Hawaii Range Complex

Draft

Draft Environmental Impact Statement/ Overseas Environmental Impact Statement (Draft EIS/OEIS)

Volume 2 of 3: Chapters 5-14, Appendices A-G

April 2007

Commander
Hawaii Range Complex
Pacific Missile Range Facility
P.O. Box 128
Kekaha, Kauai, Hawaii 96752-0128

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HAWAII RANGE COMPLEX
DRAFT ENVIRONMENTAL IMPACT STATEMENT/ OVERSEAS ENVIRONMENTAL IMPACT STATEMENT

Volume 2 of 3

APRIL 2007

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COVER SHEET
ENVIRONMENTAL IMPACT STATEMENT/ OVERSEAS ENVIRONMENTAL IMPACT STATEMENT
HAWAII RANGE COMPLEX (HRC)

Lead Agency for the EIS:	U.S. Department of the Navy
Title of the Proposed Action:	Hawaii Range Complex
Affected Jurisdiction:	Kauai, Honolulu, Maui, and Hawaii Counties
Designation:	Draft Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS)

Abstract

This Draft EIS/OEIS has been prepared by the Department of the Navy in compliance with the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. § 4321 et seq.); the Council on Environmental Quality [CEQ] Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations [CFR] §§ 1500-1508); Department of the Navy Procedures for Implementing NEPA (32 CFR § 775); and Executive Order 12114 (EO 12114), Environmental Effects Abroad of Major Federal Actions. The Navy has identified the need to support and conduct current, emerging, and future training and research, development, testing, and evaluation (RDT&E) operations in the Hawaii Range Complex (HRC). The alternatives—the No-action Alternative, Alternative 1, and Alternative 2—were analyzed in this EIS/OEIS. The No-action Alternative stands as no change from current levels of training usage and include HRC training, support, and RDT&E operations, major exercises, and maintenance of the technical and logistical facilities that support these operations and exercises, and the monitoring of marine mammals. Alternative 1 includes all ongoing operations associated with the No-action Alternative, an increased tempo and frequency of such operations, enhanced and future RDT&E operations, and enhancements to optimize HRC capabilities. Alternative 2 would include all of the operations described in Alternative 1 with the addition of increasing the tempo and frequency of training operations, enhancing RDT&E operations, future RDT&E operations, and additional major exercises, such as supporting four Strike Groups training at the same time.

This EIS/OEIS addressed the potential environmental impacts that would result from activities that would occur under the No-action Alternative and Alternatives 1 and 2. Environmental resource topics evaluated include air quality, airspace, biological resources (marine, offshore, and terrestrial), cultural resources, geology and soils, hazardous materials and waste, health and safety, land use, noise, socioeconomics, transportation, utilities, and water resources.

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5.0 CUMULATIVE IMPACTS

5.1 APPROACH

The approach taken in the analysis of cumulative effects follows the objectives of the National Environmental Policy Act (NEPA) of 1969, Council on Environmental Quality (CEQ) regulations and CEQ guidance. CEQ regulations (40 Code of Federal Regulations [CFR] §§ 1500-1508) provide the implementing procedures for NEPA. The regulations define cumulative effects as:

> The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions (40 CFR 1508.7).

CEQ guidance appears in the handbook, *Considering Cumulative Effects* (Council on Environmental Quality, 1997). The contribution of a Proposed Action to the overall impacts in a region of influence is of particular concern. While a single project may have individually minor impacts, when it is considered together with other projects on a regional scale, the effect may be collectively significant. A cumulative impact is the additive effect of all projects in the geographic area.

In general, the effects of a particular action or group of actions must meet all of the following criteria to be considered cumulative impacts:

- The effects of several actions occur in a common locale or region of influence
- The effects on a particular resource are similar in nature
- The effects are long-term since short-term impacts dissipate and cease to contribute to cumulative impacts

5.2 PROJECTS ANALYZED FOR CUMULATIVE IMPACTS

Past, present, and reasonably foreseeable actions in the cumulative effects region or region of influence are summarized in Table 5.2-1. The following represents a list of past, present, and planned projects with the potential to interact with each of the project alternatives but are neither dependent on nor part of the Proposed Action.

Table 5.2-1. Cumulative Projects List

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date
U.S. Fish and Wildlife Service (USFWS) Plant Critical Habitat	Oahu	USFWS	Protection of habitat for federally designated threatened and endangered plants.	Ongoing
Prescribed Burns at Makua Military Reservation (MMR)	MMR	U.S. Army	Prescribed burns conducted to reduce fuel load at MMR and to facilitate unexploded ordnance (UXO) clearance and surveys for cultural resources.	2002, 2003, and ongoing
Stryker Brigade Combat Team Transformation	Oahu and Hawaii	U.S. Army	Multiple construction projects and land acquisitions for converting the 2nd Brigade of the 25th ID(L) into a Stryker Brigade Combat Team.	Unknown; all construction to commence by 2008
Prescribed Burns at Army Installations on Oahu (other than MMR)	Oahu	U.S. Army	Prescribed burn to reduce fuel load at ranges. This also facilitates UXO clearance and surveys for cultural resources.	2003 and ongoing
Kahuku Windmill and Hook Parcels Land Acquisition	Kahuku Training Area (KTA)	U.S. Army	Purchase adjacent lands for Current Forces training.	2003
Turtle Bay Resort Improvements	KTA	Turtle Bay Resort	Hotel expansion and renovations.	2004
Residential Communities Initiative	Army Bases on Oahu	U.S. Army	The Army plans to turn over approximately 8,300 units of housing on Oahu to a private developer for redevelopment and operation for 50 years.	2004-2054
Farrington Highway Improvements	Mākaha (near MMR)	State of Hawaii	Construct safety and operation improvements for Farrington Highway, including sidewalks, signalized pedestrian crosswalk or bridges, and continuous left turn fences.	Funded through 2004
Farrington Highway, Replacement of Mākaha Bridges 3 and 3A	Mākaha (near MMR)	State of Hawaii	Replace two timber bridges in the vicinity of Mākaha Beach Park.	Funded through 2004
Integrated Training Area Management (ITAM)	All Oahu ranges	U.S. Army	The intent of the ITAM program is to systematically provide uniform training land management capability across U.S. Army, Hawaii (USARHAW) and to ensure that the carrying capacity of the training lands is maintained over time.	Ongoing
Implementation of the Integrated Natural Resources Management Plan (INRMP)	Oahu	U.S. Army	The INRMP “preserves, protects and enhances natural and cultural resources and complies with all applicable laws and regulations, while improving the Army’s capability to conduct training and maintain military readiness.”	Not all projects funded. Plan covers 2002-2006

