts	
	Tinian	EMUA	Yes	Yes	Possible	Avoidance –NT zones Guidelines-NCRD zones	No impacts	
		LBA	Yes	Yes	Possible		No impacts	

Table 3.13-11: Cultural Resources Impacts and Protective Measures for Alternative 2 (Continued)

Activity	Island	Location	Archaeological Resources	Architectural Resources	Traditional Resources	Protective Measures	Impacts	Mitigation Measures
	Other Guam/ CNMI	Saipan, Rota	Yes	No	No	Avoidance	Potential impacts	Consultation with the Appropriate HPO
	Guam	Andersen AFB	Yes	No	Possible	Avoidance –NT zones Guidelines- NCRD zones	No impacts	
ISR/Strike	Guam	Andersen AFB	No	No	No	None Required	No impacts	
Anti-Submarine Warfare (ASW)			Possible	No	No	Avoidance through siting	Potential impacts	Consultation with Appropriate HPO
Military Operations in Urban Terrain (MOUT)			No	No	No	None Required	No impacts	

3.13.4 Unavoidable Significant Environmental Effects

There will be no unavoidable adverse effects on cultural resources from the No Action Alternative, Alternative 1 and Alternative 2.

3.13.5 Summary of Environmental Effects (NEPA and EO 12114)

Table 3.13-12 summarizes effects and protective measures for the No Action Alternative, Alternative 1, and Alternative 2.

Table 3.13-12: Summary of Impacts on Cultural Resources

Alternative	NEPA (Land and U.S. Territorial Waters, <12 nm)	EO12114 (Non-U.S. Territorial Waters, > 12 nm)
No Action Alternative, Alternative 1, and Alternative 2	Terrestrial archaeological sites are not substantially affected by current training activities. Buildings and structures are not substantially affected by current training activities. Compliance with existing protective measures in accordance with the Navy MOA, Navy PA, and the Air Force MOA to avoid cultural resources substantially reduces effects from training activities. Impacts on additional submerged cultural resources will not occur. Effects to Alternative 1 and Alternative 2 generally are the same as described for the No Action Alternative. An increase in training exercises would not substantially affect cultural resources if avoidance conditions and stipulations are followed. If avoidance of cultural resources through siting and design of upgraded training facilities and portable training equipment were implemented, impacts to cultural resources would be unlikely to occur. If cultural resources cannot be avoided, consultation with the appropriate Historic Preservation Officer will be initiated and any adverse effect to cultural resources will be resolved prior to construction of the new or upgraded facilities.	Impacts on submerged cultural resources could occur.

3.14 TRANSPORTATION

3.14.1 Introduction and Methods

The discussion of transportation resources refers to the ground, marine, and air traffic within the vicinity of the Mariana Islands Range Complex (MIRC). Ground traffic issues refer to transportation and circulation of vehicles within an organized land framework. Ground traffic that is not compatible with commercial or recreational events is confined to restricted areas. Marine training activities that are not compatible with commercial or recreational activities are conducted outside of those areas. Where aircraft conduct training activities that are not compatible with commercial or recreational transportation (*e.g.*, hazardous weapons firing), they are confined to Special Use Airspace (SUA). Hazardous training activities are communicated to all vessels and operators by use of Notice to Mariners (NOTMAR), issued by the U.S. Coast Guard (USCG), and Notice to Airmen (NOTAM), issued by the Federal Aviation Administration (FAA).

Ocean Traffic. Ocean traffic is the transit of commercial, private, or military vessels at sea, including submarines. Ocean traffic flow in congested waters, especially near coastlines, is controlled by the use of directional shipping lanes for large vessels (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 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 increase recreational boat traffic and diving activities).

Exclusive Economic Zones (EEZs) are sea zones that were established by the Third United Nations Convention on the Law of the Sea in 1982. Part V, Article 55 of the Convention establishes that the EEZ is "an area beyond and adjacent to the territorial sea, subject to the specific legal regime established in this Part, under which the rights and jurisdiction of the coastal State and the rights and freedom of other States are governed by the relevant provisions of this Convention." (United Nations [UN] 1982). The EEZs extend 200 nautical miles (nm) from the coastal baseline (the baseline usually follows the low-water line). Within the EEZs, the coastal nation has sole exploitation rights over all natural resources; however, foreign nations have the freedom of navigation and overflight, subject to the regulation of the reigning coastal state (National Oceanic and Atmospheric Administration [NOAA] 2007). The EEZs were established by Presidential Proclamation in 1983 (NOAA 2007).

Internal waters are those waters and waterways on the landward side of the baseline. Territorial waters extend from the baseline to 12 nm. These areas were defined by the 1982 Law of the Sea Convention and established the coastal state's right to establish laws, regulate use, and have use of any resource in internal and territorial waters (NOAA 2007). The Territory of Guam manages resources within waters 0 to 3 miles (mi.) from their shorelines. In the CNMI, the submerged lands and marine resources from the shoreline to 200 mi. have been found to be owned by the Federal government, although CNMI is currently seeking to acquire jurisdiction of the area from 0 to 3 mi. through various legal means (WPRFMC 2005).

Air Traffic. Air traffic refers to movements of aircraft through airspace. 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 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 (*e.g.*, flight over international waters off the east coast). Examples of highly controlled air traffic situations are flights in the vicinity of airports where aircraft are in critical phases of flight, either takeoff or landing, and flight under Instrument Flight Rules (IFR), particularly flights on high- or low-altitude airways.

The FAA owns and operates the air traffic control system. The system of airspace designation makes use of various definitions and classifications of airspace to facilitate control. “Controlled Airspace” is a generic term that covers different classes of airspace. The controlling agency of any airspace is the FAA Air Traffic Control facility that exercises control of the airspace when SUA is not active. SUA is specially designated airspace that is used for a specific purpose and is controlled by the military unit or other organization whose activity established the requirement for the SUA (FAA 2006). SUA includes restricted areas and military training areas, as well as warning, prohibited, alert, and controlled firing areas.

- Airways are established routes used by commercial aircraft, general aviation, and military aircraft. There are two types of airway route structures: low-altitude routes (those below 18,000 feet [ft] above mean sea level [MSL]) and high-altitude routes (those above 18,000 feet MSL).
- “Victor Routes” are the network of airways serving commercial aviation operations up to 18,000 MSL.
- Class A extends from 18,000 MSL up to and including 60,000 MSL and includes designated airways for commercial aviation operations at those altitudes.
- Class B airspace extends from the ground to 10,000 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 is controlled airspace not included in Class A, B, C, or D.
- Class G is uncontrolled airspace (*i.e.*, not designated as Class A-E).

SUA refers to areas with defined dimensions where flight activities are confined due to their nature and the need to restrict or limit nonparticipating aircraft. SUA is established under procedures outlined in 14 CFR Part 73. The majority of SUA is established for military activities, and may be used for commercial or general aviation when not reserved for military activities. There are multiple types of SUA including Military Operating Areas (MOA), alert areas, and controlled firing areas; each SUA designation carries varying restrictions on the types of military and nonmilitary activities that may be conducted. One type of SUA of particular relevance to the MIRC EIS/OEIS study area is a Restricted Area, which is described by 14 Code of Federal Regulations (C.F.R.) Part 1 as a type of SUA within which nonmilitary flight activities are closely restricted. Other types of SUA include MOA, alert areas, and controlled firing areas. Another relevant type of SUA is a Warning Area, which is defined in 14 CFR 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 potential danger. A warning area may be located over domestic or international waters or both.”

Warning areas are established to contain a variety of aircraft and nonaircraft activities, such as aerial gunnery, air and surface missile firings, bombing, aircraft carrier training activities, surface and undersea training activities, and naval gunfire. Warning areas contain hazardous activities; where these activities are conducted mainly in international airspace, the FAA regulations may warn against, but do not have the authority to prohibit, flight by nonparticipating aircraft.

Ground Traffic. Transportation and circulation refer to the movement of vehicles throughout a road and highway network. Primary roads are principal arterials, such as interstates, designed to move traffic and not necessarily to provide access to all adjacent areas. Secondary roads are arterials such as rural routes and major surface streets that provide access to residential and commercial areas, hospitals, and schools. Secondary roads collect traffic from common areas and transfer it to primary roads.

3.14.2 Regulatory Framework

Section 3.14 (Transportation) was prepared in accordance with the National Environmental Policy Act (NEPA) and Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*, as described in Chapter 1. States' jurisdictional boundaries extend 3 nm offshore of the coast. Impacts of training activities evaluated under NEPA are further distinguished by state regulatory authorities where applicable.

3.14.3 Assessment Methods and Data Used

The *1999 Military Training in the Marianas Environmental Impact Statement* and the *2007 Marianas Range Complex Management Plan (RCMP) (Final Draft)* provide the baseline data for existing ground, ocean, and air traffic conditions and infrastructure. Unless otherwise indicated, the baseline information provided in this section was taken from the EIS or RCMP.

Information regarding personal watercraft was obtained in part from the USCG. In addition to its national defense role as one of the five U.S. Armed Services, the USCG is charged with a broad scope of regulatory, law-enforcement, humanitarian, and emergency-response duties. In addition to ensuring maritime safety and security, the USCG focuses on personal watercraft and boating. State tourism and parks and recreation divisions also provided sources for state-specific personal watercraft and recreational boating data.

Sport diving industry statistics are not maintained for numbers of individuals participating in specific regions of the country or for sites that are commonly used (Davison 2007; DEMA 2006). Dive locations identified in this document were established through the use of the Internet and various U.S. Commonwealth Territory agency and tourism websites including Franko's maps, Marianas Visitor's Authority, and Guam Visitor's Bureau.

3.14.3.1 Warfare Areas and Associated Environmental Stressors

Impacts to transportation are assessed in terms of anticipated levels of disruption or improvement of current transportation patterns and systems, deterioration or improvement of existing levels of service, and changes in existing levels of transportation safety. Impacts may arise from physical changes to circulation (*i.e.*, closing, rerouting, or creation of new traffic patterns), or changes in daily or peak-hour traffic volumes created by either direct or indirect changes to transportation activities. Stressors that would likely impact transportation activities are identified in Table 3.14-1. These stressors were identified by conducting a detailed analysis of the warfare areas, training activities, and specific activities included in the alternatives.

Table 3.14-1: Summary of Potential Stressors to Transportation Resources

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Transportation Resources
Army Training			
Surveillance and Reconnaissance (S&R)/ Finegayan Communications Annex, Barrigada Communications Annex,Tinian Exclusive Military Use Area (EMUA) and Lease Back Area (LBA)		Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Field Training Exercise (FTX) / Polaris Point Field, Orote Point Airfield/ Runway, NLNA, Northwest Field, Andersen South, Tinian EMUA		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Live Fire/ Tarague Beach Small Arms Range		Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Parachute Insertions and Air Assault/ Orote Point Triple Spot, Polaris Point Field, Ordnance Annex Breacher House		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Military Operations in Urban Terrain (MOUT) / Orote Point Close Quarters Combat (CQC) Facility, Ordnance Annex Breacher House, Barrigada Communications Annex, Andersen South		Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Marine Corps Training			
Ship to Objective Maneuver (STOM) / Tinian EMUA		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Operational Maneuver/ NLNA, SLNA		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Noncombatant Evacuation Order (NEO) / Tinian EMUA		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.

Table 3.14-1: Summary of Potential Stressors to Transportation Resources (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Transportation Resources
Marine Corps Training (continued)			
Assault Support (AS) / Polaris Point Field, Orote Point Small Arms Range/Known Distance (KD) Range, Tinian EMUA		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Reconnaissance and Surveillance (R&S) / Tinian EMUA		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
MOUT / Ordnance Annex Breacher House, Andersen South		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Direct Fires/ FDM, Orote Point KD Range, ATCAA 3A		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Protect and Secure Training Area/ Northwest Field		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Navy Training			
Anti-Submarine Warfare (ASW) / Open Ocean		Vessel Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Mine Warfare (MIW) Training/ Agat Bay, Inner Apra Harbor		Vessel Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Air Warfare (AW) / W-517, R-7201		Aircraft Overflight	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.

Table 3.14-1: Summary of Potential Stressors to Transportation Resources (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Transportation Resources
Navy Training (continued)			
Surface Warfare (SUW)	Surface-to-Surface Gunnery Exercise (GUNEX)	Vessel Movement Aircraft Overflight	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
	Air-to-Surface GUNEX	Vessel Movement Aircraft Overflight	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
	Visit, Board, Search, and Seizure (VBSS)	Vessel Movement	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Strike Warfare (STW) / FDM	Air-to-Ground Bombing Exercises (Land)(BOMBEX-Land)	Vehicle Movements Aircraft Overflight	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
	Air-to-Ground Missile Exercises (MISSILEX)	Vehicle Movements Aircraft Overflight	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Naval Special Warfare (NSW) / Orote Point (Airfield/Runway, CQC, Small Arms Range/KD Range, Triple Spot), Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field	Naval Special Warfare Operations (NSW OPS)	Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
	Insertion/ Extraction	Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
	Direct Action	Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
	MOUT	Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.

Table 3.14-1: Summary of Potential Stressors to Transportation Resources (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Transportation Resources
Navy Training (continued)			
Amphibious Warfare (AMW) / FDM, Orote Point Small Arms Range/KD Range, Finegayan Communications Annex, Reserve Craft Beach, Outer Apra Harbor, Tipalao Cove, Tinian EMUA	Airfield Seizure	Aircraft Movements Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
	Over-the-Beach (OTB)	Aircraft Movements Vessel Movement	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
	Breaching	Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
	Naval Surface Fire Support (FIREX Land)	Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
	Marksmanship	Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
	Expeditionary Raid	Vessel Movements Vehicle Movement	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
	Hydrographic Surveys	Vessel Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.

Table 3.14-1: Summary of Potential Stressors to Transportation Resources (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Transportation Resources
Navy Training (continued)			
Explosive Ordnance Disposal (EOD) / (refer to specific operation)	Land Demolition/ Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point Training Areas, Ordnance Annex Breacher House, Ordnance Annex Detonation Range, NLNA, Ordnance Annex Galley Building 460, SLNA, Barrigada Housing	Vehicle Movements Land Detonations	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
	Underwater Demolition/ Outer Apra Harbor, Piti and Agat Bay Floating Mine Neutralization areas	Underwater Detonations	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Field Training Exercises (FTX)/ Navy Munitions Site (Ordnance Annex) NLNA, Finegayan Communications Annex, Barrigada Communications Annex		Foot and Vehicle Land Navigation	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Logistics and Combat Services Support/ Orote Point Airfield/ Runway, Reserve Craft Beach	Combat Mission Area	Vehicle Movements Amphibious Landings	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Combat Search and Rescue (CSAR) / Tinian EMUA	Embassy Reinforcement	Vehicle Movements Building Modification	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
	Anti-Terrorism (AT)	Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.

Table 3.14-1: Summary of Potential Stressors to Transportation Resources (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Transportation Resources
Air Force Training			
Counter Land / FDM, ATCAA 3		Land Detonations	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Counter Sea (Chaff)		None	None
Airlift / Northwest Field		Aircraft Movements Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Air Expeditionary / Northwest Field		Aircraft Movements Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Force Protection / Andersen AFB Main Base, Northwest Field, Tarague Beach Small Arms Range		Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
ISR/Strike Capability / R-7201, FDM, Andersen AFB	Air-to-Ground Training	Aircraft Movements Land Detonations	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
Rapid Engineer Deployable Heavy Operational Repair Squadron Engineer (RED HORSE) / Northwest Field	Silver Flag Training	Aircraft Movements Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
	Commando Warrior Training	Aircraft Disturbance Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.
	Combat Communications	Aircraft Disturbance Vehicle Movements	Restriction, disruption, deterioration, or changes to transportation patterns and systems or changes in level of service or safety.

3.14.4 Affected Environment

3.14.4.1 Ocean Traffic

3.14.4.1.1 Military

The ocean surface and undersea areas of the range complex are included in the MIRC Study Area as depicted in Figure 1-1; extending from the international waters south of Guam to north of Pagan (CNMI), and from the Pacific Ocean east of the Mariana Islands to the Philippine Sea to the west; encompassing 450,187 square nautical miles (nm^2) of open ocean and littorals. No Surface/Undersea operating area is specified for the MIRC. However, although Warning Area (W)-517 is a SUA, the sea space below W-517 is generally accepted as the same area. The training devices/equipment and ordnance used in open ocean warning areas include:

- Sonobuoys
- General purpose bombs
- Harpoon missiles
- Submarine decoy devices
- Expendable torpedo targets
- Chaff and towed array devices
- Weather balloons

Training activities in nearshore areas occur in Agat Bay, Tipalao Cove, Outer Apra Harbor (OAH) and Inner Apra Harbor. R-7201 is a restricted airspace with a 3-nm radius surrounding FDM, although the published NOTAMs usually advise that a 10-nm radius is to be observed. The altitude limits surface to infinity and supports live-fire and inert training activities such as surface-to-ground and air-to-ground GUNEX, BOMBEX, MISSILEX, Fire Support, and Precision Weapons.

Tables 2-2 and 2-3 describe the activities performed in these areas and they are depicted in Figures 2-1 through 2-8.

Apra Harbor is a deep-water port that can accommodate the largest of Navy vessels including aircraft carriers. The OAH is controlled by Commander U.S. Naval Base Guam, Port Authority of Guam, and USCG Regulations. Commanding Officer USCG is the Captain of the Port. Navy security zones extend outward from the Navy-controlled waterfront, and the Department of Defense (DoD) has title to a majority of the outer harbor submerged lands.

3.14.4.1.2 Civilian

In the western Pacific Ocean, three commercially used waterways link Guam and the CNMI with major ports to both the east and west (RITA/BTS, 2007). These navigable waterways are utilized by commercial vessels. Figure 3.14-1 depicts the commercially used waterways and their relation to the MIRC.

Guam contains one commercial port located within Apra Harbor. The Port of Guam is the largest U.S. deepwater port in the Western Pacific (WestPac) and handles approximately 2 million tons of cargo a year (GEDCA, 2008). The west-facing entrance to Apra Harbor is 500 yd (457 m) wide, over 100 ft (30.5 m) deep, and contains several mooring buoys and piers. Although the OAH has many areas where depths exceed 100 ft, it also contains several clearly marked shoal or reef areas.

The area around FDM is usually published in NOTMARs as a 10-nm radius area for military use due to the restricted airspace R-7201. Restricted areas extend from the surface to infinity; therefore, the ocean surface area would be included in the exclusion of civilian use. This 10-nm radius danger zone is restricted for safety and security reasons.

Public access to FDM is prohibited and there are no commercial or recreational activities on the island. During training exercises, marine vessels are restricted within a 3-nm (5-km) radius, although published NOTMARs usually advise a 10-nm (18-km) radius. The U.S. Army Corps of Engineers (USACE) may promulgate regulations to establish a danger zone or restricted area to formalize the existing 10-nm safety zone around FDM. Pursuant to its authorities in Section 7 of the Rivers and Harbors Act of 1917 (40 Stat. 266; 33 U.S. Code [USC] 1) and Chapter XIX of the Army Appropriations Act of 1919 (40 Stat.892; 33 USC 3) the USACE is able to amend the regulations in 33 CFR Part 334 by establishing danger zone and restricted areas regulations where the current safety zone is activated by NOTAMs and NOTMARs. The purpose of establishing a permanent safety zone or restricted area would be to restrict all private and commercial vessels from entering the area to minimize danger from the hazardous activity in the area.