Table 5.2-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date
Implementation of the Integrated Cultural Resource Management Plan (ICRMP)	Oahu	U.S. Army	The intent of the ICRMP is to preserve, protect, and enhance cultural resources; it complies with all applicable laws and regulations, while improving the Army's capability to conduct training and maintain military readiness.	Ongoing
Implementation of Proposed Range and Training Land Program Development Plan Actions	Oahu	U.S. Army	A planning document for managing range facilities and training areas based on Army training doctrine and resource guidance.	Ongoing
Installation Information Infrastructure Architecture (I3A)	Schofield Barracks Military Reservation (SBMR) - Main Post; Wheeler Army Airfield (WAAF)	U.S. Army	Install fiber optics cables from the cantonment area to the ranges, motor pool, and other facilities within the installation.	2004
Drum Road Upgrade	Helemano Military Reservation (HMR) to KTA	U.S. Army	Align, widen, and harden approximately 23 miles (37 kilometers) of the dirt and gravel road that runs from the end of the paved road at HMR to the end of the paved road at KTA. Road upgrade done to accommodate Current Forces training.	2005/2006
Residential Development	Wai'anae	Not available (N/A)	Constructed 7 housing units.	2001/2002
Residential Development	Wai'anae	N/A	Construct 1,504 housing units.	2002 and beyond
Residential Development	Ewa	N/A	Constructed 636 housing units.	2000/2001
Residential Development	Ewa	N/A	Constructed 900 housing units.	2001/2002
Residential Development	Ewa	N/A	Construct 22,049 housing units.	Unknown
Kapolei Parkway	Ewa	Dept. of Transportation Services (DTS)	Construct a new four-lane (six lanes, if needed) boulevard across much of the Ewa plain, from Ko Olina to Ocean Pointe.	Unknown
North-South Road	Ewa	State Dept. of Transportation (DOT)	Construct a new four-lane boulevard makai from a future H-1 interchange to near Ewa Villages.	Underway
Land Transfer – Dillingham Military Reservation (DMR)	DMR	U.S. Army	Return of the portion of the beach land in front of DMR to the state	Unknown
Advanced Wastewater Treatment Upgrade	SBMR	U.S. Army	Upgrade current sewage treatment to an advanced treatment and effluent system.	2005

Table 5.2-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date
Army Facility Strategy Program	SBMR/WAAF	U.S. Army	Projects include an aviation motor pool complex at WAAF, two physical fitness centers (SBMR, WAAF), a general instruction building, and upgrades to the range at SBMR.	Unknown
Hot Cargo Pad	Hickam Air Force Base (HAFB)	U.S. Air Force	Construct facilities to simultaneously load three C-5/ C-17 aircraft.	Unknown
Lāʻie Wastewater Collection System Expansion Phase II – Lāʻie	Lāʻie (adjacent to KTA)	Town of Lāʻie	Upgrade the sewage collection system in Lāʻie.	2004
Drydock 2 Waterfront Support Facility	Pearl Harbor (near HAFB)	U.S. Navy	Construct two story metal buildings, renovate latrine, and demolish several buildings.	2003
Kamehameha Highway Bridge Replacements	Kawela Camp Road, Kaukonahua Road (near SBMR)	State of Hawaii	Replace Kawela Stream bridge and Upper Poamoho Stream Bridge	Funded through 2004
Kamehameha Highway Traffic Improvements	Kahaluʻu to Waimea Bay (near KTA)	State of Hawaii	Construct passing lanes and turning lanes at intersections, modify traffic signals, and install signs, flashers, and other warning devices.	Funded through 2004
Waiʻanae Sustainable Communities Plan	Waianae	Honolulu Dept. of Planning and Permitting	A 20-year land use plan for the Waiʻanae planning area.	Ongoing
Central Oahu Sustainable Communities Plan	Central Oahu	Honolulu Dept. of Planning and Permitting	A 25-year plan guiding land use planning for central Oahu.	Ongoing
25th ID(L) & USARHAW Revitalization Program	HAFB	U.S. Air Force	Basing of eight C-17 aircraft at HAFB; four C-130 aircraft would depart from HAFB.	Unknown (a Notice of Intent has been issued for preparation of an EA)
Proposal to base eight C-17 aircraft at HAFB and the departure of four C-130 aircraft from HAFB.	Nānākuli-Waiʻanae	Department of Hawaiian Homelands	Development of 16 parcels to provide up to 3,684 single family homes and farm lots.	Unknown
Maluohai Phase III	Kapolei	Unknown	Construct 45 homes.	August 2004
Golf Course Development	Ewa, Central Oahu, and Waiʻanae	N/A	Develop 171 golf holes on 1,798 acres at nine golf courses.	2002 and beyond
Makaha 242-foot Reservoir No. 2	Waiʻanae	Board of Water Supply (BWS)	Construct a new water reservoir in Makaha Valley, adjacent to the first reservoir.	Completed