3.14.4.2 Air Traffic

3.14.4.2.1 Military

Guam. W-517 is a Warning Area that overlays deep ocean water located approximately 50 mi. south-southwest of Guam and provides a large SUA area from surface to unlimited altitude. W-517 is constrained by commercial air traffic lanes to the east and west. The sea-space under W-517 is not a designated Operating Area (OPAREA). Nonetheless, the Navy uses the sea space under W-517 to conduct GUNEX, Chaff and Electronic Combat (EC OPS), MISSILEX, Mine Exercise (MCMEX), Sink Exercise (SINKEX), Torpedo Exercise (TORPEX), and Carrier Operations.

Open ocean Air Traffic Control Assigned Airspace (ATCAAs) within the MIRC Study Area are used for military training activities, from unit-level training to major Joint exercises. ATCAAs 1, 2, 3, 5, and 6 as depicted in Figure 1-1 have been preassigned in agreements with the Guam FAA, the Commander, U.S. Naval Forces Marianas (COMNAVMAR), and the Commander, 36th Wing. The Guam FAA works with COMNAVMAR and 36th Wing to modify or configure new ATCAA as required for training events. Preconfigured ATCAAs encompass 63,000 nm^2 from south of Guam to north-northeast of Farallon de Medinilla (FDM), from the surface to Flight Level (FL) 300 or unlimited, as depicted in Table 2-3. ATCAAs are activated for short periods to cover the time frames of training activities. COMNAVMAR coordinates ATCAA requests with the FAA and 36th Wing. If the preconfigured ATCAA 1, 2, 3A/B/C, 5, or 6 do not meet the need for a special event, then event-specific ATCAAs in the location, size, and altitude for the time frame needed may be requested contingent on agreement of the FAA and coordination with COMNAVMAR and 36th Wing. Range control consists of scheduling SUA with operational units and notifying military and civilian stakeholders of SUA schedules via NOTAMs and NOTMARs. NOTAMs are available on the Internet at https://www.notams.jcs.mil and NOTMARs can be found on the Internet at www.nga.mil/portal/site/maritime. Figure 1-1 depicts the location of W-517; ATCAAs 1, 2, 3, 5, and 6; and R-7201.

Andersen Air Force Base (AAFB) contains one airfield, Main Base, which is approximately 4,500 acres. Airspace over Main Base supports takeoffs and landings of all types of aircraft up to and including the C-5. AAFB airspace is controlled by Air Force air traffic control.

Tinian. The military conducts aviation training in the Military Lease Area (MLA) by delivering personnel and cargo to maneuver areas and providing various support functions to forces already on the ground, such as cargo delivery, firefighting, and Search and Rescue (SAR). An important feature in the

EMUA is North Field, a large abandoned World War II era airfield that is still usable as a contingency land field and supports fixed-wing and helicopter training activities. North Field's four runways, taxiways, and parking aprons provide various tactical scenarios without interfering with commercial and community activities south of the MLA. The remote area is suitable for a variety of aviation support training. Use of North Field also reduces or eliminates the need to share use of West Tinian Airport with commercial flight activity.

FDM. R-7201 is a restricted airspace with a 3-nm radius surrounding FDM, although the published NOTAMs usually advise that a 10-nm radius is to be observed. The altitude limits surface to infinity and supports live-fire and inert training activities such as Surface-to-Ground and Air-to-Ground GUNEX, BOMBEX, MISSILEX, Fire Support, and Precision Weapons.

3.14.4.2.2 Civilian

Guam. Guam International Air Terminal (GIAT) is the only civilian air transportation facility on Guam. It is operated by Guam International Airport Authority (GIAA), a public corporation and autonomous agency of the Government of Guam. GIAT contains two runways and facilities that are part of the now-closed Naval Air Station (NAS) Agana. Eight major airlines operate out of GIAT, making it a hub of air transportation for Micronesia and the WesPac.

Tinian. All commercial flights fly into West Tinian Airport. The airport has one runway that is 5,985 ft by 150 ft. The airport is equipped with a navigational light system, but has no control tower or additional navigational aids. The FAA at the Saipan International Airport conducts air traffic control for flights in and out of the airport. Daily activity consists of commuter flights connecting Tinian with Saipan, Rota, and Guam.

FDM. There is no civilian use of airspace around FDM because it is a restricted area and available only to military traffic. NOTAMs usually advise of a 10-nm radius around FDM to be used exclusively by the military.

3.14.4.3 Ground Traffic

Guam. As of 2004, Guam had a total of approximately 620 mi. of roads (CIA 2008). Most of the highway infrastructure was built by the U.S. military following the end of World War II (DoN 1999). The Government of Guam Department of Public Works is responsible for road maintenance. Traffic on Guam is heavy in certain areas, particularly on major routes during morning and evening commute rush hours.

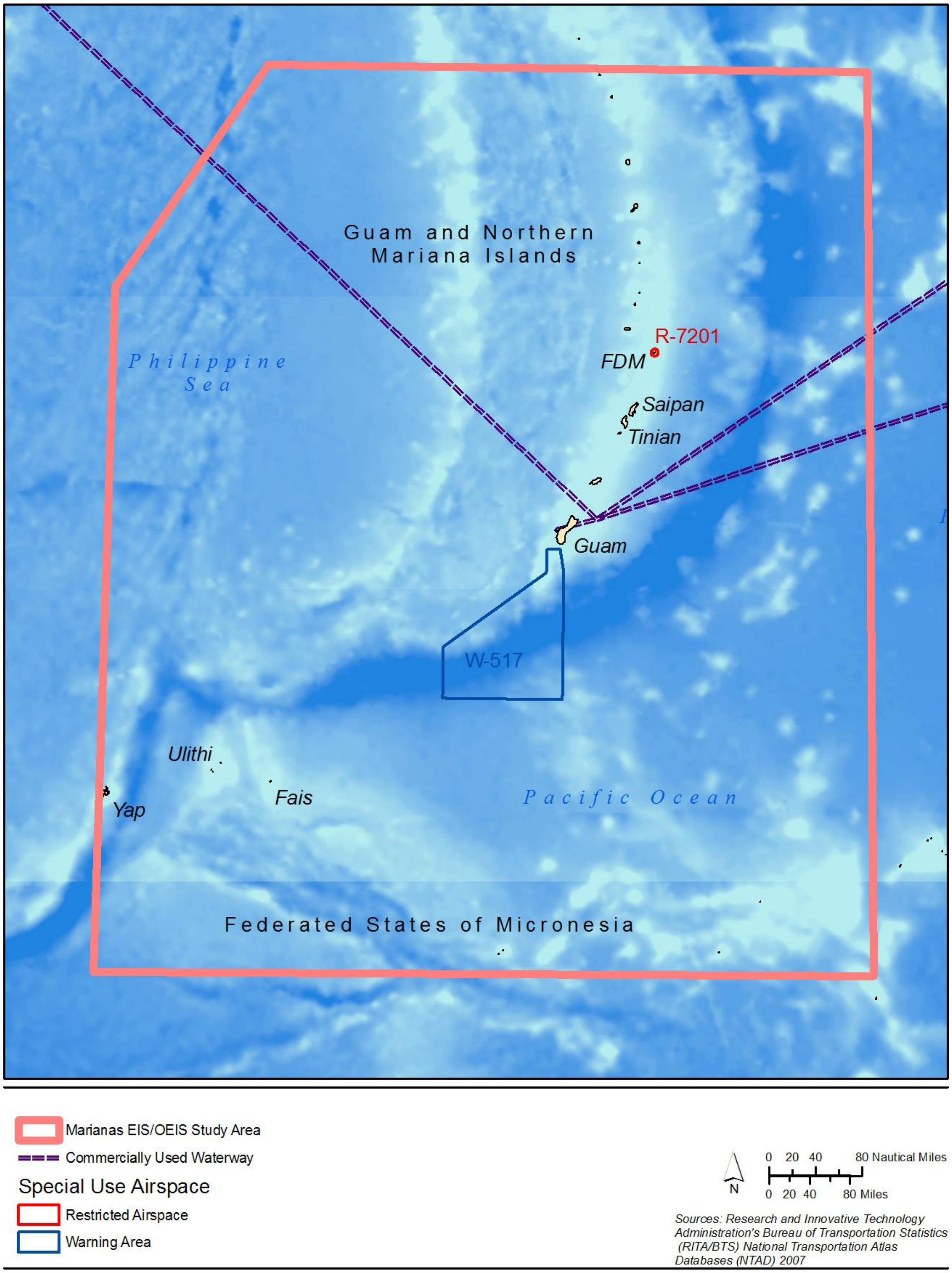


Figure 3.14-1 Commercially Used Waterways in CNMI

Tinian. Tinian has approximately 68.4 miles of roads mostly constructed prior to and during World War II (DoN 1999). Most of the roads were developed for heavy truck traffic when the island's U.S. military population was around 150,000. Presently, roads on Tinian are in good to poor condition and traffic is extremely light. Roads in the MLA include former runways, taxiways, and parking aprons constructed to support B-24 and B-29 bombers. The CNMI Department of Public Works is responsible for managing and maintaining the road system.

FDM. FDM is uninhabited and does not contain any roads; consequently it is not discussed in this section.

3.14.5 Environmental Consequences

The traffic analysis addresses ocean and air traffic in the MIRC. 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 are 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 airspace modification; or an increase in air traffic that might increase collision potential between military and nonparticipating civilian 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 MIRC. However, the need to use alternative routes during the time of exclusion does not constitute a serious disruption.

3.14.5.1 No Action Alternative

Both military and nonmilitary entities have been sharing the use of the ground, ocean, and airspace that encompasses the MIRC since World War II. Military, commercial, and general aviation activities have established an operational co-existence consistent with Federal, state, and local plans and policies and compatible with each interest's varying objectives. The No Action Alternative includes training and testing operations that are and have been routinely conducted in the area for decades. Ongoing, continuing training activities identified in this EIS/OEIS will continue to use the existing offshore areas and Warning Areas. Although the nature and intensity of use varies over time and by individual area, the continuing training activities represent precisely the kinds of training activities for which these areas were created (*i.e.*, those that present a hazard to other vessels).

The No Action Alternative would not modify existing airspace use, and would not change the existing relationship of the Navy's SUA with Federal airways, uncharted visual flight routes, and airport-related air traffic training activities.

COMNAVMAR is the principal controlling authority for marine and aviation activities within the MIRC. 36^{th} Operations Support Squadron (36^{th} OSS) is designated as the issuing agency for all NOTAM information within the military NOTAM system on training activities coordinated through their office and/or through the Area Training Office of COMNAVMAR for their area of responsibility. Through close coordination with the FAA, 36^{th} OSS and COMNAVMAR ensure that hazardous activities are carefully scheduled to avoid conflicts with civilian activities and safety standards are maintained while allowing the maximum amount of civilian access to airspace and sea space.

The stressors from proposed activities that would likely impact transportation activities stem from increases in ship training activities and aircraft training activities and the associated increase in training activities; however, military activities are either scheduled or announced ahead of execution or take place in an area that is designated for the exclusive use of military activities. Therefore, the No Action Alternative would have no significant impact on transportation resources in territorial waters. The No Action Alternative would not cause significant harm to transportation resources in non-territorial waters.

3.14.5.2 Alternative 1

If Alternative 1 were to be selected, in addition to accommodating the No Action Alternative, it would include increased training as a result of upgrades and modernization of existing capabilities. This alternative also includes training associated with ISR/Strike and other AAFB initiatives. Training will also increase as a result of the acquisition and development of new Portable Underwater Tracking Range (PUTR) capabilities as detailed in Chapter 2.

Military activities are either scheduled or announced ahead of execution or take place in an area that is designated for the exclusive use of military activities. Alternative 1 does not propose to modify existing airspace use; therefore, implementation of Alternative 1 would have no significant impact on transportation resources in territorial waters. Further, Alternative 1 would not cause significant harm to transportation resources in non-territorial waters.

3.14.5.3 Alternative 2

Implementation of Alternative 2 would include all the actions proposed for MIRC in Alternative 1 and increased training activity associated with major at-sea exercises (see Tables 2-6 and 2-7). Additional major at-sea exercises would provide additional ships and personnel maritime training, including additional use of sonar that would improve the level of Joint operating skill and teamwork between the Navy, Joint Forces, and Partner Nations. Submarine, ship, and aircraft crews train in tactics, techniques, and procedures required in carrying out the primary mission areas of maritime forces. The additional maritime exercises would take place within the MIRC and would focus on Carrier Strike Group training and ASW activities similar to training conducted in other Seventh Fleet locations, including a Fleet Strike Group Exercise, an Integrated ASW Exercise, and a Ship Squadron ASW Exercise.

Implementation of Alternative 2 would not modify existing airspace use and military activities would continue to be scheduled or announced ahead of execution or take place in an area that is designated for the exclusive use of military activities.

Implementation of Alternative 2 would have no significant impact on transportation resources in territorial waters. Further, Alternative 2 would not cause significant harm to transportation resources in non-territorial waters.

3.14.6 Unavoidable Significant Environmental Effects

There are no unavoidable significant environmental effects as a result of implementation of the No Action Alternative, Alternative 1, or Alternative 2.

3.14.7 Summary of Environmental Effects (NEPA and EO 12114)

The environmental effects to transportation resulting from implementation of the No Action Alternative, Alternative 1, or Alternative 2 would have no significant impact in territorial waters. The environmental effects of implementation of the No Action Alternative, Alternative 1, or Alternative 2 would not cause significant harm to transportation in non-territorial waters. The environmental effects to transportation are detailed in Table 3.14.-2.

Table 3.14-2: Summary of Environmental Effects of the Alternatives on the Transportation Resources in the MIRC Study Area

Alternative	NEPA (Land and U.S. Territorial Waters < 12 nm)	EO 12114 (Non-U.S. Territorial Waters > 12 nm)
No Action Alternative, Alternative 1, and Alternative 2	The FAA has established SUA W-517, R-7201, and ATCAAs for military training activities. When military aircraft are conducting training activities that are not compatible with civilian activity, the military aircraft are confined to the SUA to prevent accidental contact. Hazardous air training activities are communicated to commercial airlines and general aviation by NOTAMs, published by the FAA. There are no additional impacts on the FAA's capabilities, no expected decrease in aviation safety, and no adverse effect on commercial or general aviation activities. Military use of the offshore ocean is also compatible with civilian use. Where naval vessels are conducting training activities that are not compatible with other uses, such as weapons firing, they are confined to surface areas and SUA away from shipping lanes and other recreational use areas. Hazardous marine training activities are communicated to all vessels and operators by NOTMARs, published by the USCG. No significant impact to transportation resources.	The impacts in non-territorial waters are similar to those in territorial waters. No significant harm to transportation resources.

3.15 DEMOGRAPHICS

3.15.1 Introduction and Methods

Demographic statistics are assessed through identification and evaluation of socioeconomic factors such as population characteristics, which may include population, age, education, disabilities, poverty levels, and race and ethnicity. The study areas for demographics are the two administrative units of the Mariana Islands: Guam, which is a U.S. territory, and the Northern Mariana Islands (Saipan, Tinian, and Rota), which are a Commonwealth of the United States (CNMI 2000; GBSP 2000).

3.15.1.1 Regulatory Framework

Section 3.15 is intended to provide general information on the characteristics of human population and demographics within the MIRC EIS/OEIS Study Area. Demographic information is assessed to ensure Federal agencies focus their attention on human health and environmental conditions in minority and low-income communities and to ensure that disproportionately high and adverse human health or environmental effects on these communities are identified and addressed per Executive Order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations* (1994) and EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks* (1997).

3.15.1.2 Assessment Methods and Data Used

This section was prepared primarily by compiling and evaluating existing information supplied by the U.S. Census Bureau, state and local governmental agencies, and local organizations as shown in the reference section.

3.15.1.3 Warfare Areas and Associated Environmental Stressors

Impacts to demographics are assessed in terms of their direct effects on the local economy and related effects on other socioeconomic resources (for example, housing). The level of significance of these impacts can vary depending on the location of the Proposed Action. If implementation of an action results in the creation of 10 jobs, it is likely that in an urban setting the addition of 10 employment positions would go unnoticed, but may have significant impacts in a more rural region. If potential impacts would result in substantial shifts in population trends, or adversely affect regional spending and earning patterns, they would be significant.

Aspects of the Proposed Actions likely to act as stressors to demographics were identified by conducting a detailed analysis of the warfare areas, training activities, and specific activities included in the alternatives. The stressors to demographics are shifts in population and negative shifts in regional spending and earning patterns. Analysis of the components of the No Action Alternative, Alternative 1, and Alternative 2 revealed no changes to the identified stressors to demographics.

3.15.2 Affected Environment—Including Current Protective Measures

3.15.2.1 Population Characteristics

During the period July 1, 2000 to July 1, 2007, the population of the CNMI (which included Guam for reporting purposes) was projected to increase by 22.7 percent; the population of the United States is expecting a 6.8 percent increase during the same period (USCB 2000; 2003; CNMI 2000). In the Continental United States there were 216,124 Navy and Marine Corps personnel in active duty military installations on September 30, 2007 (DoD 2007); Guam reported 1,067 while CNMI reported 6 during the same period. Civilian personnel, affiliated with the Navy on military installations in the Continental

United States on September 30, 2005, included 160,358 personnel and Guam reported 638 personnel during the same period (DoD 2005). None were reported in CNMI and the Marine Corps were not reported separately.

The Tinian Municipality reported 3,540 people in the 2000 population census. The Saipan Municipality reported 62,392 people, Rota Municipality reported 3,283 people, and Northern Islands Municipality reported 6 (CNMI 2000).

3.15.2.2 Age Structure

The latest year for which data are available is 2000. During that period, 8.4 percent of CNMI's population was under the age of 5, 28.2 percent were under the age of 19, and 1.5 percent were over the age of 65. Guam reported 10.8 percent of the population under the age of 5, 38.4 percent under the age of 20, and 2.7 percent over the age of 65. These percentages show a distribution of the over 65 age group that is higher than that of the United States as a whole; 6.8 percent, 24.8 percent (under the age of 18), and 12.4 percent, respectively (USCB 2000; 2003; CNMI 2000).

3.15.2.3 Race and Ethnicity

Table 3.15-1 shows a comparison of the race and ethnicity of the Territory of Guam and the CNMI compared to the United States.

Table 3.15-1: Race and Ethnicity Comparison

Race/Ethnicity	CNMI	Guam	United States
White	1.9	6.8	80.2
Black	0.1	1.0	12.8
Asian	55.8	33	4.3
Native Hawaiian & Other Pacific Islander	31.5	48.9	0.2
Persons Reporting Two or More Races	9.9	8.8	1.5

Note: All numbers are percentages from 2000 Census.
Source: U.S. Census Bureau 2000; 2003; CNMI 2000.

Table 3.15-2 shows a detail of the race and ethnicity data reported in the 2000 Census.

Table 3.15-2: Race and Ethnicity Detail

Race/Ethnicity	Tinian Municipality	Saipan Municipality	Rota Municipality	Northern Islands Municipality	GUAM
One Ethnicity or Race	**3,035**	**56,355**	**2,970**	**6**	**133,252**
Native Hawaiian and Other Pacific Islander	1,354	18,781	1,861	5	69,039
Carolinian	3	2,645	4	0	123
Chamorro	1,320	11,644	1,780	5	57,297
Chuukese	4	1,382	8	0	6,229
Kosraean	0	51	5	0	292
Marshallese	0	109	3	0	257
Palauan	6	1,642	37	0	2,141
Pohnpelan	4	614	22	0	1,366
Yapese	12	192	0	0	686
Other Pacific Islander	5	502	2	0	648
Asian	1,576	35,985	1,048	1	50,329
Bangladeshi	89	690	94	0	0
Chinese	255	15,040	16	0	2,707
Fillipino	969	16,280	891	1	40,729
Japanese	18	898	36	0	2,086
Korean	70	1,945	6	0	3,816
Nepalese	129	170	1	0	0
Other Asian	46	962	4	0	991
White	69	1,121	50	0	10,509
Black or African American	4	33	4	0	1,568
Some other race or ethnic group	32	435	7	0	1,807
Two or More Races or Ethnic Groups	**505**	**6,037**	**313**	**0**	**21,553**
Carolinian and other group(s)	66	2,018	40	0	0
Chamorro and other group(s)	386	3,727	270	0	7,946
Asian and other group(s)	336	2,505	175	0	10,853

Note: The shaded areas in this table are a total of the subsequent rows of ethnic reporting.

3.15.2.4 Poverty

A United States, Territory of Guam, and CNMI comparison of poverty level is provided in Table 3.15-3.

Table 3.15-3: Poverty Level Comparison

Guam	CNMI	United States
22.9	30.6	12.7

Note: All numbers are percentages from 2000 Census.
Source: U.S. Census Bureau, 2000; 2003; CNMI, 2000.

3.15.2.5 Education

In the year 2000, the percentage of households in CNMI that spoke a primary language other than English was 89.2 percent and Guam households that spoke a primary language other than English was 61.7 percent. The United States' percentage of homes with a primary language other than English was 17.9 percent. CNMI had 35.6 percent of high school graduates and 15.5 percent of the population achieved a Bachelor's degree or higher. Guam had 31.9 percent of high school graduates and 19.9 percent of the population achieved a Bachelor's degree or higher. The United States had 80.4 percent high school graduates and 24.4 percent of the population achieved a Bachelor's degree or higher (USCB 2000).

3.15.3 Environmental Consequences

Impacts to demographics are assessed in terms of their direct effects on the local economy and related effects on population and expenditure within the study area. Demographic impacts would be considered significant if the Proposed Action or alternatives resulted in a substantial shift in population trends, spending and earning patterns, or community resources (notably housing and education).

3.15.3.1 No Action Alternative

The No Action Alternative would comprise the continuation of current Services practices; it would not result in any impacts to demographics. There are no changes anticipated to either the local population or the local economy; therefore, there are no impacts to demographics.

3.15.3.2 Alternative 1

Alternative 1 introduces new training activities and proposes an increase to some existing training activities. Alternative 1 would not require the basing or relocation of additional personnel within the Study Area. There are no changes anticipated to either the local population or the local economy; therefore, there are no impacts to demographics.

3.15.3.3 Alternative 2

The assessment of the impacts upon population trends, regional spending, regional earning, housing trends, regional employment, and education with implementation of Alternative 2 are the same as those described in Section 3.15.3.2; there would be no impacts to demographics if Alternative 2 were implemented.

3.15.4 Unavoidable Significant Environmental Effects

There are no unavoidable significant environmental effects as a result of implementation of the No Action Alternative, Alternative 1, or Alternative 2.

3.15.5 Summary of Environmental Effects (NEPA and EO 12114)

There are no aspects of the Proposed Action or Alternatives likely to act as stressors to demographics; thus, there are no National Environmental Policy Act (NEPA) or EO 12114 effects on demographics. As shown in Table 3.15-4, the Proposed Action or Alternatives would have no effect on demographics in territorial waters. In non-territorial waters there would be no effect on demographics under the No Action Alternative, Alternative 1, or Alternative 2.

Table 3.15-4: Summary of Environmental Effects of the Alternatives on the Demographics in the MIRC Study Area

<table>
<tr><th>No Action Alternative, Alternative 1, and Alternative 2 Stressors</th><th>NEPA
(Land and Territorial Waters, < 12 nm)</th><th>Executive Order 12114
(Non-Territorial Waters, >12 nm)</th></tr>
<tr><td>Shifts in Population</td><td rowspan="2">Implementation of any of the proposed alternatives would not result in substantial shifts in population trends, or adversely affect regional spending and earning patterns; therefore, they would not result in significant impacts.</td><td rowspan="2">Impacts would be similar to those described for the No Action Alternative, Alternative 1, and Alternative 2 for territorial waters. The impacts to recreational and commercial fishing will not adversely affect regional spending and earning patters; therefore, they would not result in any impacts in non-territorial waters.</td></tr>
<tr><td>Shifts in Regional Spending or Earning</td></tr>
<tr><td>Impact Conclusion</td><td>In territorial waters, there would be no impact on demographics under the No Action Alternative, Alternative 1, or Alternative 2.</td><td>In non-territorial waters, there would be no harm to demographics under the No Action Alternative, Alternative 1, or Alternative 2.</td></tr>
</table>

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3.16 REGIONAL ECONOMY (INCLUDES COMMERCIAL FISHING/TOURISM/SHIPPING)

3.16.1 Introduction and Methods

Regional economy is assessed through evaluation of economic factors including industry, commercial fishing, tourism, and recreational fishing. The Study Area for assessment of the regional economy includes the Commonwealth of the Northern Mariana Islands (CNMI) and the Territory of Guam (Guam).

3.16.1.1 Regulatory Framework

The purpose of Section 3.16 is to provide an economic backdrop to the discussion of the No Action Alternative, Alternative 1, and Alternative 2 in the MIRC EIS/OEIS. The regional economy is important to the analysis of the alternatives due to the requirements imposed by Executive Order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations* (1994), and EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks* (1997), that requires Federal agencies to focus their attention and address effects on human health or environmental effects on these communities.

3.16.1.2 Assessment Methods and Data Used

Section 3.16 was prepared primarily by compiling and evaluating existing information supplied by the U.S. Census Bureau, National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), state and local governmental agencies, and local organizations as shown in the reference section. Data were collected on commercial fisheries landings, types of fishing gear used, and fishing effort. NMFS collects data regarding national fisheries, target species, landed tonnage, and gear types by region.

3.16.1.3 Warfare Areas and Associated Environmental Stressors

Impacts to the regional economy are assessed in terms of their direct effects on the local economy and related effects on other socioeconomic resources (for example, earning, income, and transportation). If potential impacts would result in substantial shifts in earning, spending, or access trends, or adversely affect regional spending and earning patterns, they would be significant. Potential impacts might be experienced if commercial or recreational activities were denied access to areas where they previously had occurred.

Stressors would be changes in intensity or duration of training activities that directly affected the abilities of recreational or commercial boaters and fishermen to harvest in areas that have traditionally been productive. Table 3.16-1 depicts aspects of the Proposed Actions that are likely to act as stressors to the regional economy. These stressors were identified by conducting a detailed analysis of the warfare areas, training activities, and specific activities included in the alternatives.

Table 3.16-1: Summary of Potential Stressors to Regional Economy Resources

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Regional Economy Resources
Army Training			
Surveillance and Reconnaissance (S&R)/ Finegayan and Barrigada Housing, Tinian Military Lease Area (MLA)		Vehicle Movements	Restriction of commercial or recreational activities.
Field Training Exercise (FTX) / Polaris Point Field, Orote Point Airfield & Runway, Northern Land Navigation Area (NLNA), Northwest Field, Andersen South, Tinian Exclusive Military Use Area (EMUA)		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of commercial or recreational activities.
Live Fire/ Tarague Beach Small Arms Range		Vehicle Movements	Restriction of commercial or recreational activities.
Parachute Insertions and Air Assault/ Orote Point Triple Spot, Polaris Point Field, Ordnance Annex Breacher House		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of commercial or recreational activities.
Military Operations in Urban Terrain (MOUT) / Orote Point Close Quarters Combat (CQC) House, Ordnance Annex Breacher House, Barrigada Housing, Andersen South		Vehicle Movements	Restriction of commercial or recreational activities.
Marine Corps Training			
Ship to Objective Maneuver (STOM) / Tinian EMUA		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of commercial or recreational activities.
Operational Maneuver/ NLNA, Southern Land Navigation Area (SLNA)		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of commercial or recreational activities.
Noncombatant Evacuation Order (NEO) / Tinian EMUA		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of commercial or recreational activities.
Assault Support (AS) / Polaris Point Field, Orote Point Known Distance (KD) Range, Tinian EMUA		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of commercial or recreational activities.
Reconnaissance and Surveillance (R&S) / Tinian EMUA		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of commercial or recreational activities.
MOUT / Ordnance Annex Breacher House, Andersen South		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of commercial or recreational activities.

Table 3.16-1: Summary of Potential Stressors to Regional Economy Resources (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Regional Economy Resources
Marine Corps Training (continued)			
Direct Fires/ FDM, Orote Point KD Range, Air Traffic Control Assigned Airspace (ATCAA) 3A		Vehicle Movements Aircraft Overflight Vessel Movements	Restriction of commercial or recreational activities.
Protect and Secure Training Area/ Northwest Field		Vehicle Movements Aircraft Overflight Vessel Movements	Restriction of commercial or recreational activities.
Navy Training			
Anti-Submarine Warfare (ASW) / Open Ocean		Vessel Movements	Restriction of commercial or recreational activities.
Mine Warfare (MIW) Training/ Agat Bay, Inner Apra Harbor		Vessel Movements	Restriction of commercial or recreational activities.
Air Warfare (AW) / W-517, R-7201		Aircraft Overflight	Restriction of commercial or recreational activities.
Surface Warfare (SUW)	Surface-to-Surface Gunnery Exercise (GUNEX)	Vessel Movement Aircraft Overflight	Restriction of commercial or recreational activities.
	Air-to-Surface GUNEX	Vessel Movement Aircraft Overflight	Restriction of commercial or recreational activities.
	Visit, Board, Search, and Seizure (VBSS)	Vessel Movement	Restriction of commercial or recreational activities.
Strike Warfare (STW) / FDM	Air-to-Ground Bombing Exercises (Land)(BOMBEX-Land)	Vehicle Movements Aircraft Overflight	Restriction of commercial or recreational activities.
	Air-to-Ground Missile Exercises (MISSILEX)	Vehicle Movements Aircraft Overflight	Restriction of commercial or recreational activities.
Naval Special Warfare (NSW) / Orote Point Training Areas, House, Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field	Naval Special Warfare Operations (NSW OPS)	Vehicle Movements	Restriction of commercial or recreational activities.
	Insertion/ Extraction	Vehicle Movements	Restriction of commercial or recreational activities.
	Direct Action	Vehicle Movements	Restriction of commercial or recreational activities.
	MOUT	Vehicle Movements	Restriction of commercial or recreational activities.

Table 3.16-1: Summary of Potential Stressors to Regional Economy Resources (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Regional Economy Resources
Navy Training (continued)			
Naval Special Warfare (NSW) / Orote Point Training Areas, House, Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field (continued)	Airfield Seizure	Aircraft Movements Vehicle Movements	Restriction of commercial or recreational activities.
	Over-the-Beach (OTB)	Aircraft Movements Vessel Movement	Restriction of commercial or recreational activities.
	Breaching	Vehicle Movements	Restriction of commercial or recreational activities.
Amphibious Warfare (AMW) / FDM, Orote Point and Finegayan Small Arms Ranges, Orote Point KD Range, Reserve Craft Beach, Outer Apra Harbor, Tipalao Cove, Tinian EMUA	Naval Surface Fire Support (FIREX Land)	Vehicle Movements	Restriction of commercial or recreational activities.
	Marksmanship	Vehicle Movements	Restriction of commercial or recreational activities.
	Expeditionary Raid	Vessel Movements Vehicle Movement	Restriction of commercial or recreational activities.
	Hydrographic Surveys	Vessel Movements	Restriction of commercial or recreational activities.
Explosive Ordnance Disposal (EOD) / (refer to specific operation)	Land Demolition/ Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point Training Areas, Ordnance Annex Breacher House, Ordnance Annex Detonation Range, NLNA, Ordnance Annex Galley Building 460, SLNA, Barrigada Housing	Vehicle Movements	Restriction of commercial or recreational activities.
	Underwater Demolition/ Outer Apra Harbor, Piti and Agat Bay Floating Mine Neutralization Areas	Vessel Movements	Restriction of commercial or recreational activities.

3.16.2 Affected Environment

3.16.2.1 Industry

The 2002 U.S. Census represents data for the Northern Mariana Islands and three municipalities (Saipan, Tinian, and Rota). The Northern Islands did not report any activity. The U.S. Census indicates that the greatest number of establishments in the Continental United States was in the retail trade industry. The Northern Mariana Islands, Rota, Saipan, and Tinian reflected that trend with the retail trade industry leading with the greatest number of establishments (297, 13, 277, and 7 respectively). The retail trade in

CNMI is garment manufacturing (CNMI's greatest income and tax revenue source) (PBCP 2008). The garment certification fees for the Fiscal Year (FY) 2005-2006 fell 25.2 percent from the same period last year and 44.3 percent from the same period in FY 2001. On Tinian, casino gambling was hoped to be the economy staple, but the isolation (transportation to the island is via ferry and the airport runway is too short for bigger jets) has limited the success of the gambling industry (FHB 2006-2007).

Within the Continental United States information services are consistently the least number of industries (USCB 2002). Tourism and the garment industries have long been the main industries for CNMI. The tourism industry took severe cuts in the 1990s and subsequently took a severe blow when Japan Air Lines discontinued its scheduled flights between Japan and Saipan. Japan Air Lines carried 40 percent of the Japanese tourists that made up 73 percent of all tourists to CNMI. The result was a 29 percent reduction of tourists in 2005. Subsequently in December 2007, Northwest Airlines began operation of a daily nonstop flight from Osaka to Saipan. The Korean market continues to expand with Asian Airlines now operating 18 weekly flight s from Seoul and Busan to Saipan. There is no year-round service from China, only seasonal charter flights (Saipan Tribune 2008). The garment industry has seen the loss of 9 of the 27 factories on Saipan between 2004 and 2006, which resulted in an estimated 3,842 job cuts (OIA 2008). Recently the government has taken to furloughing public sector employees every other Friday (FHB 2006-2007).

It is difficult to assess Guam economic trends given the last published estimate of Guam's Gross Territorial Product (the broadest measure of the economy) was for the year 2002, the last published unemployment rate was 2004, and the inflation rate is available only through 2005. The Port Authority of Guam is the entry point for most goods entering Guam. The Port Authority serves 20 cargo ships outbound monthly, receives over 160,000 20-foot (ft) equivalent containers, 5 million barrels of fuel, up to 100 fuel tanker port calls, and 27,000 passengers annually (FHB 2006-2007). For Guam, the 2002 U.S. Census data is provided in a single report that represents data for Guam and its election districts. Guam's greatest number of establishments was retail trade with 632 establishments; the least number of establishments was found in utilities with 4 establishments. Guam's tourist industry is on the rise due to an increase in the 80 percent of Japanese visitors to Guam; Japan Air Lines did not discontinue service to Guam as it did to CNMI (OIA 2006).

3.16.2.2 Tourism

CNMI is composed of a 14-island chain that features the three main islands of Saipan, Tinian, and Rota. With an average temperature of 84 degrees Fahrenheit and average humidity of 79 percent, these islands offer sky diving, jungle tours, and venues that offer dances of the Pacific Islanders, resorts, golf, scuba diving (including historic ship and aircraft wrecks), touring historic sites, music, arts and crafts, Eurobungy trampoline, climbing wall, and gambling. Other tourist activities include snorkeling, parasailing, water skiing, submarine tours, and sea walker tours (a 3-meter [m] dive for the uncertified tourist), banana boat rides (a nonmotorized boat pulled by a motor boat), bird watching, deep sea fishing, flora and fauna tours, glass bottom boats, and cultural festivals featuring native food, arts, and crafts (MVA 2008). Between 1988 and 1996 the tourism industry rose 15 percent annually. After a sharp decline in 1997 and 1998, a modest recovery had begun before the September 11, 2001 incidents. The 2001 event caused the tourism trade to decline a further 1.4 percent (PBCP 2008).

Guam's tourism industry comprises 60 percent of the island's revenue and Japan and Korea contribute 90 percent of those visitors. Visitors to Guam enjoy water clarity that seasonally has visibility as much as 150 ft, with turquoise lagoons. Diving for photography, spear fishing, wreck and reefs, and snorkeling are favorite sports along with jet skiing, wind surfing, sea kayaking, water tours, dolphin watching, and submarine and semisubmersible tours.

The 2003 Guam Economic Report (BOH 2003) indicates that accurate calculations have not been made for Guam but it is believed that the income multiplier or ripple effect of Federal defense spending is much higher than that for recreational spending. In effect, defense dollars generate more than each visitor dollar. Analysis of past defense spending history in the United States (to include Hawaii) shows that each dollar of defense spending could generate 75 cents of gross domestic product (GDP), which is the final value of the economy's total annual output. The 75 cent contribution (or multiplier) to GDP is the sum of direct, indirect, and induced effects of defense spending (Pula 2008). In 2003 the major revenue sources in Guam were 60 percent in tourism, 30 percent in military and Federal spending, and 10 percent defined as "other" (GEDCA 2008).

3.16.2.3 Commercial Fishing Management

CNMI's submerged lands and marine resources in the zone from the shoreline to 200 miles (mi.) are owned by the Federal government (WPRFMC 2005a). Guam manages the marine resources in the zone 0 to 3 mi. from their shorelines. Marine resources 0 to 3 mi. off of Department of Defense (DoD) property on Guam is managed by the appropriate Service. Both CNMI and Guam are members of the Western Pacific Regional Fishery Management Council (WPRFMC). The WPRFMC is tasked by Congress to monitor, develop, and regulate fisheries in the Exclusive Economic Zone[1] (EEZ) (WPRFMC 2005b). In the Western Pacific (WestPac) Region, the management of coastal and ocean activities is conducted by a number of agencies at the Federal, state, county, and even village level. These activities' representatives provide the WPRFMC input into the development and management of planning efforts, management plans, amendments, and management efforts for commercial, recreational, and subsistence fisheries. Since the 1980s the WPRFMC has managed fisheries through the following fishery management plans which regulate gear types, seasonal closures, monitoring, and reporting:

- Bottomfish and Seamount Groundfish Management Plan
- Crustaceans Management Plan
- Precious Corals Management Plan[2]
- Coral Reef Ecosystems Management Plan
- Pelagic Management Plan

Since 2005, the WPRFMC has been transitioning to a system of Fishery Ecosystem Plans that are designed to provide a comprehensive approach to fisheries management while restructuring the management of the ecosystems to ensure a "collaborative and adaptive" management process (WPRFMC 2005c).

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[1] Exclusive Economic Zones (EEZs) are seazones that were established by the Third United Nations Convention on the Law of the Sea in 1982. Part V, Article 55 of the Convention establishes that the EEZ is "an area beyond and adjacent to the territorial sea, subject to the specific legal regime established in this Part, under which the rights and jurisdiction of the coastal State and the rights and freedom of other States are governed by the relevant provisions of this Convention." (UN, 1982). The EEZs extend 200 nm from the coastal baseline (the baseline usually follows the low-water line). Within the EEZ, the coastal nation has sole exploitation rights over all natural resources; however, foreign nations have the freedom of navigation and over-flight, subject to the regulation of the reigning coastal state. The EEZ was established by Presidential Proclamation in 1983 (NOAA, 2008a/b).