Table 5.2-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date
Nānākuli 242-foot Reservoir	Wai‘anae	BWS	Construct a new reservoir on Puu Haleakala in Nānākuli.	Unknown
Wai‘anae Regional Park	Wai‘anae	Dept. of Design and Construction (DDC)	Expand the existing regional park and add other improvements, such as an ocean recreation center and additional fields.	Underway
Wai‘anae Wastewater Treatment Plant Modification	Wai‘anae	DDC	Wastewater improvements to the existing treatment plant.	Completed
Wai‘anae Coast Emergency Alternate Route	Wai‘anae	DTS	Develop a second through-road (for emergencies only) mauka of Farrington Highway from Makaha to Nānākuli, by constructing new road links between existing sections of public or private road.	Unknown
Honouliuli Waste Water Treatment Plant (WWTP) Effluent Reuse	Ewa	DDC	Modify transmission system to distribute 13 million gallons per day (MGD) of reclaimed wastewater, as required by consent decree.	Completed
Honouliuli WWTP Handling Upgrades	Ewa	DDC	Modify solids handling facilities and odor control to improve operations within current 38 MGD capacity.	Underway
Honouliuli WWTP Expansion	Ewa	DDC	Increase the primary liquid treatment capacity (an increase of 13 MGD).	Unknown
Kamokila (Honokai Hale) Community Park	Ewa	DDC	Acquire the land under an existing city park, including land needed for access.	Underway
Ewa Mahiko District Park	Ewa	DDC	Develop a new park at the old mill site in Ewa Villages.	Underway
Honouliuli WWTP site Expansion (Mauka)	Ewa	DDC	Add 27 acres to the existing WWTP site so that ultimate capacity can be raised above 51 MGD.	Underway
Asing Community Park	Ewa	DDC	Develop a new 24-acre park to serve West Loch Estates and Fairways.	Underway
Farrington Highway Improvement	Ewa	DDC	Increase the right-of-way and widen highway from two lanes to six lanes along 12 miles from Fort Weaver Road to the proposed North-South Road.	Unknown
Oneula Beach Park Expansion	Ewa	DDC	Add six acres in conjunction with the development of the Ocean Pointe community.	Underway
Kalaeloa Regional Park	Ewa	DDC	Develop a new regional park on approximately 456 acres of the former Barbers Point Naval Air Station.	Underway
Makakilo Neighborhood Park	Ewa	DDC	Develop a new neighborhood park in the Makakilo area of the water park.	Underway

Table 5.2-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date
Renton Road Improvements (Ewa Town)	Ewa	DTS	Widening the road from two to four lanes within Ewa Villages.	Underway
Kaloi Gulch Channel	Ewa	N/A	Drainage improvements in the Varona Village area of Ewa Villages.	Underway
Kalaeloa Desalination Plant	Ewa	BWS	Construct a new, high-technology 15 MGD water production facility in Campbell Industrial Park.	Underway
Ewa Shaft Renovation	Ewa	BWS	Convert an existing private irrigation source into a municipal water production facility.	Underway
Park Row Road	Ewa	DTS	Construct a short extension of Park Row Road makai from Renton Road to the future Kapolei Parkway.	Underway
Residential Development	Central Oahu	N/A	Constructed 644 housing units.	2000/2001
Residential Development	Central Oahu	N/A	Constructed 811 housing units.	2001/2002
Residential Development	Central Oahu	N/A	Construct 8,710 housing units.	2002 and beyond
Pearl Harbor Historic Trail (Middle Loch Park)	Central Oahu	DDC	Aiea and Pearl City communities interested in enhancing a walking trail from Ewa to Ko Olina Resort along old OR&L railroad corridor. Trail is intended to preserve land and open space and offer viewscapes of Pearl Harbor and nearby wetlands.	2001 and beyond
Waipahu Wells III	Central Oahu	BWS	Potable well installation along with 5 pumps to produce 2-3 MGD for the surrounding area.	Underway
Waipio Peninsula Recreation Complex	Central Oahu	DDC	Public soccer complex and park includes soccer fields, stadium, parking lot, and park.	Completed
Central Oahu Regional Park (Waiola Sports Complex)	Central Oahu	DDC	Public sports complex includes a park, baseball fields, and tennis courts.	Underway
Waipahu Wells II Addition (two projects)	Central Oahu	BWS	Construction of pump and reservoir improvements including a 1.5 MGD well.	Underway
Waipahu Wells IV	Central Oahu	BWS	Installation of four 1.5 MGD wells, and GAC treatment facility.	Underway
Haleiwa Drainage Improvements	North Shore	DDC	Upgrades to the existing drainage ditch along Haleiwa Road (mauka side).	Underway
Banzai Rock Beach Support Park	North Shore	DDC	Develop a new parking area (and possibly bath house) mauka of Kamehameha Highway.	Underway

Table 5.2-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date
Kaunala Beach Park	North Shore	DDC	Create a new beach park at the Velzyland surf site, including a comfort station and a pavilion.	Underway
Kahawai Beach Support Park (including Sunset Beach Recreation Center)	North Shore	DDC	Create a new 2.6-acre park mauka of Kamehameha Highway near Pupukea Beach Park, to include a recreation center, comfort station, additional parking, and an area for an open market.	Underway
Waimea Valley Park	North Shore	DDC	Purchase the Waimea Falls Park, a private recreational area and botanical garden, in order to preserve the scenic valley and the botanical collection and keep the tourist attraction running.	Land acquisition underway
Residential Development	Primary Urban Center	N/A	Constructed 74 housing units.	2000/2001
Residential Development	Primary Urban Center	N/A	Constructed 91 housing units.	2001/2002
Residential Development	Primary Urban Center	N/A	Construct 1,667 housing units.	2002 and beyond
Nimitz Highway Reconstructed Sewer (Fort Street Mall to Alakea Street)	Primary Urban Center	N/A	Install 30-inch-diameter, 800-foot long subsurface water line between Fort Street Mall and Alakea Street.	2000/2001
Moanalua Road Widening	Primary Urban Center	DDC	Widening one lane of a 1,000-foot-long corridor.	2001 and beyond (no design to date; funding pending)
Pele Street Mini-Park	Primary Urban Center	DDC	Small community park	2004
Residential Development	East Honolulu	N/A	Constructed 204 housing units.	2000/2001
Residential Development	East Honolulu	N/A	Constructed 165 housing units.	2001/2002
Residential Development	East Honolulu	N/A	Construct 1,177 housing units.	2002 and beyond
Waialae Nui Well	East Honolulu	BWS	Construct a new potable well near the Waialae Nui residential subdivision.	Completed
Kalama Valley Community Park	East Honolulu	DDC	Construct new recreation building and related site improvements.	Underway
Koko Crater Botanical Garden	East Honolulu	DDC	Construct a new visitor center and related site improvements.	Underway
Koko Head Regional Park and Nature Preserve	East Honolulu	DDC	Modifications include education and visitor centers, parking, roadways, comfort stations, an enhanced trail system, and a people mover system.	Underway