[2] The precious coral fishery consists of one industry but two distinct and separate fisheries. The first is the harvest of black coral by scuba divers from depths of 30-100 m. The second is a fishery for pink and gold coral at depths between 400 and 1500 m. Precious corals are managed separately because of their widely separated, patch distribution and the sessile nature of individual colonies.

3.16.2.4 Commercial Fisheries

The Pacific Islands Fisheries Science Center published data for the year 2005, compiled by the CNMI Division of Fish and Wildlife (DFW) and the Western Pacific Fishery Information Network, in July 2007. Data are collected for these statistics through a dealer invoicing system that is collected on a monthly basis by the DFW. Estimates since 1983 indicate that more than 90 percent of the commercial landings have been recorded in Saipan, although the data represents 100 percent coverage (NOAA 2007a).

3.16.2.4.1 CNMI

To commercially fish in CNMI's EEZ in a 25- to 50-ft boat (over 5 net tons) requires a commercial fishing license that is issued annually. The NOAA Pacific Islands Fisheries Science Center reports that four commercial fishing licenses were issued in 1997 (NOAA 2008a). The annual commercial landings in CNMI have remained relatively stable and associated revenues have been subject to a steady decrease since the high of 489,710 pounds ($1,131,600) produced in 2002 to the low of 367,150 pounds ($820,860) produced in 2004 (Table 3.16.2). The resultant average over this 5-year period was 420,898 pounds ($960,244) (NOAA 2007a).

Over the past 6 years (1999-2005), approximately 63 percent of local fishermen making commercial sales participated for only a single year and no fishermen participated in all 6 years of the survey. The distance to the northern islands requires extensive investment in larger vessels and long-term commitment; thus it is difficult to recoup startup costs. Efforts to initiate a training program in bottomfishing that addresses proper handling and maintenance of the harvest, use of fathometers, nautical charts, modern electronic equipment (such as GPS and fish finders), anchoring techniques, and marketing and financial planning are anticipated to take advantage of side-band sonar mapping of the banks from Farallon de Medinilla (FDM) to Rota that is taking place in an effort to gain growth in this sector (WPRFMC 2005c).

The Navy has leased FDM from CNMI since 1971 and in 1983 negotiated a 50-year lease with an option to renew for another 50 years. Public access to FDM is prohibited and there are no commercial or recreational activities on the island. During training exercises, marine vessels are restricted within a 3-nm (5-km) radius, although published Notices to Mariners (NOTMARs) and Notices to Airmen (NOTAMs) usually advise a 3- to 30-nm (5- to 56-km) radius. The U.S. Army Corps of Engineers (USACE) may promulgate regulations to establish a danger zone or restricted area to formalize the 10-nm (56-km) safety zone around FDM. Pursuant to its authorities in Section 7 of the Rivers and Harbors Act of 1917 (40 Stat. 266; 33 USC 1) and Chapter XIX of the Army Appropriations Act of 1919 (40 Stat.892; 33 USC 3), the USACE is able to amend the regulations in 33 CFR Part 334 by establishing danger zone and restricted areas regulations. The purpose of establishing a permanent safety zone or restricted area would be to restrict all private and commercial vessels from entering the area to minimize danger from the hazardous activity in the area.

Table 3.16-2: CNMI Commercial Landings (2001-2006), All Species

Year	Pounds	Dollars
2001	433,860	1,082,900
2002	489,710	1,131,600
2003	380,980	854,800
2004	367,150	820,860
2005	432,790	911,059
TOTAL	**21,044,90**	**4,801,219**

Notes: Numbers may not total exactly due to rounding.
Source: NOAA 2007b

3.16.2.4.2 Guam

The annual commercial landings in Guam have remained relatively stable and associated revenues have been subject to a steady decrease since the high of 617,000 pounds ($1,305,000) produced in 2001 to the low of 358,000 pounds ($748,000) produced in 2005 (Table 3.16.3). The resultant average over this 5-year period was 443,000 pounds ($880,000) (NOAA 2006).

Table 3.16-3: Guam Commercial Landings (2001-2006), All Species

Year	Pounds	Dollars
2001	617,000	1,305,000
2002	486,000	945,000
2003	359,000	649,000
2004	397,000	754,000
2005	358,000	748,000
TOTAL	2,217,000	4,401,000

Notes: Numbers may not total exactly due to rounding.
Source: NOAA 2006

3.16.2.4.3 CNMI Bottomfish Fisheries

The CNMI bottomfish fishery is primarily commercial in both the shallow water (<500 ft) and the deep water (>500 ft) fishing zones. Some subsistence and recreational fishing does occur in the shallow water; however in 2004 the DFW reported only 43 vessels (these vessels included both large and small vessels) that recorded commercially fishing in the bottomfish fishery. In previous years only 8 of these vessels were reported to be commercial vessels and WPRFMC reported in 2005 that only 4 were presently active. The small vessels or skiffs are generally less than 24 ft in length and restricted because of their size to use during daylight hours within a 30-mi. radius of Saipan (WPRFMC 2005c).

3.16.2.4.4 CNMI and Guam Crustacean Fisheries

Lobsters are harvested in the zone 0 to 3 mi. from shore and are primarily for personal consumption. The commercial trade is not reported due to low volume. Shrimp and crab harvests have been attempted commercially, but are not of a reportable volume due to the strong currents, rough bottom topography, and fishing depths that are present and result in high fishing gear loss when attempting to harvest these species. Two permits were issued for crustacean harvest in 2004 in the EEZ around Guam, but the results of the harvest are unknown.

3.16.2.4.5 CNMI Coral Reef Fisheries

Coral reef fisheries are limited to the shallow water (<500 ft).

3.16.2.4.6 Guam Coral Reef Fisheries

Offshore coral reef fishing is not predominating in Guam due to the expense of required equipment and a cultural history of shore fishing of the reefs. As a result, shore-based fishing from coral reefs accounts for the majority of the harvest; however there is no accounting system to determine the level of harvest. A co-op has been established and includes over 160 full-time and part-time fishermen and accounts for an estimated 80 percent of the local commercial harvest. Less than 20 percent of the harvest occurs in the EEZ. Shallow water (<500 ft) accounts for almost 68 percent of the harvest (WPRFMC, 2005c).

3.16.2.4.7 Guam Bottomfish Fisheries

Most shallow water fishing in the zone 0 to 3 mi. from shore is recreational and subsistence fishing conducted by vessels less than 25 ft long. The commercial vessels are generally longer than 25 ft and concentrate their efforts in the deep water (> 500 ft). Less than 20 percent of the total shallow-water marine resources harvested in Guam are outside 3 mi.; the offshore is subject to strong currents and contains shark infested waters that are only accessible during calm weather in the summer months. Local fishermen have reported that up to 10 commercial boats use this area when the weather permits (WPRFMC 2005c).

3.16.2.4.8 CNMI and Guam Precious Coral Fisheries

Due to the steep topography, little is known of the CNMI precious coral fisheries; theoretically the precious corals could exist in both the nearshore and offshore waters. There is no precious coral fishery currently operating around Guam.

3.16.2.5 Fishing Gear

3.16.2.5.1 CNMI Fishing Gear

Bottomfish Fisheries. The CNMI bottomfish fishery gear for recreational and subsistence fishermen includes handlines, home fabricated hand reels, and electric reels. Larger commercial vessels commonly use electric reels and hydraulics. There are no known commercial vessels with ice-making or freezer capabilities (WPRFMC 2005c). Trolling is the most common fishing method. Lobsters are harvested by hand with scuba equipment or free diving.

3.16.2.5.2 Guam Fishing Gear

Inshore fishing is usually conducted without the use of a boat and consists mostly of nearshore casting, netting, and spear fishing (NOAA 2007c). Bottomfishing is done by hook-and-line and jigging at night for bigeye scad. Recreational and subsistence fishermen troll for pelagic fish. Commercial spear fishing using scuba at night allows for spearing in deeper water.

3.16.2.6 Recreational Fishing

3.16.2.6.1 CNMI Recreational and Subsistence Fisheries

Both CNMI and Guam are categorized as “fishing communities” by the WPRFMC. This designation is given due to considerations such as the portion of the population that is dependent upon fishing for subsistence, the economic importance of fishery resources to the islands, and the geographic, demographic, and cultural attributes of the communities (WPRFMC 2005c). The CNMI recreational and subsistence fishermen are primarily found in the shallow water (<500 ft) and limited to daylight hours within a 30-mi. radius of Saipan due to the distances to port and the limited size of the vessels (usually less than 24 ft in length) (WPRFMC 2005c). This type of fishing is conducted without fathometers or nautical charts as the fishermen rely on land features for guidance to a fishing area (NOAA 2008a). The lobster harvest occurs exclusively within the zone 0 to 3 nm from shore. This harvest is for personal consumption and volume is not reported. There is no information available regarding the subsistence or recreational harvest of coral reef resources inshore; however, a survey program is being established. Saipan Lagoon is thought to be heavily harvested by subsistence and recreational fishermen. Coral reefs are not believed to be used with any frequency by subsistence or recreational fishermen, but poaching by foreign boats is believed to occur (WPRFMC 2005c).

3.16.2.6.2 Guam Recreational and Subsistence Fisheries

Both commercial and recreational fishing activities originate from one of the three principal harbors located on the west coast and southern tip of the island. Charter fishing accounts for 15 to 20 percent of all bottomfishing trips. Charter vessels typically make multiple 2- to 4-hour trips on a daily basis with as many as 35 patrons per trip (WPRFMC 2005c). Crustacean harvest occurs in inshore territorial waters for recreational and subsistence purposes.

3.16.3 Environmental Consequences

The environmental consequences of the Proposed Action and Alternatives upon the regional economy are assessed in terms of the direct effect impacts have upon the local economy. Regional economy impacts would be considered significant if the alternative chosen for implementation resulted in a substantial shift in regional employment and spending or earning patterns.

3.16.3.1 No Action Alternative

The No Action Alternative would continue current training activities, research, development, testing and evaluation activities, and ongoing base operations. Implementation of the No Action Alternative in the territorial waters would not result in a substantial shift in regional employment or spending and earning patterns. In non-territorial waters, the environmental effects of the No Action Alternative would not cause significant harm or impacts to regional economy resources.

3.16.3.2 Alternative 1

Industry. Alternative 1 would entail an increase in training activities (and modernization) of existing range and training areas. The industries of CNMI are primarily tourism and the garment industry. Guam's major industries are tourism and retail trade. The increase in training activities and modernization of existing training areas proposed in Alternative 1 will not directly impact the leading industries in either CNMI or Guam. There would be no impacts to these industries if Alternative 1 were implemented.

Commercial Fisheries. Commercial fisheries in CNMI and Guam have remained relatively stable during current military training activities. The proposed increases in training under Alternative 1 are in existing training areas. The number of commercial fishing vessels has remained under 10 during the reporting period that is available. Given the size of the training area and the limited number of commercial fishing vessels, it is unlikely that the commercial fishing industry would realize an impact as it is unlikely that implementation of Alternative 1 would change or have an impact on commercial fishing.

Fishing Gear. Fishing activities have the potential to interact with equipment used during the proposed training activities. There are currently no training activities proposed in the Study Area that would interact with either commercial or recreational fishing activity.

Tourism. Tourism activities in the Study Area include many activities that involve both the island and ocean space. The training activities proposed in Alternative 1 are confined to existing training areas; therefore, the potential for impacts to tourism is minimal.

Recreational and Subsistence Fishing. CNMI and Guam are established fishing communities with the majority of the population fishing for subsistence. Island and shallow water fishing provides the majority of the harvest due to the distance from port, use of small vessels (<25 ft), shark-infested waters, and strong currents. Given that the proposed training activities in Alternative 1 involve established range and training activities, it is unlikely that recreational or subsistence fishing would be impacted.

The environmental effects of Alternative 1 in territorial waters on regional economy would have no significant impact. In non-territorial waters, the environmental effects of Alternative 1 would not cause significant harm to regional economy resources.

3.16.3.3 Alternative 2

The assessment of impacts to industry, commercial fishing, fishing gear, or recreational fishing with implementation of Alternative 2 is the same as those described in Section 3.16.3.2 for Alternative 1. The environmental effects of Alternative 2 in territorial waters on regional economy would have no significant impact. In non-territorial waters, the environmental effects of Alternative 2 would not cause significant harm to regional economy resources.

3.16.4 Unavoidable Significant Environmental Effects

There are no unavoidable significant environmental effects as a result of implementation of the No Action Alternative, Alternative 1, or Alternative 2.

3.16.5 Summary of Environmental Effects (NEPA and EO 12114)

Table 3.16-4 depicts the summary of the National Environmental Policy Act (NEPA) and EO 12114 environmental effects of the No Action Alternative, Alternative 1, and Alternative 2 on territorial and non-territorial waters. In territorial waters, the environmental effects of the No Action Alternative, Alternative 1, and Alternative 2 would not cause harm to regional economy resources. In non-territorial waters, the environmental effects of the No Action Alternative, Alternative 1, and Alternative 2 would not cause harm to regional economy resources.

Table 3.16-4: Summary of Environmental Effects of the Alternatives on the Regional Economy in the MIRC Study Area

Alternative	NEPA (Land and U.S. Territorial Waters, < 12 nm)	EO 12114 (Non-U.S. Territorial Waters, > 12 nm)
No Action Alternative, Alternative 1, and Alternative 2	<u>Industry</u> – Training activities in existing ranges and training areas and the increase in training activities and modernization of existing ranges and training areas proposed in Alternative 1 and Alternative 2 will not directly impact the leading industries in either CNMI or Guam. There would be no impacts to these industries if the No Action Alternative, Alternative 1, or Alternative 2 were implemented. <u>Commercial Fisheries</u> – Given the size of the training area and the limited number of commercial fishing vessels, it is unlikely that the commercial fishing industry would realize an impact as it is unlikely that implementation of the No Action Alternative, Alternative 1, or Alternative 2 would change or result in an impact to commercial fishing. <u>Fishing Gear</u> – Fishing activities have the potential to interact with equipment used during the proposed training activities. There are currently no training activities proposed in the Study Area that would interact with either commercial or recreational fishing activity. <u>Tourism</u> – The training activities proposed in the No Action Alternative, Alternative 1, or Alternative 2 are confined to existing training areas; therefore, the potential for impacts to tourism is minimal. <u>Recreational and Subsistence Fishing</u> – Given that the proposed training activities in the No Action Alternative, Alternative 1, and Alternative 2 involve established range and training activities, it is unlikely that recreational or subsistence fishing would be impacted.	<u>Industry</u> – The analysis of industry is not applicable to the non-U.S. territorial waters. The impacts to commercial fisheries, fishing gear, tourism, and recreational and subsistence fishing are similar to those for the territorial waters.

3.17 RECREATION

3.17.1 Introduction and Methods

This recreation section (Section 3.17) refers to noncommercial activities that occur in the MIRC EIS/OEIS Study Area. Commercial recreation activities are addressed in Section 3.16 (Regional Economy) of this EIS/OEIS. Offshore areas of the east coast are in use by both military and civilian interests. These activities are compatible with Navy ships, accounting for 3 percent of the total ship presence out to 200 nautical miles (nm) (CNA 2001). Where naval vessels and aircraft conduct training that is not compatible (*e.g.*, hazardous weapons firing), it is conducted away from shipping lanes and inside Special Use Airspace (SUA). Activities that could be dangerous are communicated to all vessels and operators by use of Notices to Mariners (NOTMARs), issued by the U.S. Coast Guard (USCG) and Notices to Airmen (NOTAMs) issued by the Federal Aviation Administration (FAA).

NOTMARs provide advance notice to recreational boaters and other users, informing them when the military will be operating in a specific area, and allowing them to plan their own activities accordingly. Schedules are updated when changes occur up until the date of the operation. If training activities are cancelled at any time, this information is posted and the area is again identified as clear for public use. NOTMARs advise the public, fishermen, and divers in advance of ongoing military activities that may temporarily relocate civilian/recreational activities. NOTAMs are available on the internet at https://www.notams.jcs.mil and NOTMARs can be found on the internet at www.nga.mil/portal/site/maritime.

The principal purpose of Navy lands and waters is to support mission-related activities. It is the policy of the Department of Defense (DoD) to make those lands available to the public for educational or recreational use of natural and cultural resources when such access is compatible with military mission activities, ecosystem sustainability, and other considerations such as safety, security, and fiscal soundness (Integrated Natural Resource Management Plan [INRMP] 2001).

3.17.1.1 Regulatory Framework

Section 3.17 was prepared in accordance with the National Environmental Policy Act (NEPA) and Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*, as described in Chapter 1. States' jurisdictional boundaries extend 3 nm offshore of the coast. Impacts of training activities evaluated under NEPA are further distinguished by state regulatory authorities where applicable.

3.17.1.2 Assessment Methods and Data Used

Information regarding personal watercraft was obtained in part from the USCG. In addition to its national defense role as one of the five U.S. Armed Services, the USCG is charged with a broad scope of regulatory, law-enforcement, humanitarian, and emergency-response duties. In addition to ensuring maritime safety and security, the USCG focuses on personal watercraft and boating. State tourism and parks and recreation divisions also provided sources for state-specific personal watercraft and recreational boating data.

Sport diving industry statistics are not maintained for numbers of individuals participating in specific regions of the country or for sites that are commonly used (Davison 2007; DEMA 2006). Dive locations identified in this document were established through the use of the National Oceanic and Atmospheric Administration (NOAA) Office of Coast Survey's Automated Wreck and Obstruction Information System, a survey of dive charter company websites, Veridian Corporation's 2001 Global Maritime Wrecks Database, and state tourism and parks and recreation information.

Areas that consistently provide good catches of sport fishes are considered fish havens. Favored fishing areas change over time with changes in fish populations and communities, changes in preferred target species, or changes in fishing modes and styles. Popular fishing sites are characterized by relative ease of access, ability to anchor or secure the boat, and abundant presence of target fishes. Fishermen focusing on areas of bottom relief not only catch reef-associated fishes but also coastal pelagic species that may be attracted to the habitat.

3.17.1.3 Warfare Areas and Associated Environmental Stressors

Impacts to recreation are assessed in terms of anticipated levels of disruption or improvement of current levels of access to recreational areas. Impacts may arise from physical restriction of recreational areas and, as a result, stressors that would likely impact recreational interests are increases in ship and aircraft activity and their associated increases in training events, and thus increases in military use of restricted areas for exclusive use of military training. Table 3.17-1 depicts aspects of the Proposed Actions that are likely to act as stressors to recreational resources. These stressors were identified by conducting a detailed analysis of the warfare areas, training events, and specific activities included in the alternatives.

Table 3.17-1: Summary of Potential Stressors to Recreation Resources

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Recreation Resources
Army Training			
Surveillance and Reconnaissance (S&R)/ Finegayan and Barrigada Housing, Tinian Military Lease Area (MLA)		Vehicle Movements	Restriction of recreational activities.
Field Training Exercise (FTX) / Polaris Point Field, Orote Point Airfield & Runway, Northern Land Navigation Area (NLNA), Northwest Field, Andersen South, Tinian Exclusive Military Use Area (EMUA)		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of recreational activities.
Live Fire/ Tarague Beach Small Arms Range		Vehicle Movements	Restriction of recreational activities.
Parachute Insertions and Air Assault/ Orote Point Triple Spot, Polaris Point Field, Ordnance Annex Breacher House		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of recreational activities.
Military Operations in Urban Terrain (MOUT) / Orote Point Close Quarters Combat (CQC) House, Ordnance Annex Breacher House, Barrigada Housing, Andersen South		Vehicle Movements	Restriction of recreational activities.
Marine Corps Training			
Ship to Objective Maneuver (STOM) / Tinian EMUA		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of recreational activities.
Operational Maneuver/ NLNA, Southern Land Navigation Area (SLNA)		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of recreational activities.