Table 5.2-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date
Aina Haina Nature Preserve	East Honolulu	DDC	Develop a new nature park, complete with a trail system, parking, and related improvements.	Unknown
Queen's Beach Park (Wawamalu)	East Honolulu	DDC	Construct a new beach park in the Queen's Beach area, east of the Hawaii Kai Golf Course.	Completed
Hanauma Bay Modification	East Honolulu	DDC	Modifications included parking, food concessions, and information/education centers.	Completed
Kamilo Iki Community Park Modifications	East Honolulu	DDC	Develop new athletic fields and courts at an existing park.	Underway
Ka Iwi Shoreline Park	East Honolulu	DDC	Construct limited park improvements along Ka Iwi Coast, in conjunction with the state.	Land acquisition completed
Wailupe Stream Flood Control	East Honolulu	DDC	Plan to channelize Wailupe Stream in Aina Haina and expand the existing upland drainage basin.	Underway
Aina Haina Slide Remediation, Zone B	East Honolulu	DDC	Plan to create a passive park by compacting, regrading, and landscaping to stabilize a slide area.	Underway
Koko Crater Access Road	East Honolulu	DDC	Construct a boulevard to replace and relocate the existing private road into Koko Crater.	Underway
Koko Crater Entrance Park	East Honolulu	DDC	Construct a new passive park between Queens Gate and the proposed Koko Villas subdivision.	Underway
Residential Development	Koolaupoko	N/A	Constructed 75 housing units.	2000/2001
Residential Development	Koolaupoko	N/A	Constructed 86 housing units.	2001/2002
Residential Development	Koolaupoko	N/A	Construct 1,381 housing units.	2002 and beyond
Kamehameha Highway Scenic Enhancement	Koolaupoko	DDC	Acquiring and preserving the Waihee Marsh along the shoreline in the Kahaluu area.	Unknown
Haiku Valley Nature Preserve	Koolaupoko	DDC	Plans to purchase and improve the former US Coast Guard Omega Station and the Haiku Stairs as a park and nature preserve.	Underway
Waiahole Beach Park	Koolaupoko	DDC	Plans to expand and improve the existing Waiahole Beach Park.	Underway
Waimanalo Well II	Koolaupoko	BWS	Construct a new potable water well mauka of the former Meadow Gold Dairies pasture land.	Unknown

Table 5.2-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date
Kahaluu Regional Park	Koolaupoko	DDC	Plans to expand the existing regional park mauka toward the Kahaluu Elementary School and adjacent park.	Underway
Kailua 272 Reservoir	Koolaupoko	BWS	Construct a new reservoir at Kalae O Kaiwa Ridge in Kailua.	Underway
Kaneohe Stream Green Belt Park	Koolaupoko	DDC	Plans to establish a greenbelt park along the lower reaches of Kaneohe Stream.	Underway
Kawa Stream Improvements	Koolaupoko	DDC	Channelize Kawa Stream within the Piloiloa Subdivision behind Castle High School in Kaneohe.	Underway
Kailua Beach Park Improvements	Koolaupoko	DDC	Construct a new pavilion, canoe halau, relocated comfort station, and various grounds improvements.	Unknown
Waimanalo Treatment and Disposal System	Koolaupoko	DDC	Expand the existing Waimanalo Wastewater Treatment Plant to accommodate increasing demand and to provide service to areas currently using cesspools.	Underway
Kawai Nui Gateway Park	Koolaupoko	DDC	Plans to create a nature walk, dog park, and additional landscaping at various places along the northern and eastern borders of Kawai Nui Marsh.	Underway
Kawai Nui Community Park	Koolaupoko	DDC	Improve an existing park by adding a recreation building, comfort station, and play courts.	Completed
Kailua Park	Koolaupoko	DDC	Develop a new nature park in Maunawili Valley, surrounding and including the existing Luana Hills Golf Course.	Land acquisition underway
Pali Golf Course Improvements	Koolaupoko	DDC	Modifications include replacing the clubhouse and improving all areas of the golf course.	Underway
Kaneohe Bayside Park (Kahua O Waikalua Neighborhood Park)	Koolaupoko	DDC	Create a new park on the site of the soon-to-be-phased-out Kaneohe Sewage Treatment Plant, to include ball fields and open spaces.	Underway
Waikane Nature Preserve	Koolaupoko	DDC	Establish a nature preserve in Waikane Valley, with improvements limited to walking trails.	Underway
Kuou Well III	Koolaupoko	DDC	Construct a new potable water well next to Ho’omaluhia Botanical Garden in Kaneohe.	Completed
Kualoa Regional Park	Koolaupoko	DDC	Upgrade an existing park by constructing a sewage system and improving buildings and roads.	Underway
Kailua Sewage Treatment Plant Modification	Koolaupoko	DDC	Upgrade the existing plant to increase storage capacity and improve odor control.	Underway

Table 5.2-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date
Kaneohe Sewage Treatment Plant Modification	Koolaupoko	DDC	Convert the existing treatment plant to a pretreatment facility that has additional capacity to handle wet-weather flows, and demolish the existing structures and tanks so that the land can be used as a park.	Completed
Heeia Kea Park	Koolaupoko	DDC	Create a nature park and passive recreational area within Heeia Kea Valley.	Underway
Kalaeloa Artificial Reef	Ewa	State of Hawaii	Establish an artificial reef site on the seafloor offshore from the Ewa District of the Island of Oahu	Unknown
Kaluanui Well Addition	Koolauloa	BWS	Construct a new potable water well within Heeia Kea Valley.	Underway
Hauula Community Park Building Expansion	Koolauloa	DDC	Expand the existing multi-purpose building and construct related improvements.	Underway
Opana Wells	Koolauloa	BWS	Construct a new potable water well in the Kawela area mauka of the proposed Kuilima Resort.	Completed
Kahuku District Park Improvements	Koolauloa	DDC	Construct a new multi-purpose building, play courts, and related improvements.	Underway
Laie Beach Park (Bluff)	Koolauloa	DDC	Expand the existing beach park and construct related park improvements.	Underway
Hauula Fire Station Relocation	Koolauloa	DDC	Construct a new fire station (possibly including an ambulance facility) outside of the flood plain area.	Underway
Hawaii Superferry		DOT, Harbors Division	Operation of a high-speed ferry between the islands of Oahu, Maui, and Kauai, running in designated close-to-shore water lanes.	2007
ATG Trainer Facility		U.S. Navy	Warehouse structure to house Anti-terrorism Force Protection trainers/simulators.	2013
Waterfront Upgrade		U.S. Navy	Wharf and supporting facilities to berth Pearl Harbor home ported submarines.	2013
Consolidated fire station	Naval Station area	U.S. Navy	Consolidation of three fire stations into one new station.	Unknown
Fire station	West Loch	U.S. Navy	Replacement of existing fire station.	Unknown
Compressed air plant	Pearl Harbor Naval Shipyard dry docks, Yankee and Sierra piers	U.S. Navy	Compressed air plant to support submarine overhauls and repairs.	Unknown
Magazine driveway paving	Driveways to Naval Magazine (NAVMAG) ammunition magazines	U.S. Navy	Pavement of unpaved driveways.	2013

Table 5.2-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date
Advanced Sea, Air & Land (SEAL) delivery system/SEAL delivery vehicle operations wharf	Between wharves Victor 1 and Victor 2	U.S. Navy	Construction of a new wharf structure.	2013
Conference and Technology Learning Center	Fort DeRussy Armed Forces Recreation Center	U.S. Navy	Construction of a one-story building.	Unknown
Dry Docks 1 & 2 Ship Support Services	Dry docks 1 &2, Bravo piers 1 & 2	U.S. Navy	Provision of air, water, nitrogen, and gas systems for ships undergoing repair.	Unknown
Renovate Facilities for Naval Undersea Warfare Center Detachment Hawaii	Ford Island	U.S. Navy	Renovate five buildings and construct underwater test facility.	Unknown
Joint Forces Deployment Staging Area		U.S. Navy	Construction of staging area for deployment of 25^{th} Infantry Division.	Unknown
Ship Maintenance Waterfront Facility		U.S. Navy	Building renovations.	Unknown
P-587 Pacific Fleet Submarine Drive-In	Beckoning Point, Pearl Harbor, HI	Naval Station Pearl Harbor	Construction of a concrete slip to support a drive-in Magnetic Silencing Facility.	FY08 program year
P-202 Joint Forces Deployment Staging Area	NS Pearl Harbor, HI	Commander, Navy Region Hawaii; Commander, Navy Installations Command	Creation of a deployment staging area to support deployment of Joint Forces.	FY10
P-173 Construct Communication Center, Naval Computer and Telecommunications Area Master Station	Wahiawa	U.S. Navy	Construction of a communication center.	2008
P-578 Construct Fitness Center	NAVSTA Main Base	U.S. Navy	Construction of a fitness center.	Unknown
P-005 Joint Prisoner of War/Missing in Action (POW/MIA) Accounting Command	Hickam AFB	U.S. Navy	Construction of a facility to accommodate the Joint POW/MIA Accounting Command.	2010
P-004 Construct Conference and Technology Learning Center	Ft. DeRussy	U.S. Navy	Construction of a learning center.	2010

Table 5.2-1. Cumulative Projects List (Continued)

Project	Related Project Location	Project Sponsor	Project Description	Projected Completion Date
P-182 Construct Missile Magazines, NAVMAG WL		U.S. Navy	Construction of five earth-covered box magazines.	2010
P-013 Consolidate Command Support Functions		U.S. Navy	Renovation and demolition of buildings in support of consolidation of support functions.	2010
P-634 Waterfront Upgrades Bravo 21	Bravo docks 20 and 21	U.S. Navy	Construction of new concrete wharves.	2010
P-302 Dry Dock Ship Support Services	Dry docks 1 and 2, Bravo piers 1 and 2	U.S. Navy	Modifications of docks and piers to provide ship support services.	2012
P-639 Construct Advanced SEAL Delivery System/SEAL Delivery Vehicle (ASDS/SDV) Operations Wharf	Wharf Victor 2	U.S. Navy	Construction of a new wharf structure.	2013
Advanced Radar Detection Laboratory (ARDEL)	Pacific Missile Range Facility	Navy Sea Systems Command	The ARDEL would serve to mitigate development risk on the Air and Missile Defense Radar for the next generation cruiser, referred to as the CG(X).	2011
Rim of the Pacific (RIMPAC) Training Events	HRC	U.S. Navy	RIMPAC is a biennial, sea controlled projection fleet exercise that has been conducted since 1968.	2006
Undersea Warfare Exercise (USWEX)	HRC	U.S. Navy	USWEX is an advanced Anti-Submarine Warfare Exercise proposed to be conducted by the U.S. Navy's Carrier Strike Groups and Expeditionary Strike Groups while in transit from the west coast of the United States to the western Pacific Ocean.	2007

Source: U.S. Army, 2005

5.2.1 OTHER ACTIVITIES

5.2.1.1 COMMERCIAL FISHING

To date, there have only been three observed interactions with Endangered Species Act (ESA) listed whale species and pelagic longline fisheries. Two of the incidents involved humpback whales, and one involved a sperm whale. Recent Biological Opinions have concluded that the region's pelagic fisheries are not likely to have an adverse effect on the populations of the seven ESA listed whale species in the region. In pelagic fisheries managed under a Fisheries Management Plan, there are documented interactions with several non-ESA listed marine mammals. Observer data from the Hawaii-based longline fishery show that interactions with non-ESA listed marine mammals are infrequent. At present, the Hawaii-based pelagic fisheries are classified as Category III fisheries under Section 118 of the Marine Mammals Protection Act; which defines them to have a remote likelihood or no known incidental take of marine mammals

(National Oceanic Atmospheric Administration Fisheries, 2004). Therefore, the potential for cumulative impacts on marine mammals from commercial fishing are minimal.

5.2.1.2 VESSEL TRAFFIC

Ship strikes, or ship collisions with whales, are a recognized source of whale mortality worldwide. Of the 11 species known to be hit by ships, the most frequently reported is the fin whale. In the Hawaiian Islands, ship strikes of the humpback whale are of particular concern. Whale-watching tours are becoming increasingly popular, and ship strikes have risen in recent years. Whale watching could also have an effect on whales by distracting them, displacing them from rich food patches, or by dispersing food patches with wake or propeller wash (Katona and Kraus, 1999). Ship strikes remain a significant threat to some whale populations. In North Atlantic right whales, for example, ship strikes are believed to be a significant factor limiting the recovery of this species (Knowlton and Kraus, 2001).