Table 3.17-1: Summary of Potential Stressors to Recreation Resources (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Recreation Resources
Marine Corps Training (continued)			
Noncombatant Evacuation Order (NEO) / Tinian EMUA		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of recreational activities.
Assault Support (AS) / Polaris Point Field, Orote Point Known Distance (KD) Range, Tinian EMUA		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of recreational activities.
Reconnaissance and Surveillance (R&S) / Tinian EMUA		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of recreational activities.
MOUT / Ordnance Annex Breacher House, Andersen South		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of recreational activities.
Direct Fires/ FDM, Orote Point KD Range, Air Traffic Control Assigned Airspace (ATCAA) 3A		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of recreational activities.
Protect and Secure Training Area/ Northwest Field		Vehicle Movements Aircraft Overflights Vessel Movements	Restriction of recreational activities.
Navy Training			
Anti-Submarine Warfare (ASW) / Open Ocean		Vessel Movements	Restriction of recreational activities.
Mine Warfare (MIW) Training/ Agat Bay, Inner Apra Harbor		Vessel Movements	Restriction of recreational activities.
Air Warfare (AW) / W-517, R-7201		Aircraft Overflight	Restriction of recreational activities.
Surface Warfare (SUW)	Surface-to-Surface Gunnery Exercise (GUNEX)	Vessel Movement Aircraft Overflight	Restriction of recreational activities.
	Air-to-Surface GUNEX	Vessel Movement Aircraft Overflight	Restriction of recreational activities.
	Visit, Board, Search, and Seizure (VBSS)	Vessel Movement	Restriction of recreational activities.
Strike Warfare (STW) / FDM	Air-to-Ground Bombing Exercises (Land)(BOMBEX-Land)	Vehicle Movements Aircraft Overflight	Restriction of recreational activities.
	Air-to-Ground Missile Exercises (MISSILEX)	Vehicle Movements Aircraft Overflight	Restriction of recreational activities.
Naval Special Warfare (NSW) / Orote Point Training Areas, House, Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field	Naval Special Warfare Operations (NSW OPS)	Vehicle Movements	Restriction of recreational activities.
	Insertion/ Extraction	Vehicle Movements	Restriction of recreational activities.
	Direct Action	Vehicle Movements	Restriction of recreational activities.
	MOUT	Vehicle Movements	Restriction of recreational activities.

Table 3.17-1: Summary of Potential Stressors to Recreation Resources (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Recreation Resources
Navy Training (continued)			
Naval Special Warfare (NSW) / Orote Point Training Areas, House, Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field (continued)	Airfield Seizure	Aircraft Movements Vehicle Movements	Restriction of recreational activities.
	Over-the-Beach (OTB)	Aircraft Movements Vessel Movement	Restriction of recreational activities.
	Breaching	Vehicle Movements	Restriction of recreational activities.
Amphibious Warfare (AMW) / FDM, Orote Point and Finegayan Small Arms Ranges, Orote Point KD Range, Reserve Craft Beach, Outer Apra Harbor, Tipalao Cove, Tinian EMUA	Naval Surface Fire Support (FIREX Land)	Vehicle Movements	Restriction of recreational activities.
	Marksmanship	Vehicle Movements	Restriction of recreational activities.
	Expeditionary Raid	Vessel Movements Vehicle Movement	Restriction of recreational activities.
	Hydrographic Surveys	Vessel Movements	Restriction of recreational activities.
Explosive Ordnance Disposal (EOD) / (refer to specific operation)	Land Demolition/ Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point Training Areas, Ordnance Annex Breacher House, Ordnance Annex Detonation Range, NLNA, Ordnance Annex Galley Building 460, SLNA, Barrigada Housing	Vehicle Movements	Restriction of recreational activities.
	Underwater Demolition/ Outer Apra Harbor, Piti and Agat Bay Floating Mine Neutralization areas	Vessel Movements	Restriction of recreational activities.

3.17.2 Affected Environment

Both CNMI and Guam are categorized as “fishing communities” by the Western Pacific Regional Fisheries Management Council (WPRFMC). This designation is given due to considerations like the number of the population who are dependent upon fishing for subsistence, the economic importance of fishery resources to the islands, and the geographic, demographic, and cultural attributes of the communities. As a result of the type of recreational and subsistence harvest and the sharing amongst the community, there are no systems yet available to record these types of harvest, although there are a number of programs under development.

3.17.2.1 CNMI Tourism

CNMI is a 14-island chain across a 400-mile (mi.) area that features the three main islands of Saipan, Tinian, and Rota. The average climate is stable at 84 degrees Fahrenheit (°F) and humidity of 79 percent. The ocean temperature averages 82 °F. The islands offer sky diving, jungle tours, bird watching, flora and fauna tours, as well as venues that offer traditional Polynesian dance and music; a Eurobungy trampoline and climbing wall, and gambling. Marine activities include snorkeling, parasailing, water skiing, submarine tours, sea walker tours (a 3-meter (m) meter dive for uncertified divers), a Banana boat ride (nonmotorized boat pulled by a motor boat), glass bottom boats, and deep sea fishing (MVA 2008a).

Tourism was once the largest industry in CNMI (1988-1996). There have been serious declines in tourism due to the Asian financial crisis, Severe Acute Respiratory Syndrome (SARS), and the 9/11 attacks on the United States (OIA 2008). Today the garment industry, though declining because of changes to international trade regulations, is the greatest contributor to the local economy, with five factories still open (CNMI’s greatest income and tax revenue source) (PBCP, 2008) Both industries are facing continued economic difficulties, including increased costs associated with the $2.10 per hour increase in the Federal minimum wage standards. The result is a short-term imbalance in the economy caused by the increased operating costs in the tourism industry and exacerbated by lagging tourist numbers (PBCP 2008). The withdrawal of Japan Air Lines from scheduled flights between Japan and Saipan reduced the CNMI Japanese tourist population from 40 percent of the total tourism to 29 percent in 2005 (OIA 2008). The Marianas Visitors Authority (MVA) reported 32,349 visitors to CNMI in March 2008 (MVA 2008c). Visitor arrivals from Japan continue to fall, but the MVA reported double-digit growth in Korean arrivals and a growth in arrivals from China.

The island of Tinian has a total land area of approximately 39 square miles (mi^2) but only about 13 mi^2 of the island is outside the DoD-leased lands. Local government is the island’s largest employer and Tinian is the only populated island in the Mariana Islands that has not experienced dramatic economic development over the last 15 years. Most retail establishments are located in San Jose, and include a large hotel/casino, nightclubs, convenience stores, gas stations, small restaurants, bakeries, and banks (National Park Service [NPS] 2001). Although gambling is the most profitable tourist attraction, the World War II historic sites and wildlife viewing attract tourists to the island and encourage longer stays. Most of the historic sites are located within the EMUA (INRMP 2004).

A historic trail with 14 points of interest is located on Tinian (NPS 2001). The Navy produced an interpretive brochure with maps and descriptions of the sites. The Tinian landing beaches, World War II era buildings of Ushi Point Field, and North Field runways are considered a National Historic Landmark (NHL). The Navy, through funding from the DoD Legacy Resource Management Program, has cleared roads and trails, produced and installed interpretive signs, and printed an interpretive guide for North Field that describes North Field’s historic resources. Figure 3.17-1 depicts the points of interest on Tinian, which includes the Ushi Field-North Field walking trail.

Source: DoN 2005; Aquasmith

Figure 3.17-1: Ushi Field-North Field Trail

The sites can be visited by the public, except during periods of military training. The DoD, through the Navy, retains exclusive use, control, and possession of lands encompassing the NHL based on a 50-year lease agreement with CNMI (the landowner) that is in place from 1983 through 2033 (NPS 2001). The Navy provides advance notice to CNMI agencies when military training is going to take place on Tinian (NPS 2001); during those periods the public is restricted from accessing the training areas. The area is otherwise open to the public for recreational purposes (INRMP 2004).

The Voice of America (VoA) operates the Mariana Relay Station on the coast of northwestern Tinian within the EMUA. The 800-acre VoA parcel is within the EMUA and a security gate restricts public access to the relay station operations buildings. The public has access to the coastal areas for recreation (INRMP 2004).

No tourism is allowed in the area around FDM. Public access to FDM is prohibited and there are no commercial or recreational activities on the island. The area is exclusive military use and is usually published in NOTMARs and NOTAMs as a 3- to 30-nm (5- to 56-kilometer [km]) radius area for military use due to the restricted airspace R-7201. Restricted airspace extends from the surface to infinity; therefore, the ocean surface area would be included in the exclusion of civilian use. The proposed 10-nm (18-km) radius security zone is intended to restrict nearshore access to FDM for safety and security reasons. The U.S. Army Corps of Engineers (USACE) may promulgate regulations to establish a danger zone or restricted area to formalize the 10-nm (18-km) safety zone around FDM. Pursuant to its authorities in Section 7 of the Rivers and Harbors Act of 1917 (40 Stat. 266; 33 U.S. Code [USC] 1) and Chapter XIX of the Army Appropriations Act of 1919 (40 Stat.892; 33 USC 3), the USACE is able to amend the regulations in 33 Code of Federal Regulations (CFR) Part 334 by establishing danger zone and restricted area regulations. The purpose of establishing a permanent safety zone or restricted area would be to restrict all private and commercial vessels from entering the area to minimize danger from the hazardous activity in the area.

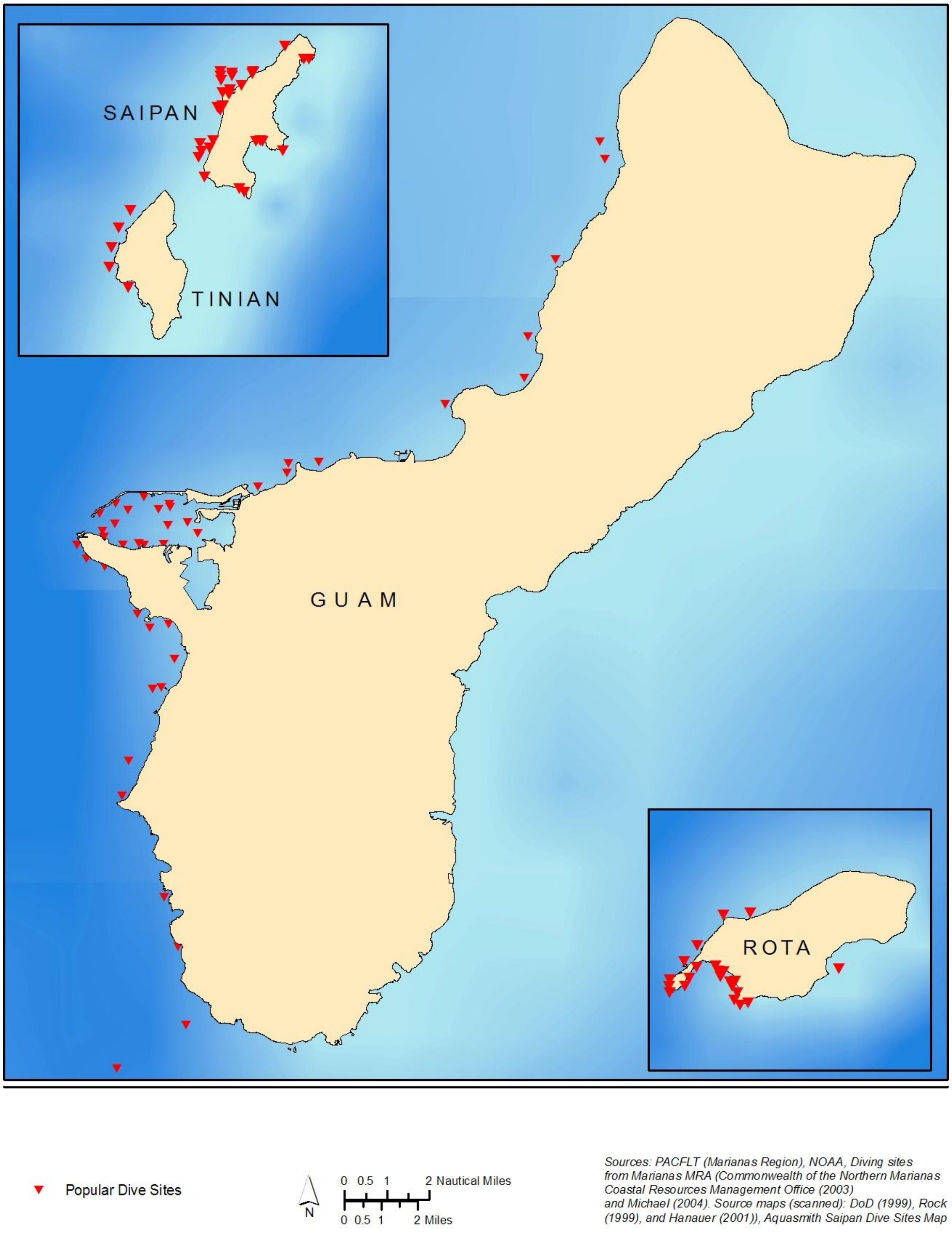
3.17.2.2 CNMI Diving

CNMI diving is attractive due to warm water and prolific coral reefs, which are some of the most beautiful and diverse in the world (CRMO 2008). Saipan has over 18 different dive sites. Tinian has numerous World War II sites while Rota offers numerous schools of goatfish, yellow spotted emperorfish, surgeonfish, parrotfish, stonefish, and lionfish (MVA 2008b). Figure 3.17-2 shows the popular dive sites in the Study Area.

3.17.2.3 CNMI Recreational Fishing

In 2006, CNMI ranked 55 out of 55 U.S. territories for registered boats. In 2006, CNMI had 310 registered boats, an increase of 101 from 2005. The scope of registered boats in CNMI only includes motor boats. Sailboats, canoes, kayaks, and row boats are not included in the current registration system (USCG 2006). In a 5-year summary of boating accidents, the USCG reports that CNMI had 10 boating accidents during the period 2002-2006 and that the accidents resulted in two fatalities. In 2006, CNMI had 3 boating accidents that did not result in any fatalities, but did have $6,700 in damage (USCG 2006).

CNMI generally has small fishing fleets comprised of small-scale subsistence and recreational vessels. In 2005, CNMI's Department of Fish and Wildlife (DFW) reported 150 vessels were being used for subsistence fishing (WPRFMC 2005). Bottomfishing occurs around the island sand banks from Rota Island to Zealandia Bank north of Sarigan in shallow water (<500 feet [ft]). This group targets the red gilled emperor. Some trips last more than a day, but generally the subsistence and recreational fishers are limited to single-day, daylight trips within a 30-mi. radius of Saipan (WPRFMC 2005). Lobsters are harvested within the 0- to 3-nm zone of the inhabited southern islands using scuba or diving gear; this harvest is for personal consumption and volume is not reported. There is no information available regarding the subsistence or recreational harvest of coral reef resources inshore; however, a survey program is being established. Saipan Lagoon is thought to be heavily harvested by subsistence and recreational fishermen. Coral reefs are not believed to be used with any frequency by subsistence or recreational fishermen, but poaching by foreign boats is believed to occur. CNMI's Coastal Resources Management Office has recently received a 3-year grant from NOAA to manage damage to fisheries habitats in coral reef environments on Saipan, Tinian, and Rota (CRI 2008).



Source: DoN 2005; Aquasmith

Figure 3.17-2: Popular Dive Sites in the MIRC EIS/OEIS Study Area

3.17.2.4 Guam Tourism

Guam Visitors Bureau (GVB) information indicates that Guam tourism generates 60 percent of the territory's revenue. In 2006, approximately $1.35 million was generated by tourism and 20,000 jobs were dependent upon tourism (approximately 35 percent of the island's employment). Japan and Korea comprise 90 percent of Guam's visitors. The United States contributed 4 percent, Taiwan was 2 percent, and CNMI and Micronesia were 3 percent (GVB 2007b). In 2007 Guam welcomed approximately 1.2 million visitors (GVB 2007a).

Tumon Bay, halfway between Apra Harbor and the northern part of the island, is the premier resort destination on Guam (GVB 2008a). Luxury hotels line the beachfront with access to white sand and crystal clear, warm waters ideal for swimming and snorkeling (guam-online.com, 2001). A few hotels are also located in the southern and central parts of the island (GVB 2008a).

The GVB projects an increase of visitors to "integrated" resorts (theme parks, entertainment, hotels, casinos, and conventions in one place) and wellness and medical tourism that includes spa and herbal treatments. Student travel seeking English language tours and volunteer tourism are the coming trends (GVB, 2007b).

Guam offers water sports that include jet skiing, wind surfing, sea kayak, water tours, dolphin watching, submarine rides, and semisubmersible rides due to deep sea currents, water clarity, and turquoise lagoons. Diving includes photography, spear fishing, wreck and reef diving, and snorkeling (GVB 2008a). Talofofo Falls is a waterfall located in the southern section of Guam and is located in Talofofo Falls Park. Tourists arrive via a gondola ride and spend their time at the falls swimming and visiting the local museum.

Bonnie stomping, or hiking through the jungle, is another activity available on Guam. Every Saturday Guam's Bonnie Stompers offer public hikes to a variety of sites including beaches, snorkeling sites, waterfalls, mountains, caves, *latte* sites, and World War II sites (GVB 2008b).

Guam offers seven world-class golf courses designed by famous U.S. and Japanese golfers. All of Guam's golf courses and driving ranges are open to the public (at all skill levels) and no golf course is more than 20 minutes away from the major hotels. The major golf courses include:

- Country Club of the Pacific
- Guam International Country Club
- Alte Guam Golf Resort
- Windward Hills Country Club
- Leo Palace Golf Resort
- Talafofo Golf Course
- Mangilao Country Club

In 2006, Guam ranked 53 out of 55 U.S. territories for registered boats. In 2006 Guam had 3,061 registered boats, an increase of 299 from 2005. The scope of registered boats in Guam is an estimate that includes all watercraft (USCG 2006). In a 5-year summary (2002-2006) of boating accidents, the USCG reported that Guam had 15 boating accidents. Seven of the accidents included fatalities, with two of these in 2006; the property damage due to accidents in 2006 was $3,800 (USCG 2006).

3.17.2.4.1 Communications Annex, Finegayan

The Communications Annex, Finegayan, contains the Navy Haputo Ecological Resource Area which was established as a mitigation measure for the construction of Kilo Wharf. This area is popular for hiking, wildlife viewing, crabbing, fishing, and beach-combing (INRMP 2001). This area has beaches and coastal areas that are desirable for public recreational use; however, the public must pass through security gates and operational areas to access the coastal areas. Recreational hunting has occasionally been permitted with limited areas as the population of deer and feral pig in this area is high; however, due to safety concerns, recreational hunting is not presently authorized on any Navy property.

3.17.2.4.2 Communications Annex, Barrigada

The Nimitz Golf Course is a popular recreation area for active and retired service personnel and their families. A portion of Communication Annex, Barrigada, is leased to the Village of Barrigada and used as a public recreation area. The surrounding area is generally urban (INRMP 2001).

3.17.2.4.3 Waterfront Annex and Orote Peninsula Ecological Reserve Area

The Orote Peninsula Ecological Reserve Area was established by the Navy in 1994 as a mitigation measure for the construction of Kilo Wharf. The Waterfront Annex has several areas that offer recreational opportunities, including hiking on historical trails, swimming, snorkeling, scuba diving, wildlife viewing, crabbing, fishing, and beach-combing. On Orote Peninsula, the Spanish Steps area is a popular hiking, swimming, and snorkeling site. The Navy Morale, Welfare, and Recreation Center is responsible for organized outdoor recreational activities and the management of the developed beach areas that include Dadi, Tipalao, Gab Gab, and San Luis beaches. Scuba diving is popular along the coastal areas of Outer Apra Harbor and the Sumay Marina rents sail boats, power boats, and kayaks. Public access to these recreational sites is limited.

3.17.2.4.4 Ordnance Annex

Ordnance Annex provides recreational opportunities that include hiking on historical trails, wildlife viewing, and fishing. Fena Reservoir has occasionally been opened for fishing to both Navy personnel and on special occasions to the general public. Hiking along rivers within Ordnance Annex provides nature viewing opportunities. Access to these recreational sites is very restricted because of the ESQD arcs (INRMP 2001). This area has beaches and coastal areas that are desirable for public recreational use; however, the public must pass through security gates and operational areas to access the coastal areas.

3.17.2.4.5 Andersen Air Force Base (AAFB)

The outdoor recreation activity at AAFB includes beach activities (picnicking, swimming, scuba diving, snorkeling). Restricted hunting, camping, fishing, land crab hunting, traditional plant gathering, rappelling, hiking, and wildlife photography also occurs. Guided interpretive outings, educational and interpretive brochures and signs, military and public educational briefings, and natural resource management programs are all present on AAFB. Table 3.17-2 outlines the recreational activities and public access of those activities on AAFB (INRMP 2003).

Table 3.17-2: Recreational Activities and Public Access on AAFB

Recreation Activity	Size of Area	Public Access
Beaches (Tarague Basin)	26	
Tarague Beach	15	Open to installation personnel and guests.
Sirena Beach	6	Open to installation personnel and guests.
Scout Beach	3	Area is open only to scouting groups.
Pati Beach	2	Off limits.
Picnic Sites (Family and Individuals)	Not Specified	Open to installation personnel and guests.
Picnic Sites (Large Groups- >20)	Not Specified	Open to installation personnel and guests.
Camping Areas (Tarague Basin)	Not Specified	
Tarague Beach Campsites	10	Open to installation personnel and guests.
Sirena Beach	Not Specified	Open to installation personnel and guests.
Scout Beach Campsites	Not Specified	Area is open only to scouting groups.
Water Sports	4	
SCUBA Diving	1	Open to installation personnel and guests.
Swimming (Tarague Beach, Sirena Beach)	3 (Offshore)	Open to installation personnel and guests.
Game Hunting (Feral Pigs & Deer)	1,000	Access generally open; controlled public access requires hunting license and special access permit and within manageable quotas.
Fishing (Shoreline Pole & Line Only)	2 Mi. of Coastline	Open to installation personnel and guests.
Land Crab/Traditional Plant Collecting	Not Specified	Open to installation personnel and guests.
Hiking Trails	4 Mi.	Open to installation personnel and guests.
Nature Study Sites	12,700	Closed. Requires special access permit through the natural resources planner or conservation officer.
Scenic Drives/Overlooks	Not Specified	
Tarague Beach Road	5 Mi.	Open to installation personnel and guests.
Ritidian Point Overlook	Not Specified	Open to installation personnel and guests.
Interpretive Centers	1 Kiosk	Open to installation personnel and guests.

Source: 2003 AAFB INRMP

3.17.2.4.6 Pati Point Natural Area

The Pati Point Natural Area is a 750-acre natural presented whose southern boundary is contiguous with the Government of Guam Anao Conservation Area. The primary purpose of the natural area is to protect the natural diversity of the native flora and fauna; thus public uses are not permitted.

3.17.2.5 Guam Diving

Guam's warm waters offer dives for all skill levels with numerous opportunities for the uncertified diver as well as the most skilled. Guam's waters offer the ability to dive from either a boat or the shore. Guam boasts that it is the only site in the world that has shipwrecks from both World War I and World War II, from two different countries, which can be visited at the same time: the Tokai Maru and the SMS Cormoran (GVB 2006; MDA 2008; FDG 2008). Figure 3.17-2 shows the popular dive sites in the Study Area.

3.17.2.6 Guam Recreational Fishing

Like CNMI, Guam bottomfish fishery is a combination of subsistence, recreation, and commercial fishing. The majority of vessels are less than 25 ft long and operate in shallow waters (<500 ft). Public boat launch sites (Figure 3.17-3) include the following:

- Agana Boat Basin – centrally located on the western leeward coast. Used for fishing areas off the central and northern leeward coasts and the northern banks.
- Merizo Boat Ramp – provides access to the southern coasts, Apra Harbor, Cocos Lagoon, and the southern banks.
- Seaplane Ramp in Apra Harbor – provides access to the southern coasts, Apra Harbor, Cocos Lagoon, and the southern banks.
- Agat Marina – provides access to the southern coasts, Apra Harbor, Cocos Lagoon, and the southern banks.
- Ylig Bay – provides access to the east side of the island.

Rough seas limit small boats during most of the year and limit subsistence and recreational bottomfish fishery to summer months when the sea conditions are calm. Galvez Bank is fished the most often due to accessibility and distance. White Tuna, Santa Rose, and Rota Banks are remote and only fished during good weather conditions.

Charter fishing has accounted for 15 to 20 percent of all bottomfishing trips from 1995 through 2004. These trips are generally to the same areas, 2 to 4 hours per day, with the majority of the catch released back to the ocean. Guam fishing for the crustacean fishery occurs for subsistence and recreation in inshore territorial waters. Shore-based fishing accounts for most of the fish and invertebrate harvest from coral reefs. More than 100 species of fish are available in the waters around Guam. Nearshore reefs are badly degraded due to sedimentation, overuse, and overharvesting (WPRFMS 2005).

3.17.3 Environmental Consequences

The recreational resource analysis addresses recreational activities in the MIRC. The principal issue is the potential for existing or proposed military ocean or air activities to affect existing recreational activities. Impacts on recreational activities are assessed with respect to the potential for disruption of recreational activities. Factors used to assess the significance of impacts on recreational activities include consideration of an alternative's potential to an increase in military restricted activities such that nonparticipating civilian recreational activities would be excluded from use of the area. A serious disruption occurs when civilian recreational activities are excluded from areas in the MIRC; however, the need to use alternative recreational areas during the time of the temporary exclusion does not constitute a serious disruption.

3.17.3.1 No Action Alternative

Civilian recreational activities conducted in the MIRC Study Area include sport fishing/diving, sailing, and other tourist-related activities. These activities make a majority of the contribution to the overall economy of both CNMI and Guam. Military land training is conducted on land designated for that purpose. Temporary clearance procedures for safety purposes do not adversely affect these economic activities because displacement is temporary. The Navy has performed military training events in this region in the past and has not precluded fishing or recreational use in the area, even during peak fishing seasons.

When safety clearance of an area is required, a NOTMAR is provided in advance, which allows boats to select an alternate destination without substantially affecting their activities. The majority of recreational fishing occurs within a few miles of shore due to swift currents, shark infested waters, and the size of the fishing vessels. Some commercial vessels do use offshore waters (>500 feet) and these activities are compatible with Navy training activities. Potential stressors of increased ship and aircraft training events and their associated training activities are confined to existing training areas. Potentially dangerous activities are communicated to all vessels and operators by use of NOTMARs, issued by the USCG, and NOTAMs, issued by the FAA.

Operational activities are required to avoid recreational boaters in the range. The No Action Alternative does not have a significant impact on recreational activities as they are now executed due to the Navy's policy of avoidance. Military activity on land is performed on existing training areas. Military activity in territorial waters would have no significant impact on recreational activities under the No Action Alternative. Military activity in non-territorial waters would not cause significant harm to recreational activities under the No Action Alternative.

3.17.3.2 Alternative 1

The proposed increase in training activities and enhanced range capabilities related to land, airspace, sea and ocean space (as detailed in Chapter 2) do not significantly impact use of the MIRC in areas analyzed in this EIS/OEIS. The potential impacts to recreational interests associated with Alternative 1 would be similar to those described for the No Action Alternative. Military activity on land is performed on existing training areas. Military activity in territorial waters would have no significant impact on recreational activities under Alternative 1. Military activity in non-territorial waters would not cause significant harm to recreational activities under Alternative 1.

3.17.3.3 Alternative 2

The potential impacts to recreational interests associated with Alternative 2 would be similar to those described for the No Action Alternative. Military activity on land is performed on existing training areas. Military activity in territorial waters would have no significant impact on recreational activities under Alternative 2. Military activity in non-territorial waters would not cause significant harm to recreational activities under Alternative 2.

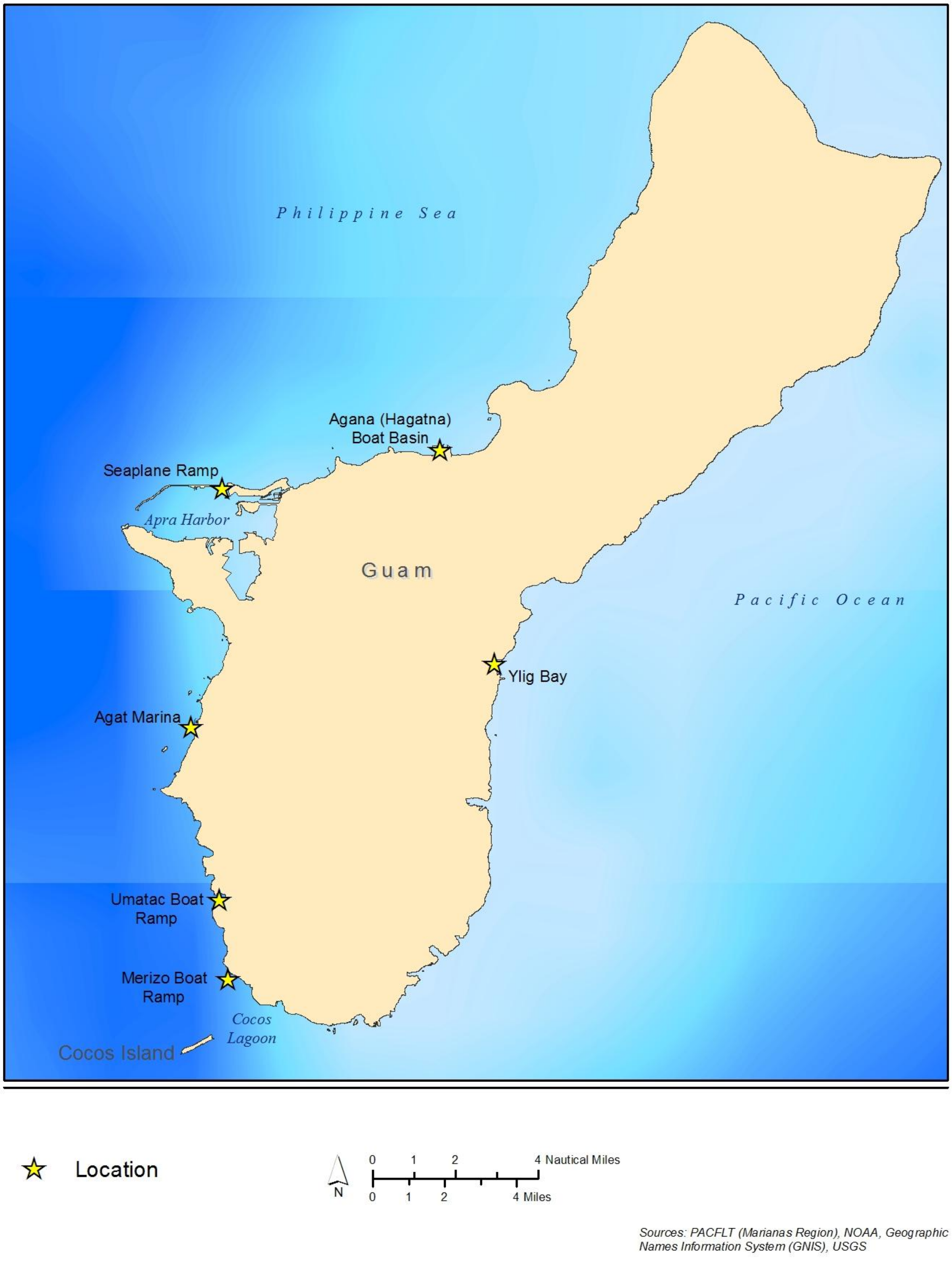


Figure 3.17-3: Guam Public Boat Launch Sites

3.17.4 Unavoidable Significant Environmental Effects

There would be no unavoidable significant environmental effects as a result of implementation of the No Action Alternative, Alternative 1, or Alternative 2.

3.17.5 Summary of Environmental Effects (NEPA and EO 12114)

As summarized in Table 3.17-3, the environmental effects of the No Action Alternative, Alternative 1, and Alternative 2 on recreation would be less than significant.

Table 3.17-3: Summary of Environmental Effects of the Alternatives on Recreation in the MIRC Study Area

<table>
<tr><th>No Action Alternative, Alternative 1, and Alternative 2 Stressors</th><th>NEPA
(Land and Territorial Waters, < 12 nm)</th><th>Executive Order 12114
(Non-Territorial Waters, >12 nm)</th></tr>
<tr><td>Ship Training Events</td><td rowspan="3">Conflicts between Navy training events and civilian recreation are confined to existing training areas; hazardous training events are communicated to all vessels and operators by use of NOTMARs issued by the USCG, and NOTAMs issued by the FAA.
Training activities are required to avoid recreational boaters in the range. Recreational activity exclusions will continue in existing areas and will be of a localized and temporary nature.</td><td rowspan="3">Conflicts between Navy training events and civilian recreation are confined to existing training areas; hazardous training events are communicated to all vessels and operators by use of NOTMARs issued by the USCG, and NOTAMs issued by the FAA.
Training activities are required to avoid recreational boaters in the range. Recreational activity exclusions will continue in existing areas and will be of a localized and temporary nature.</td></tr>
<tr><td>Aircraft Training Events</td></tr>
<tr><td>Land Training Events</td></tr>
<tr><td>Impact Conclusion</td><td>Military activity in territorial waters would have no significant impact on recreational activities under the No Action Alternative, Alternative 1, or Alternative 2.</td><td>Military activity in non-territorial waters would not cause significant harm to recreational activities under the No Action Alternative, Alternative 1, or Alternative 2.</td></tr>
</table>

3.18 ENVIRONMENTAL JUSTICE AND PROTECTION OF CHILDREN

3.18.1 Introduction and Methods

Environmental Justice. Executive Order (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 and low-income populations. The U.S. Environmental Protection Agency (USEPA) and Council on Environmental Quality (CEQ) emphasize 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 EIS/OEIS include development of Federal agency implementation strategies, identification of minority and low-income populations where proposed Federal actions have disproportionately high and adverse human health and environmental effects, and participation of minority and low-income populations in the public participation process.

Protection of Children. The President issued EO 13045, Protection of Children from Environmental Health Risks and Safety Risks, in 1997. This EO requires each Federal agency to "…make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children and shall...ensure that its policies, programs, activities, and standards address disproportionate risks to children…" This order was issued because a growing body of scientific knowledge demonstrates that children may suffer disproportionately from environmental health risks and safety risks.

***OPNAVINST 5090.1C, Navy Environmental and Natural Resources Program Manual*.** Both EO 12898 and EO 13045 require each Federal agency to identify and address effects of their programs, policies, and activities. The Navy has chosen to ensure compliance with both EO 12898 and EO 13045 through implementation of OPNAVINST 5090.1C, Navy Environmental and Natural Resources Program Manual (30 October 2007).. This policy provides instructions for naval personnel to integrate environmental planning into Navy decision-making. Identification and assessment of stressors to and disproportionately high and adverse effects upon minority, low-income, and children populations is a component of this policy that institutes processes that result in consistent and efficient consideration of environmental effects upon Navy decision making.

3.18.1.1 Regulatory Framework

The purpose of Section 3.18 is to provide an evaluation of the potential for disproportionate impacts to minorities, low-income populations, or children in the region of influence as a result of implementation of the No Action Alternative, Alternative 1, or Alternative 2. The communities of minority, low-income, and children are important to the analysis of the alternatives due to the requirements imposed by EO 12898 and EO 13045, which require Federal agencies to focus their attention and address effects on human health or environmental effects on these communities.

3.18.1.2 Assessment Methods and Data Used

This section was prepared primarily by compiling and evaluating existing information supplied by the U.S. Census Bureau and state and local governmental agencies and local organizations, as shown in Chapter 7, which references the socioeconomic (regional economy, demographics, transportation, and recreation) and public health and safety sections. A review of the resources discussed in Chapter 7 was conducted to identify stressors on individual resources and whether the identified stressors could result in disproportionately high and adverse impacts for the purposes of the environmental justice analysis. An evaluation was then conducted to determine if further analysis was needed to determine if impacts could disproportionately fall on minorities, low-income populations, or children.

3.18.1.3 Warfare Areas and Associated Environmental Stressors

The CEQ's Environmental Justice Guidance under the NEPA identifies factors that are to be considered to the extent practicable when determining whether environmental impacts to minority populations and low-income populations are disproportionately high and adverse. These factors include whether there is or will be an effect on the natural or physical environment that adversely affect a minority population, low-income population, or Indian tribe. Such impacts may include ecological, cultural, human health, economic, or social impacts when those impacts are interrelated to impacts to the natural or physical environment. Other factors to be considered if adverse impacts are projected include (1) whether the impacts will appreciably exceed those same impacts to the general population or other appropriate comparison group, and (2) whether these populations have been affected by cumulative or multiple exposures from environmental hazards.

The methodology used to conduct the impacts analysis included a review of conclusions for resources discussed in Chapter 3 to determine if stressors exist for environmental justice. If impacts were identified or if the identified impacts were disproportionately high and adverse for the purposes of environmental justice analysis, an evaluation was conducted to determine if impacts could disproportionately fall on minority populations or low-income populations. A review of the conclusions for the resources in Chapter 3 revealed that there were no major environmental impacts that would require additional analysis.

3.18.2 Affected Environment

The Affected Environment is primarily open water and the administrative units of the Mariana Islands, Guam (which is a U.S. Territory), and the Northern Mariana Islands (Saipan, Tinian, and Rota), which are a Commonwealth of the United States (CNMI 2000; GBSP 2000). Populations that could be impacted would be fisherman and recreational users of the open water areas who are most likely to live in the coastal areas adjacent to the Proposed Action. In the MIRC EIS/OEIS Study Area (which for reporting purposes includes Guam and CNMI), the number of children under the age of 5 is 8.4 percent of the total population. This is consistent with the United States, which reports that 6.8 percent of the total population is under the age of 5.

The Study Area poverty level is 22.9 percent, which is approximately 10 percent more than the U.S. rate of 12.7 percent. The percentage of the white race population (which excludes Black, American Indian and Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, Hispanic or Latino Origin, and persons reporting two or more races) is under 10 percent of the total population, and the U.S. white population is 80.2 percent.

The U.S. percentage of population that attained a high school diploma was 80.4; Guam had 31.9 percent, and CNMI had 35.6. For attainment of bachelor degrees or higher, the United States had 24.4 percent of the population attain degrees while Guam had 19.9 percent and CNMI had 15.5 percent. The 2002 U.S. Census indicates that the greatest number of establishments in the United States was in the retail trade industry. Guam and CNMI reflected that same trend with the retail trade industry leading the Study Area with the greatest number of establishments (USCB 2002).