A review of recent reports on ship strikes provides some insight regarding the types of whales, locations and vessels involved, but also reveal significant gaps in the data. The Large Whale Ship Strike Database provides a summary of the 292 worldwide confirmed or possible whale/ship collisions from 1975 through 2002 (Jensen and Silber, 2003). The report notes that the database represents a minimum number of collisions, because the vast majority probably go undetected or unreported.

All types of ships can hit whales, and much of the time the marine mammal is either seen too late, not observed until the collision occurs, or not detected. The ability of a ship to avoid a collision and to detect a collision depends on a variety of factors, including environmental conditions, ship design, size, and manning.

Naval ships, particularly the smaller ships such as U.S. Navy frigates and destroyers and U.S. Coast Guard cutters, have a number of advantages for avoiding ship strikes as compared to most merchant vessels.

- U.S. Navy and U.S. Coast Guard ships have their bridges positioned forward, offering good visibility ahead of the bow.
- Crew size is much larger than merchant ships, and there are dedicated lookouts posted during each watch.
- Naval vessels are generally twin screw and much more maneuverable than single screw commercial craft.
- Due to smaller ship size and higher deck manning, some U.S. Navy and U.S. Coast Guard vessels are likely to detect any strike that does occur, and these agencies' standard operating procedures include reporting of ship strikes.
- Overall, the percentages of U.S. Navy traffic relative to overall large shipping traffic are very small (on the order of 2 percent).

The National Oceanic and Atmospheric Administration (NOAA) continues to review all shipping activities and their relationship to cumulative effects, in particular on large whale species. According to the NOAA report, the factors that contribute to ship strikes of whales are not clear, nor is it understood why some species appear more vulnerable than others. Nonetheless, the number of known ship strikes indicates that deaths and injuries from ships and shipping activities remain a threat to endangered large whale species, right whales in particular.

5.2.1.3 COASTAL DEVELOPMENT ACTIVITIES

Habitat loss and degradation is now acknowledged to be a significant threat to cetacean populations (Kemp, 1996). The impact of coastal development on whales has not been thoroughly investigated. Habitat alteration has the potential to disrupt the social behavior, food supply, and health of whales. Such activities may stress the animals and cause them to avoid traditional feeding and breeding areas, or migratory routes. The most serious threat to cetacean populations from habitat destruction may ultimately prove to be its impact on the lower trophic levels in their food chains (Kemp, 1996).

5.2.1.4 ENVIRONMENTAL CONTAMINATION AND BIOTOXINS

Insufficient information is available to determine how, or at what levels and in what combinations, environmental contaminants may affect cetaceans (Marine Mammal Commission, 2003). There is growing evidence that high contaminant burdens are associated with several physiological abnormalities, including skeletal deformations, developmental effects, reproductive and immunological disorders, and hormonal alterations (Reijnders and Aguilar, 2002). It is possible that anthropogenic chemical contaminants initially cause immunosuppression, rendering whales susceptible to opportunistic bacterial, viral, and parasitic infection (De Swart et al., 1995). Specific information regarding the potential effects of environmental contamination on marine mammals in the Hawaiian Islands is not available, and therefore cumulative effects can not be adequately assessed.

5.3 CUMULATIVE IMPACT ANALYSIS

This section addresses the additive effects of the No-action Alternative, Alternative 1, or Alternative 2 in combination with the projects identified in Section 5.2. Since environmental analyses for some of the projects listed are not complete or do not include quantitative data, cumulative impacts are addressed qualitatively and are described below.

5.3.1 AIR QUALITY

Implementation of the No-action Alternative, Alternative 1, or Alternative 2 in conjunction with the cumulative actions listed in Table 5.2-1 would result in increases in air emissions within the region of influence. However, the State of Hawaii is generally in compliance with the Federal National Ambient Air Quality Standards and the State Ambient Air Quality Standards. Air pollution levels in Hawaii are generally low due to the small size and isolation of the state. Historic air quality monitoring data do not show any recent upward or downward trends in average air quality conditions in Oahu or Hawaii (U.S. Army, 2005). Federal ozone standards have not been exceeded in Hawaii during the past decade, despite the cumulative emissions from highway traffic, commercial and military aircraft operations, commercial and industrial facility operations, agriculture operations, and construction projects in both urban and rural areas. Training operations that occur in the open ocean have limited effect on air quality due to their distance offshore and meteorological conditions. For operations occurring at Pacific Missile Range Facility (PMRF), a Title V Covered Source Permit has been issued and was renewed in 2003 to cover all significant stationary emissions sources on PMRF. Aircraft and missile exhaust emissions are considered mobile sources and are thus exempt from permitting requirements. Minor increases in air emissions may occur as a result of implementation of

Alternatives 1 and 2; however, these increases would not violate the federal or state ambient air quality standards or any other federal or state air standards, rules, or regulations.

5.3.2 AIRSPACE

The development of military lands prior to and after World War II had the biggest impact on airspace in the Hawaiian Islands. The expansion of military airfields continued as larger and more military aircraft were stationed in Hawaii. Following World War II, the increase in tourism resulted in an expansion of civilian airfields and airports. As with the military, the civilian aircraft increased in numbers and size requiring expansion of the existing airports. This historic development resulted in close monitoring of airspace as the land area is small in Hawaii with limited airspace (U.S. Army, 2004).

Implementation of the No-action Alternative, Alternative 1, or Alternative 2 in conjunction with the cumulative actions listed in Table 5.2-1 would not incrementally affect airspace within the region of influence because no airspace impacts were identified in the analysis presented in Chapter 4. No other projects in the region of influence have been identified that would have the potential for incremental additive cumulative impacts on controlled or uncontrolled airspace, special use airspace, military training routes, en route airways and jet routes, airports/airfields, or air traffic control. Consultation with the Federal Aviation Administration on all matters affecting airspace would eliminate the possibility of indirect adverse impacts and associated cumulative impacts on airspace use in the Hawaiian Islands.