3.18.3 Environmental Consequences:

Environmental effects related to Environmental Justice or Protection of Children would be considered significant if they would disproportionately affect minority populations, low-income populations, or populations of children. Agencies are required to ensure that their programs and activities that affect human health or the environment do not directly or indirectly use criteria, methods, or practices that discriminate on the basis of race, color, or national origin.

The inhabited locations of the Study Area have a very complex and dynamic ethnic history, which even today is in flux because of nonresident workers. Given this rich diversity, it would be arbitrary and perhaps misleading to label one or another group as a "minority," when perhaps all could be considered minorities either nationally or regionally. The highest proportional element of the population on each island is Micronesian.

To ensure public participation in the NEPA process and an opportunity for the entire population of the Study Area to assist in the development of the range of issues to be discussed in the EIS/OEIS, an early and open scoping process was conducted. The Notice of Intent was published in the Federal Register and local newspapers. Scoping meetings were held at three locations: Tumon Bay, Guam, Garapan Village, Saipan, and San Jose Village, Tinian. There were a total of 135 attendees (65 in Guam, 48 in Saipan, and 22 in Tinian). The public was invited to provide comments through comment forms that could be turned in at the scoping meeting or mailed, through oral comments (either using a tape recorder or speaking to a naval representative who transcribed comments electronically), or via emailed comments.

The Draft EIS/OEIS will be made available for public as well as state and Federal agency review and will be followed by public meetings that will be conducted in similar venues as the scoping meetings. Public comments received during the review period will be addressed in the Final EIS/OEIS. Responses to public comments may take various forms as necessary, including correction of data, clarification of and modification to analytical approaches, and inclusion of additional data or analyses. The Final EIS will then be made available for public review.

In addition to the activities to ensure public participation, the Navy initiated Government-to-Government consultation. Meetings included Guam legislative and executive branches of government, Mayor's Council, Chamber of Commerce, the CNMI legislative and executive branches of government which included briefings to the Governors and their staffs at each jurisdiction, and Congressional delegations from each jurisdiction.

In evaluating the potential for the Proposed Action to cause disproportionate impacts, it first must be determined whether there are any such impacts, and, second whether these impacts are allocated in a manner that disproportionately affects any minority group or population of children.

3.18.3.1 No Action Alternative

Training activities in the Study Area are primarily on military controlled lands. The population within the Study Area could be considered "low-income" if compared to the overall income of the United States (approximately 10 percent of the population is below the "poverty" level than those in the United States total population). In a 2005 Census 2000 Special Report, 17 states in the United States (excluding CNMI and Guam) reported a percentage of the population that exceeded the 1999 percentage of the population living in poverty areas. Thirteen of those states exceeded the 22.9 percent poverty level reported in 2000 in Guam and five exceed CNMI's 2000 census level of 30.6 of the total population below the poverty level.

The No Action Alternative would consist of the continuation of current Department of Defense (DoD) training. As the training activities are primarily on lands or waters owned, controlled, or leased by the military, and there is no clear pattern of differential residential or economic use among various ethnic populations associated with the Study Area, disproportionate impacts would not result from the No Action Alternative. In addition, since training occurs primarily on lands or waters owned, controlled, or leased by the military, there are no concentrations of children in the immediate vicinity of training areas. There would be no displacement of residents, changes in existing access for commercial or recreational activities, community disruptions, or impacts to subsistence fishing. Therefore, disproportionate environmental health risks and safety risks will not occur as a result of the No Action alternative.

3.18.3.2 Alternative 1

The proposed increase in training activities and enhanced range capabilities related to land, airspace, sea and ocean space (as detailed in Chapter 2) do not significantly impact use of the MIRC in the Study Area analyzed in this EIS/OEIS. The potential impacts to environmental justice and the protection of children associated with Alternative 1 would be similar to those described for the No Action Alternative. Naval activity in territorial waters would have no significant impact on minority populations or the protection of children under Alternative 1. Naval activity in non-territorial waters would not cause significant harm to minority populations or the protection of children under Alternative 1.

3.18.3.3 Alternative 2

Implementation of Alternative 2 would include all the actions proposed for MIRC, including the No Action Alternative and Alternative 1, and additional major exercises. The potential impacts to environmental justice and the protection of children associated with Alternative 2 would be similar to those described for the No Action Alternative. Naval activity in territorial waters would have no significant impact on minority populations or the protection of children under Alternative 2. Naval activity in non-territorial waters would not cause significant harm to minority populations or the protection of children under Alternative 2.

3.18.4 Unavoidable Significant Environmental Effects

Based upon the preceding analysis, there are no unavoidable significant environmental effects to components of environmental justice or the protection of children as a result of implementation of the No Action Alternative, Alternative 1, or Alternative 2.

3.18.5 Summary of Environmental Effects (NEPA and EO 12114)

Table 3.18-1 shows a summary of the environmental impacts of the No Action Alternative, Alternative 1, and Alternative 2 on environmental justice or the protection of children. There are no aspects of the Proposed Actions likely to act as stressors to minorities, low-income, and children populations; thus, the No Action Alternative, Alternative 1, or Alternative 2 would not result in effects on minority populations or the protection of children. Proposed Actions would have no effect on environmental justice components in territorial waters under the No Action Alternative, Alternative 1, or Alternative 2. In non-territorial waters there would be no effect on environmental justice components under the No Action Alternative, Alternative 1, or Alternative 2.

Table 3.18-1: Summary of Environmental Impacts of the Alternatives on Environmental Justice in the MIRC

Alternative and Stressor	NEPA (Land and U.S. Territory, < 12 nm)	EO 12114 (Non-Territorial Waters, >12 nm)
No Action Alternative, Alternative 1, and Alternative 2		
No Stressors Identified	The analysis of resources in Chapter 3 did not identify any stressors to the general population that would disproportionately affect minority or low-income populations or the environmental health or level of safety risks to children.	The analysis of resources in Chapter 3 did not identify any stressors to the general population that would disproportionately affect minority or low-income populations or the environmental health or level of safety risks to children.
Impact Conclusion	Implementation of No Action Alternative, Alternative 1, or Alternative 2 would have no impact on the minority populations or protection of children within the Study Area.	Implementation of No Action Alternative, Alternative 1, or Alternative 2 would have no impact on the minority population or protection of children within the Study Area.

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3.19 PUBLIC HEALTH AND SAFETY

3.19.1 Introduction and Methods

Public health and safety issues include potential hazards inherent in aircraft training activities, vessel movements, ordnance drops, mine laying, shore bombardment, underwater demolitions, and onshore small arms firing. It is the policy of the Services to observe every possible precaution in the planning and execution of all training activities that occur onshore or offshore to prevent injury to people or damage to property.

3.19.1.1 Regulatory Framework

3.19.1.1.1 Federal Laws and Regulations

The Federal Aviation Administration (FAA) regulates the use of airspace, including Special Use Airspace (SUA). Prohibited and restricted areas (*e.g.*, R-7201) are regulatory SUAs and are established in 14 Code of Federal Regulations (C.F.R.) Part 73 through the rulemaking process. Warning areas (*e.g.*, W-517), military training areas, and controlled firing areas are non-regulatory SUAs. SUAs, with the exception of controlled firing areas, are described in FAA Order JO 7400.8, Special Use Airspace.

Restricted areas contain airspace within which the flight of aircraft, while not wholly prohibited, is subject to restrictions. Restricted areas denote the existence of unusual, often invisible, hazards to aircraft such as artillery firing, aerial gunnery, or guided missiles. Penetration of restricted areas without authorization from the using or controlling agency may be extremely hazardous to the aircraft and its occupants. If the restricted area is not active and has been released to the FAA, Air Traffic Control (ATC) will allow an aircraft to operate in the restricted airspace without issuing a specific clearance for it to do so. If the restricted area is active and has not been released to the FAA, ATC will issue a clearance which will ensure the aircraft avoids the restricted airspace unless it is on an approved altitude reservation mission or has obtained its own permission to operate in the airspace and so informs the controlling facility.

Warning areas are airspace of defined dimensions extending from 3 nm (5.6 km) outward from the coast of the U.S., that contain activity that may be hazardous to nonparticipating aircraft. The purpose of such warning areas is to warn nonparticipating pilots of the potential danger. Warning areas may be located over domestic or international waters or both.

Military training areas consist of airspace of defined vertical and lateral limits established for the purpose of separating certain military training activities from Instrument Flight Rules (IFR) traffic. When a military training area is in use, nonparticipating IFR traffic may be cleared through a military operating area (MOA) if IFR separation can be provided by ATC. Otherwise, ATC will reroute or restrict nonparticipating IFR traffic. The Department of Defense (DoD) has been issued an authorization to operate aircraft at indicated airspeeds in excess of 250 knots below 10,000 ft (3,030 m) Mean Sea Level (MSL) within active military training areas.

The DoD Explosives Safety Board (DDESB), formerly called the Armed Forces Explosives Safety Board, was established in 1928 by the Seventieth Congress under Title 10 U.S.C. The DDESB mission is to provide objective advice to the Secretary of Defense and Service Secretaries on matters concerning explosives safety and to prevent hazardous conditions to life and property on and off DoD installations from the explosives and environmental effects of DoD-titled munitions.

DoD 6055.9-STD, Ammunition and Explosives Safety Standards, was developed by the DDESB to establish uniform safety standards applicable to ammunition and explosives, to associated personnel and property exposed to the potential damaging effects of an accident involving ammunition and explosives during development, manufacturing, testing, transportation, handling, storage, maintenance, demilitarization, and disposal. Among other things, the standard defines requirements for siting (quantity/distance criteria); construction of storage facilities; personnel protection; hazard identification for fire fighting and emergency planning; and minimum criteria for contingencies, combat operations, military operations other than war, and associated training. DoD components may issue supplementary instructions only when necessary to provide for unique requirements within their respective components.

The U.S. Coast Guard is an agency of the United States Department of Homeland Security responsible for maritime law enforcement, maintaining aids to navigation, marine safety, military and civilian search and rescue, and typical homeland security and military duties, such as port security. The Coast Guard operates under USC Titles 6, 10, 14, 19, 33, 46 and others, and can conduct military operations under the DoD (as a service under the Navy) or directly for the President in accordance with 14 USC 1-3, and Title 10.

3.19.1.1.2 Territory and Commonwealth Laws and Regulations

The Guam Police Department, under Title 10 GCA, has jurisdiction within the Territory of Guam over all lands, whether titled to the government or not, including submerged lands, all waterways whether navigable or not, and over all air space above such land and waterways with respect to which the Territory has jurisdiction. The department is authorized to cooperate with any federal, state, national or international law enforcement agency, including any law enforcement entity of any possession of the U.S., where a reciprocal agreement exists in detecting crime, apprehending criminal offenders and preserving law and order.

The Customs and Quarantine Agency of Guam enforces border protection regulations such as requirements relative to foreign and interstate commerce of firearms, ammunition and explosives; preventing the introduction and spread of quarantinable and communicable diseases; enforcement of agricultural inspection programs, and providing assistance to other government law enforcement and regulatory agencies in the enforcement of local and federal rules, regulations, and laws.

The mission of the Port Authority of Guam is to provide for the general needs of ocean commerce, shipping, recreational and commercial boating, and navigation in all territorial waters. Under Title 12 GCA, the Port Authority is responsible for operating, maintaining, and regulating the use of, and navigations within, portions of Apra Harbor, the Port of Guam, Hagatna Boat Basin, Agat Marina, and all other public ports, harbors, boat basins, and recreational boating facilities in Guam.

The CNMI Department of Public Safety includes Police, Fire, Corrections and the Motor Vehicles Departments. The Commonwealth Ports Authority, created under PL 2-48, is tasked with managing and operating all the airports and seaports of the Northern Marianas which includes Saipan International Airport, Tinian International Airport, Rota International Airport, the Port of Saipan, the Port of Tinian, and Rota West Harbor.

3.19.1.2 Assessment Methods and Data Used

All current and proposed training activities were examined for the possibility of exposure of the civilian population to training hazards or the potential for damage to property. Current military safety procedures were assessed for their protection of the general public and whether these procedures would protect the public from hazardous training activities proposed in the alternatives presented.

3.19.1.3 Warfare Areas and Associated Stressors to Public Health and Safety

Impacts to public health and safety are assessed in terms of the potential of military 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 activities, use of explosives, torpedoes, missiles and various ordnance, expended materials, and radio frequencies.

The training areas and training activities in the Mariana Islands Range Complex (MIRC) are listed in Table 3.19-1 and described in general below. Training activities with public health and safety stressors are listed for each training area. These sources/stressors are associated with either the training platform, the weapon system utilized during the exercise, or the target or support craft. Although there are increases in training activities from one alternative to the other, the nature of the public health and safety hazards of these training activities would be the same for all alternatives. In addition, all training areas are restricted from public access during training.

Table 3.19-1: MIRC Training Areas and Associated Public Health and Safety Stressors

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Public Health and Safety
Army Training			
Surveillance and Reconnaissance (S&R)/ Finegayan and Barrigada Housing, Tinian MLA		Vehicle and Troop Movements	Injury from collision with vehicles.
Field Training Exercise (FTX) / Polaris Point Field, Orote Point Airfield & Runway, NLNA, Northwest Field, Andersen South, Tinian EMUA		Vehicle and Troop Movements Aircraft Overflights	Injury from collision with vehicles. Injury from aircraft mishap.
Live Fire/ Pati Point CATM Range		Weapons Firing	Injury from ordnance impact.
Parachute Insertions and Air Assault/ Orote Point Triple Spot, Polaris Point Field, Ordnance Annex Breacher House		Vehicle Movements Aircraft Overflights	Injury from collision with vehicles. Injury from aircraft mishap.
Military Operations in Urban Terrain (MOUT) / Orote Point CQC House, Ordnance Annex Breacher House, Barrigada Housing, Andersen South		Vehicle and Troop Movements Weapons Firing	Injury from collision with vehicles. Injury from aircraft mishap. Injury from ordnance impacts.
Marine Corps Training			
Ship to Objective Maneuver (STOM) / Tinian EMUA		Vehicle Movements Aircraft Overflights Vessel Movements	Injury from collision with vehicles and vessels. Injury from aircraft mishap.
Operational Maneuver/ NLNA, SLNA		Vehicle and Troop Movements	Injury from collision with vehicles.
Non-Combatant Evacuation Order (NEO) / Tinian EMUA		Vehicle and Troop Movements Vessel Movements Weapons Firing	Injury from collision with vehicles. Injury from aircraft mishap. Injury from ordnance impacts.

Table 3.19-1: MIRC Training Areas and Associated Public Health and Safety Stressors (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Public Health and Safety
Assault Support (AS) / Polaris Point Field, Orote Point KD Range, Tinian EMUA		Vehicle and Troop Movements Aircraft Overflights Weapons Firing	Injury from collision with vehicles. Injury from aircraft mishap. Injury from ordnance impacts.
Reconnaissance and Surveillance (R&S) / Tinian EMUA		Vehicle and Troop Movements Weapons Firing	Injury from collision with vehicles. Injury from ordnance impacts.
MOUT / Ordnance Annex Breacher House, Orote Point CQC		Vehicle and Troop Movements Weapons Firing	Injury from collision with vehicles. Injury from ordnance impacts.
Direct Fires/ FDM, Orote Point KD Range, ATCAA 3A		Weapons Firing Aircraft Overflights Vessel Movements	Injury from collision with vessels. Injury from aircraft mishap. Injury from ordnance impacts.
Protect the Force/ Northwest Field		Vehicle Movements Weapons Firing	Injury from collision with vehicles. Injury from ordnance impacts.
Navy Training			
Anti-Submarine Warfare (ASW) / Open Ocean		Vessel Movements Aircraft Overflights Weapons Firing	Injury from collision with vessels. Injury from aircraft mishap. Injury from ordnance impacts.
Mine Warfare (MIW) Training/ Agat Bay, Inner Apra Harbor, Gab Gab Beach, Reserve Craft Beach, Polaris Point Field, Orote Point Airfield/ Runway, OPCQC, Ordnance Annex Breacher House, Ordnance Annex Emergency Detonation Site, NLNA, SLNA, Barrigada Housing, Piti and Agat Bay Floating Mine Neutralization Areas		Vessel Movements Explosives Detonations	Injury from collision with vessels. Injury from ordnance impacts.
Air Warfare (AW) / W-517, R-7201		Aircraft Overflights Weapons Firing	Injury from aircraft mishap. Injury from ordnance impacts.
Surface Warfare (SUW)/ FDM, W-517	Surface-to-Surface Gunnery Exercise (GUNEX)	Vessel Movements Aircraft Overflight Weapons Firing	Injury from collision with vessels. Injury from aircraft mishap. Injury from ordnance impacts.
	Air-to-Surface Gunnery Exercise	Vessel Movements Aircraft Overflights Weapons Firing	Injury from collision with vessels. Injury from aircraft mishap. Injury from ordnance impacts.
	Visit Board Search and Seizure (VBSS)	Vessel Movements	Injury from collision with vessels.
Strike Warfare (STW) / FDM	Air-to-Ground Bombing Exercises (Land)(BOMBEX-Land)	Vessel Movements Aircraft Overflights Land Detonations	Injury from collision with vessels. Injury from aircraft mishap. Injury from ordnance impacts.
	Air-to-Ground Missile Exercises (MISSILEX)	Vessel Movements Aircraft Overflights Land Detonations	Injury from collision with vessels. Injury from aircraft mishap. Injury from ordnance impacts.

Table 3.19-1: MIRC Training Areas and Associated Public Health and Safety Stressors (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Public Health and Safety
Naval Special Warfare (NSW) / Orote Point Training Areas, House, Ordnance Annex Breacher House, Gab Gab Beach, Apra Harbor, Andersen South, Northwest Field, Apra Harbor, Reserve Craft Beach, Polaris Point Field, Dan Dan Drop Zone	Naval Special Warfare Operations (NSW OPS)	Vehicle Movements Vessel Movements Weapons Firing	Injury from collision with vehicles and vessels. Injury from aircraft mishap. Injury from ordnance impacts.
	Insertion/ Extraction	Vehicle Movements	Injury from collision with vehicles.
	Direct Action	Vessel Movements Weapons Firing	Injury from collision with vessels. Injury from ordnance impacts.
	MOUT	Vehicle and Troop Movements Weapons Firing	Injury from collision with vehicles. Injury from ordnance impacts.
	Airfield Seizure	Vehicle and Troop Movements	Injury from collision with vehicles.
	Over the Beach (OTB)	Vessel Movements Weapons Firing	Injury from collision with vehicles. Injury from ordnance impacts.
	Breaching	Vehicle and Troop Movements Land Detonations	Injury from collision with vehicles. Injury from ordnance impacts.
Amphibious Warfare (AMW) / FDM, Orote Point and Finegayan Small Arms Ranges, Orote Point KD Range, Reserve Craft Beach, Outer Apra Harbor, Tipalao Cove, Tinian EMUA	Naval Surface Fire Support (FIREX Land)	Vehicle Movements Land Detonations	Injury from collision with vehicles. Injury from ordnance impacts.
	Marksmanship	Weapons Firing	Injury from ordnance impacts.
	Expeditionary Raid	Vessel Movements Weapons Firing	Injury from collision with vessels. Injury from ordnance impacts.
	Hydrographic Surveys	Vessel Movements	Injury from collision with vessels.
Combat Search & Rescue (CSAR)/ Tinian North Field (for NVG)		Vehicle and Troop Movements Vessel Movements Aircraft Overflights	Injury from collision with vessels and vehicles. Injury from aircraft mishap.
Protect and Secure Area of Operations/ Navy Main Base, Inner Apra Harbor, Kilo Wharf, Reserve Craft Beach, Orote Point Training Areas, Polaris Point Site III, Ordnance Annex Breacher House, Orote Annex Emergency Detonation Site	Embassy Reinforcement (Force Protection)	Vehicle and Troop Movements	Injury from collision with vehicles.
	Anti-Terrorism	Vehicle and Troop Movements	Injury from collision with vehicles.