5.3.3 BIOLOGICAL RESOURCES

5.3.3.1 TERRESTRIAL BIOLOGICAL RESOURCES

Implementation of the No-action Alternative, Alternative 1, or Alternative 2 in conjunction with the cumulative actions listed in Table 5.2-1 could affect terrestrial biological resources within the region of influence. Several operations contribute cumulatively to habitat degradation, including disturbance to soils and vegetation, spread of invasive non-native species, erosion and sedimentation, and impacts on native plant species. Although individual impacts may be less than significant, collectively they have the potential to be significant over time and space. Some potential effects of invasive species are difficult to foresee (such as leading to a change in fire frequency or intensity); however, it is clear that the potential for damage associated with introduction or spread of invasive plant species is high and increases over time with repeated training missions, especially exercises that cover a very large area, because of the difficulty in effectively monitoring for invasive establishment and achieving timely control. The Navy is addressing these effects with several strategies including (1) implementation of Integrated Natural Resources Management Plans (INRMPs), (2) continued development and implementation of measures to prevent the establishment of invasive plant species by minimizing the potential for introductions of seed or other plant parts (propagules) of exotic species, and (3) finding and eliminating incipient populations before they are able to spread. Key measures include:

- Minimizing the amount of seed or propagules of non-native plant species introduced to the islands through continued efforts to remove seed and soil from all vehicles (including contractor vehicles) coming to the island by pressure washing at the ports of debarcation, and stepped up efforts to ensure that imported construction materials such as sand, gravel, aggregate, or road base material are weed free.

- Regular monitoring and treatment to detect and eliminate establishing exotic species, focusing on areas where equipment and construction materials come ashore and areas within which there is movement of equipment and personnel and soil disturbance which favor the spread and establishment of invasive species (e.g., along roadsides, and disturbed areas).
- Effective measures to foster the reestablishment of native vegetation in areas where non-native vegetation is present.
- Prohibiting living plant materials to be brought to the islands from the mainland (in order to avoid introduction of inappropriate genetic strains of native plants or exotic species, including weeds, insects and invertebrates).

Although there are impacts associated with the implementation of the No-action Alternative, Alternative 1, and Alternative 2 on terrestrial biology within the HRC; these impacts would be mitigated to less than significant level. Any construction project or training operation would be required to be in compliance with the established INRMP and U.S. Fish and Wildlife Service Biological Opinions. In addition, any project proposed within the HRC affecting threatened or endangered species would have included ESA Section 7 consultation addressing direct, indirect, and cumulative impacts.

5.3.3.2 MARINE BIOLOGICAL RESOURCES

Implementation of the No-action Alternative, Alternative 1, or Alternative 2 in conjunction with the cumulative actions listed in Table 5.2-1 could affect marine biological resources within the region of influence; however, no significant impacts in the overall health and viability of commercial, recreational, and other fish stocks would occur. Although underwater detonations could have an effect on individual fish, these activities would occur infrequently. Therefore, the incremental impacts would be localized and temporary and would not represent a significant contribution to the cumulative effects on marine fish or their habitat.

The analysis of potential effects of mid-frequency active sonar from training operations determined there is a potential for incidental Level B harassment of marine mammals as well as a limited potential for Level A harassment of beaked whale species. It is possible that harassment in any form may cause a stress response (Fair and Becker, 2000). Cetaceans can exhibit some of the same stress symptoms as found in terrestrial mammals (Curry, 1999). Disturbance from ship traffic, noise from ships, aircraft, and/or exposure to biotoxins and anthropogenic contaminants may stress animals, weakening their immune systems, making them more vulnerable to parasites and diseases that normally would not be fatal. It is possible that the temporary harassment incidents associated with training operations within the HRC would result in a minimal incremental contribution to cumulative impacts on marine mammals. The Protective Measures identified in Chapter 6 would be implemented in order to minimize any potential adverse effects to marine mammals. Impacts are not likely to affect the species or stock through effects on annual rates of recruitment or survival. Therefore, the incremental impacts would not represent a significant contribution to the cumulative effects on marine mammals when added to other past, present, and reasonably foreseeable future actions.

5.3.4 CULTURAL RESOURCES

Implementation of the No-action Alternative, Alternative 1, or Alternative 2 in conjunction with the cumulative actions listed in Table 5.2-1 would include the avoidance of shipwrecks within the area and appropriate mitigation measures for impacts to terrestrial cultural resources within the region of influence. The potential for impacts to cultural, archaeological, and historic sites throughout the State of Hawaii and in surrounding waters was examined. Due to the large number of known and estimated sites and the use of land areas for military operations, there is a potential for significant cumulative impacts. However, in compliance with the National Historic Preservation Act (NHPA) Section 106 review and comment process and the Advisory Council on Historic Preservation (ACHP) regulations implementing Section 106 (36 CFR 800), the Navy will consult with SHPO and the ACHP to establish and/or implement measures to ensure any adverse impacts to potential cultural resources that could result from implementation of the No-action Alternative, Alternative 1, or Alternative would be mitigated. Since avoidance is the primary method of addressing potential impacts to cultural resources, the cumulative impacts of the various projects are not additive or synergistic. Cultural resources occur in different locations throughout the Hawaiian Islands and, as each resource is being managed in its own context, there is no cause and effect relationship among them that would induce direct or indirect cumulative impacts at a level of significance. Since any project with the potential for significant impacts to cultural resources would have undergone Section 106 review, and would be mitigated as required, implementation of the No-action Alternative, Alternative 1, or Alternative 2, in conjunction with other projects within the State of Hawaii, would not result in significant cumulative impacts to cultural resources.

5.3.5 GEOLOGY AND SOILS

Implementation of the No-action Alternative, Alternative 1, or Alternative 2 in conjunction with the cumulative actions listed in Table 5.2-1 would not result in significant impacts to geology and soils within the region of influence. The impacts on geology are very minor and mostly consist of limited temporal and spatial disturbances to underwater sediments or localized soil disturbance in previously disturbed areas on the islands. Erosion is a naturally recurring issue, but it is not heavily exacerbated by military operations. While construction type projects in the region may have localized erosion, overall cumulative effects would be negligible since Best Management Practices for soil disturbing activities are typically implemented during any construction activity.