Table 3.19-1: MIRC Training Areas and Associated Public Health and Safety Stressors (Continued)

Training Event Type/Location	Training Event Name	Potential Stressor	Potential Activity Effect on Public Health and Safety
Logistics and Combat Services Support / Orote Point Airfield/ Runway, Reserve Craft Beach	Combat Mission Area Training	Vehicle and Troop Movements Vessel Movements	Injury from collision with vehicles and vessels. Injury from aircraft mishap. Injury from ordnance impacts.
Air Force Training			
Counter Land / FDM, ATCAA 3		Land Detonations Aircraft Overflights	Injury from aircraft mishap. Injury from ordnance impacts.
Counter Air (Chaff)/ W-517, ATCAAs 1 and 2		Aircraft Overflights	Injury from aircraft mishap.
Airlift/ Northwest Field		Vehicle Movements Aircraft Overflights Weapons Firing	Injury from collision with vehicles. Injury from aircraft mishap. Injury from ordnance impacts.
Air Expeditionary/ Northwest Field		Vehicle Movements Aircraft Overflights Weapons Firing	Injury from collision with vehicles. Injury from aircraft mishap. Injury from ordnance impacts.
Force Protection/ Northwest Field		Vehicle Use Weapons Firing	Injury from collision with vehicles. Injury from ordnance impacts.

3.19.2 Affected Environment

3.19.2.1 Training Areas

3.19.2.1.1 Ocean Areas

MIRC activities occur in the open ocean area surrounding Guam and the Commonwealth of the Northern Mariana Islands (CNMI). The open ocean areas support aircraft training activities, ship maneuvers, Naval Special Warfare (NSW), Anti-Submarine Warfare (ASW), Mine Warfare (MIW), electronic combat training activities, Gunnery Exercise (GUNEX), Sinking Exercise (SINKEX), Missile Exercise (MISSILEX) and Torpedo Exercise (TORPEX).

Training activities are generally conducted in W-517 (see Figure 2-1) and in Air Traffic Control Assigned Airspace (ATCAAs) (see Figure 2-9). These areas have been previously established by the FAA and Commander, United States Naval Forces Marianas (COMNAVMAR) for use by military users as needed. The areas allow military sea space and airspace training activities to occur with minimal interference of commercial ocean and air operations. When not in use, the airspace reverts back to FAA control. Training events in the open ocean area follow all range safety, aviation safety, submarine safety, surface ship, and munitions safety procedures, including clearing the area prior to the commencement of any exercise. The areas used during MIRC training in open ocean areas are far off shore and are generally free of commercial and recreational boating.

3.19.2.1.2 Land Areas

The land areas used during MIRC training include the military lands on Guam, FDM, Tinian, and Rota where similar training routinely takes place. The land areas support aircraft training activities, amphibious exercises, troop movements, NSW, and Noncombatant Evacuation Operations (NEO). Training events on land areas follow all range, aviation, and munitions safety procedures.

Public access to training areas on Guam is restricted by their locations within military installations, except at Northwest Field and Ordnance Annex when permitted during non-training days. Public access to Farallon de Medinilla (FDM) is totally restricted. Access to training areas on Tinian and Rota by the public is allowed during non-training days.

3.19.2.1.3 Nearshore Areas

Some training events in the MIRC require nearshore areas. These events could take place in a variety of locations around the previously mentioned military land areas. Nearshore areas support MIRC training in amphibious exercises, mining and demolition exercises, NSW, and NEO.

Public access to nearshore training areas on Guam is restricted by their locations within military installations. Access to nearshore training areas on Tinian and Rota by the public is allowed during non-training days.

3.19.2.2 Training Hazards and Safety Procedures

3.19.2.2.1 Range Training Activities

Hazardous training activities include small arms fire, artillery fire, naval surface fire support, underwater demolition in nearshore areas, and air-to-ground munitions delivery. Where live and inert munitions are expended, a qualified Range Safety Officer (RSO) is always on duty on the range. FDM is an exception because it is uninhabited. However, for each flight event involving air-to-ground ordnance, one member of the flight assumes RSO duties.

The safety of participants is the primary consideration for all MIRC training activities. The fundamental guidance adhered to by military units during training is that the range must be able to safely contain the hazard footprints of the weapons and equipment employed. RSOs ensure that these hazardous areas are clear of personnel during training activities. After a live-fire event, the participating unit ensures that all weapons are safe and clear of live rounds. The RSOs also are responsible for the emergency medical evacuation of personnel from the range in the case of a mishap.

3.19.2.2.2 Munitions

Ordnance of various types is stored and used at military facilities on Guam. Ordnance storage facilities include ready service lockers and reinforced munitions bunkers. Munitions are handled and stored in accordance with standard protocols and procedures. The presence of a munitions storage site restricts the types of activities that can occur in its vicinity. Ordnance is stored by the Navy at the Ordnance Annex and by the Air Force at the Munitions Storage Area at Northwest Field at Andersen Air Force Base (AFB).

The types and amounts of explosive material that may be stored in an area are determined by explosives safety quantity-distance (ESQD) requirements established by the DoD Explosives Safety Board. ESQD arcs determine the minimum safe distance from munitions storage areas to habitable structures.

3.19.2.2.3 Missiles

For MISSILEXs, safety is the top priority and paramount concern. These training activities can be surface-to-surface, subsurface-to-surface, surface-to-air, or air-to-air. A 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 that observes an unsafe situation can communicate a “Red Range” order over any voice communication system. When a “Red Range” is called, all training activities are suspended.

3.19.2.2.4 Laser Safety

Lasers are used on the ranges for precision distance range finding and for target designation for guided munitions. Strict precautions are observed and written instructions are in place for laser users to ensure non-participants are not exposed to the intense light energy. Laser safety measures for aircraft include a dry run to ensure that target areas are clear. Aircraft run-in headings are restricted to preclude inadvertent lasing of areas where personnel may be present. Lasers cannot be fired over water if the surface is smooth enough to cause reflections and possible injury to personnel. For laser training activities on land, a qualified Laser Safety Officer must be present.

3.19.2.2.5 Aircraft

Military aircraft in offshore areas operate under Visual Flight Rules (VFR) and under visual meteorological conditions. The commanders of military aircraft are responsible for separating their aircraft from other aircraft in the area, and for the safe conduct of the flight. Prior to releasing any weapon or ordnance, flight personnel must confirm that the impact area is clear of non-participating vessels and aircraft. The Officer Conducting the Exercise is responsible for the safe conduct of range training. During all training events or exercises, a qualified Safety Officer also is on duty, and can terminate activities if unsafe conditions exist. During training activities on the range, aircraft are required to be in radio contact when entering a designated traffic area.

3.19.3 Environmental Consequences

Public health and safety impacts are considered significant if the general public is substantially endangered as a result of military training activities on the ranges. Several factors were considered in evaluating the effects of the Service’s activities on public health and safety. These factors include proximity to the public, access control, scheduling, public notification of events, frequency of events, duration of events, range safety procedures, operational control of training events, and safety history.

3.19.3.1 No Action Alternative

3.19.3.1.1 Ocean Areas

Fleet training activities that occur in the ocean areas would continue to be conducted mainly in W-517 and the ATCAAs. The Navy would ensure that projectiles, targets, and missiles were operated safely, and that air training activities and other hazardous fleet training activities were safely executed in controlled areas. The Navy’s standard Range Safety procedures are designed to avoid risks to the public and to Navy personnel. Before any training activity is allowed to proceed, the overwater target area would be determined to be clear using inputs from ship sensors, visual surveillance of the range from aircraft and range safety boats, and radar and acoustic data.

Target areas would be cleared of personnel prior to conducting training activities, so the only public health and safety issue would be if a training event exceeded the safety area boundaries. Risks to public health and safety are reduced, in part, by providing termination systems on some of the missiles and by determining that the target area—based on the distance the system can travel for those missiles without flight termination (typical air-to-air missile)—is clear. In those cases where a weapon system does 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-mi area beyond the system performance parameters.

In addition, all training activities must comply with DoD Directive 4540.01, Use of International Airspace by U.S. Military Aircraft and for Missile/Projectile Firing, (Department of Defense 2007), which specifies procedures for conducting aircraft training 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 2007). ATCAAs would continue to be used and the airspace would be released to the user by the FAA only when requested, for a fixed period, and then returned to FAA control.

Demolition activities would be conducted in accordance with Commander, Naval Surface Forces Pacific (COMNAVSURFPAC) Instruction 3120.8F, Procedures for Disposal of Explosives at Sea/Firing of Depth Charges and Other Underwater Ordnance (DoN 2003). This instruction specifies detonation procedures for underwater ordnance to avoid endangering the public or impacting other non-military activities, such as shipping, recreational boaters, divers, and commercial or recreational fishermen.

Recreational diving activities within the ocean areas take place primarily at known diving sites. The locations of popular diving sites are well-documented, 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 Navy would also notify the public of hazardous training activities through Notices to Airmen (NOTAM) and Notices to Mariners (NOTMAR).

Prior public notification of MIRC training activities, use of known training areas, avoidance of non-military vessels and personnel, and the remoteness of the offshore areas reduce the potential for interaction between the public and Navy vessels. These generally conservative safety strategies have been successful.

Management of hazardous materials and hazardous wastes in conjunction with training exercises on the ocean areas is addressed in Sections 3.2.2.1, 3.2.2.2, and 3.2.2.3. No substantial releases of these materials to the environment are anticipated.

With regard to electromagnetic radiation (EMR) hazards, standard operating procedures are in place to protect military personnel and the public. These procedures 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. Sources of EMR include radar, navigational aids, and electronic warfare (EW) systems. These systems are the same as, or similar to, civilian navigational aids and radars at local airports and television weather stations throughout the U.S. EW systems emit EMR similar to that from cell phones, hand-held radios, commercial radios, and television stations. Measures are also in place to avoid excessive exposure from EMR emitted by military aircraft. EMR fields become much weaker as the distance from the source increases. As a result, the risk of exposure to EMR is limited to military personnel and not to the general public or to wildlife.

3.19.3.1.2 Land Areas

3.19.3.1.3 Ordnance Annex, Apra Harbor, Communications Annex

MIRC activities would include explosive detonations. The public would not be exposed to the energetic effects (overpressure and fragments) of the detonations because the ESQD arc for these training munitions lies completely within the lands controlled by the Services and from which the public is excluded.

Field Training Exercise (FTX), anti-terrorism, airfield seizure, force protection, Military Operations in Urban Terrain (MOUT), parachute insertion, embassy reinforcement, direct live fire, and marksmanship activities are conducted in accordance with established directives which are developed to ensure public health and safety.

3.19.3.1.4 Tinian and Other CNMI

Ship to Objective Maneuver (STOM), FTX, NEO, assault support, and Combat Search and Rescue (CSAR) activities would be conducted in accordance with established directives which are developed to ensure public health and safety.

All potential impacts of aviation training are significant, if they affect human safety. Military training SOPs and area-specific constraints are established to prevent accidents associated with aviation. The SOPs are established on safety criteria and related operational/training procedures published by responsible government agencies and tailored for specific airfields. All airfields have designated accident potential zones, clear zones, and safety buffers imposing safety restrictions on adjacent land use. Site-specific criteria were used to evaluate impacts at existing and proposed airfields, Landing Zones (LZs), and Drop Zones (DZs).

Use of North Field and West Tinian Airport for training has the potential to place civilians at risk and to interfere with civilian air traffic. Relevant training activities are:

- West Tinian Airport: fixed-wing air traffic transporting troops and equipment to and from Tinian for training, temporary use of parking aprons, and parachute jumps east of the airport.
- North Field: fixed-wing and rotary-wing landings and takeoffs both day and night, aircrew night vision goggle training, and personnel and cargo parachute training from low-altitude fixed wing aircraft.

Impacts to civilians are possible on the ground at North Field. There is an established historic trail with 14 points of interest in the Lease Back Area (LBA) and Exclusive Military Use Area (EMUA), including sites on North Field. The EMUA has a large number of intersecting roadways, former runways, and taxiways that allow tourists broad access to North Field. Persons who inadvertently intrude onto aviation operating surfaces during aviation training could cause or suffer from aviation hazards.

If there is a lack of knowledge of military activities or a lack of direct communication between military ATC at North Field and the FAA's ATC at Saipan's International Airport, significant impacts are possible as a result of North Field aviation activity interference to or by commercial flights.

West Tinian Airport is a shared use airport. Impacts are possible at Tinian's airport due to its single runway and limited parking apron space. Shared use could become more difficult to schedule without interference to commercial flights. There is a surveyed parachute drop zone east of West Tinian Airport. Activities at the DZ must also be fully coordinated to avoid significant impacts to airport activities.

Existing and proposed deepwater training generates shock waves with the potential to affect civilian and military swimmers. Certain dive locations are less than the safe swimming distance from the existing sites.

3.19.3.1.5 Andersen AFB

Public notification procedures and established airfield operating procedures are in place and well established at Andersen AFB. FTX, anti-terrorism, airfield seizure, force protection, MOUT, and direct live fire activities are accomplished in accordance with established directives which are developed to ensure public health and safety.

3.19.3.1.6 Farallon de Medinilla

Unexploded Ordnance (UXO) is found on the island, consisting of various iron bombs, naval gunfire projectiles, and small, hard-to-detect cluster bombs. The latter are highly sensitive to disturbance and are considered extremely dangerous. The recent discovery of cluster bombs on the island reaffirms the decision to restrict civilian and military personnel access to the island, except for military personnel who are DoD explosive-certified involved in range training activities and maintenance.

A three-mile restricted area has been formally established around and above the island and is in effect at all times. The nearby ocean areas are used by commercial and sports fishermen, and local fishermen have stated that persons have gone on the island or anchored on its lee side as protection during storms. Whenever use of the range is to occur, public safety announcements are made including publication and marine band broadcasting a NOTMAR warning of the restricted water space within a three-mile (5 km) radius around the island. The airspace is also restricted to civilian aircraft for a radius of three miles and published by NOTAM. Under Alternatives 1 and 2, the 3-mile restricted area will be extended to a 10-mile (18-km) safety/exclusionary area.

Regardless of advance notification of range use, CNMI officials expressed concern that many of the fishing crews are non-English speakers and may not be informed of the potential danger.

Potential public safety impacts at FDM:

- UXO on land and to a lesser extent along the shoreline and in the water may harm anyone attempting to go on the island.
- Boats or aircraft could enter R-7201 regardless of NOTAM and NOTMAR publications and broadcasts.

The Army Corps of Engineers may promulgate regulations to establish a danger zone or restricted area to formalize the 10-nm (18-km) safety zone around FDM. Pursuant to its authorities in Section 7 of the Rivers and Harbors Act of 1917 (40 Stat. 266; 33 U.S.C. 1) and Chapter XIX of the Army Appropriations Act of 1919 (40 Stat.892; 33 U.S.C. 3) the Corps is able to amend the regulations in 33 C.F.R. part 334 by establishing danger zone and restricted areas regulations. The purpose of establishing a permanent safety zone or restricted area would be to restrict all private and commercial vessels from entering the area to minimize danger from the hazardous activity in the area.

3.19.3.1.7 Nearshore Areas - Guam Commercial Harbor and Apra Harbor

Insertion/extraction, underwater demolition, and Visit Board Search, and Seizure (VBSS) activities are accomplished in accordance with Navy criteria which are developed to ensure public health and safety. Public health and safety risks associated with this training activity include the possible dispersal of hazardous explosives residues in the bay waters, re-suspension of bay sediment contaminants, and possible public proximity to an underwater detonation. The Navy regulates recreational fishing and boating in the Apra Harbor, and allows active duty and retired military personnel in specified areas of the harbor for such purposes. Prohibited areas are identified and information on these prohibited areas is made available to the public.

3.19.3.2 Alternative 1

The locations and types of activities that would be accomplished under Alternative 1 are identical to the No Action Alternative. Alternative 1 also includes training associated with the Air Force ISR/Strike and other initiatives for Northwest Field and the Navy's acquisition of the PUTR for TRACKEX and TORPEX activities. There would be increased levels of activity under Alternative 1 and the procedures under which the activities are accomplished were developed to ensure public health and safety based on the type of event. In addition, Alternative 1 includes extension of the safety/exclusionary zone around FDM to 10 miles, increasing the level of safety. Therefore, the discussion for the No Action Alternative applies to Alternative 1.

3.19.3.3 Alternative 2

The locations and types of activities that would be accomplished under Alternative 2 are similar to the No Action Alternative and Alternative 1. Although there would be increased levels of activity, the procedures under which the activities are accomplished are developed to ensure public health and safety based on the type of event. Therefore, the discussion for the No Action Alternative applies to Alternative 2.

3.19.4 Unavoidable Significant Environmental Effects

No unavoidable significant environmental effects would be expected because the MIRC activities would continue to be accomplished in accordance with directives that are developed to ensure public health and safety.

3.19.5 Summary of Environmental Effects (NEPA and EO 12114)

Impacts to public health and safety associated with the implementation of Alternatives 1 and 2 would be similar to that of the No Action Alternative. As shown in Table 3.19-2, implementation of the No Action Alternative, Alternative 1, or Alternative 2 would not result in significant adverse impacts to public health and safety. Implementation of the No Action Alternative, Alternative 1, or Alternative 2 would not result in significant harm to public health and safety in the global commons.

Table 3.19-2: Summary of Environmental Effects of the Alternatives on Public Health and Safety in the MIRC Study Area

Summary of Effects and Impact Conclusion		
Alternative, Area, and Stressors	**NEPA (Land and Territorial Waters, <12 nm)**	**Executive Order 12114 (Non-Territorial Waters, > 12 nm)**
No Action Alternative, Alternative 1, and Alternative 2		
Ocean area **Range training activities, munitions, missiles, lasers, aircraft**	No impact. Ocean area training activities occur outside of territorial waters.	No long-term harm to public health and safety in the global commons. Implementation of safety procedures would reduce impacts to public health and safety in the global commons.
Land areas **Range training activities, munitions, lasers, aircraft**	Minor. Impacts to public health and safety reduced by access restrictions to land-based training areas and prior notification (where appropriate) during training events. Implementation of applicable safety procedures further reduces potential impacts to public health and safety.	No impact. Training activities would occur on land.
Nearshore **Range training activities, munitions, aircraft**	Minor. Impacts to public health and safety reduced by access restrictions to nearshore training areas and prior notification (where appropriate) during training events. Implementation of applicable safety procedures further reduces potential impacts to public health and safety.	No impact. Training activities would occur on nearshore training areas.
Impact Conclusion	No significant impacts to public health and safety under the No Action Alternative, Alternative 1, or Alternative 2.	No significant harm to public health and safety in the global commons under the No Action Alternative, Alternative 1, or Alternative 2.

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