5.3.6 HAZARDOUS MATERIALS

Implementation of the No-action Alternative, Alternative 1, or Alternative 2 in conjunction with the cumulative actions listed in Table 5.2-1 would not result in cumulative impacts associated with the use of hazardous materials within the region of influence. There are a large number of hazardous materials inherent in the training and testing operations within the Hawaii Range Complex (HRC). For ordnance items that are used in the water, the vast majority are recovered (torpedoes), while non-ordnance items like sonobuoys are discarded. The primary concern with sonobuoys is the metal in the batteries, but studies have shown that with the three types of batteries in use, there is no substantial degradation of marine water quality.

The majority of the materials in artillery shells, naval gunfire shells, and cannon shells are converted into gaseous products. Hazardous materials and wastes not converted to gaseous products are contained within designated impact areas. Overall, constituents of concern have little effect or result in only short-term impacts on water quality and soils. There is no long-term degradation of marine or surface water quality and less than significant impacts overall.

Cumulatively, hazardous materials and wastes, when added to those of the other projects examined, would not result in significant impacts for the region. The factors that influence this analysis are: (1) many of the training ordnance items are retrieved from the water and recycled for later use; (2) items that cannot be retrieved are dispersed over a wide area, separated by long distances, and do not aggregate (thus, there is little likelihood that the constituents of concern would be additive); (3) the concentrations in the water from constituents of concern are small; (4) constituents disperse rapidly into a large volume of ocean water, further diluting their effects; (5) hazardous constituents on land are primarily confined to designated, active "ranges" that are set aside, managed, and used to conduct research, development, testing, and evaluation and training with munitions; and (6) the hazardous constituents are further clustered into specific impact areas, inside the ranges, that are designed to capture and contain the explosives and resulting debris.

5.3.7 HEALTH AND SAFETY

Implementation of the No-action Alternative, Alternative 1, or Alternative 2 in conjunction with the cumulative actions listed in Table 5.2-1 would not affect public health and safety within the region of influence. The major factors influencing this analysis are: (1) the distance of hazardous operations from the islands; (2) the dispersed context of the operations, such that the intensity of the effects are not additive; (3) the lack of synergistic effects; (4) comprehensive Navy safety procedures in place to ensure that members of the general public are not placed in physical jeopardy due to testing and training operations at sea; and (5) specific range clearance procedures and practices implemented daily prior to commencement of hazardous operations. Based on these factors, no significant cumulative impacts would occur relative to public health and safety.

5.3.8 LAND USE

Implementation of the No-action Alternative, Alternative 1, or Alternative 2, in conjunction with the identified cumulative actions listed in Table 5.2-1 would not affect land use within the region of influence because no adverse land use impacts were identified in Chapter 4 and existing land use designations would not change. No land uses are proposed which would be incompatible with State of Hawaii planning efforts. PMRF would continue to maintain a strip of coastline for public recreational purposes (except when closed for hazardous operations). Overall, recreational resources would continue to be protected and shoreline access would continue to be unimpeded.

5.3.9 NOISE

Implementation of the No-action Alternative, Alternative 1, or Alternative 2 in conjunction with the cumulative actions listed in Table 5.2-1 would not incrementally affect noise within the region of influence. Noise levels are inherently localized because sound levels decrease relatively quickly with increasing distance from the source. Cumulative impacts would occur when multiple projects affect the same geographic areas simultaneously or when sequential projects extend the duration of noise impacts on a given area over a longer period of time. The noise environment in the Hawaiian Islands has changed over the years with the increase in human activity. The increased level of training operations proposed under Alternatives 1 and 2 would increase noise levels; however, noise levels from training operations would be intermittent and similar to other noise levels already experienced in the region of influence. In addition, spatial separation among the cumulative projects listed in Table 5.2-1 would minimize or preclude cumulative noise impacts within the region of influence.

For the open ocean, the cumulative impact of these projects in a regional context does not reach a level of significance because of the intermittent nature of the noise events and the lack of sensitive receptors over the large ocean areas involved. Potential cumulative impacts associated with underwater noise and impacts to marine mammals are addressed in Section 5.3.3.2.

5.3.10 SOCIOECONOMICS

Implementation of the No-action Alternative, Alternative 1, or Alternative 2 in conjunction with the cumulative actions listed in Table 5.2-1 would not result in significant socioeconomic impacts within the region of influence. Implementation of the No-action Alternative, Alternative 1, or Alternative 2 would not produce any significant regional employment, income, housing, or infrastructure impacts. Effects on commercial and recreational fishermen, commercial tour boats, divers, and boaters would be short term in nature and produce some temporary access limitations. Some offshore operations, especially if coincident with peak fishing locations and periods or whale migration periods, could cause temporary displacement and potential economic loss to individual fishermen and commercial tour boat operators. However, most offshore operations are of short duration and have a small operational footprint. Effects on fishermen and commercial tour boat operators are mitigated by public notification of scheduled activities. In selected instances where safety requires exclusive use of a specific area, commercial fishing vessels, commercial vessels, or private vessels may be asked to relocate to a safer nearby area for the duration of the exercise. These measures should not significantly impact any individual fisherman, overall commercial revenue, or public recreational opportunity in the open ocean area. Implementation of the No-action Alternative, Alternative 1, or Alternative 2 would not affect minority or low-income populations disproportionately, nor would children be exposed to increased noise levels or safety risks because operations mainly occur in marine waters where no populations of children exist.

5.3.11 TRANSPORTATION

Implementation of the No-action Alternative, Alternative 1, or Alternative 2 in conjunction with the cumulative actions listed in Table 5.2-1 would not represent a significant increase in average daily traffic on island roadways or vessel traffic in the open ocean. Within the regional context of the Hawaiian Islands, there are large numbers of ship and boat movements. Ship traffic is, to a degree, additive, and the trends are upward. However, the civilian traffic of commercial shipping and military training by Navy ships generally tend to steam to and remain in range areas for training and testing operations. Navy training operations do not have a significant impact on other vessel traffic in the Hawaiian waters. In regards to the Hawaii Superferry, given the location of the ferry water lanes, it is not anticipated that the increased vessel traffic from this commuting vessel would contribute to the cumulative effects when assessed in combination with the actions proposed in this EIS/OEIS.

5.3.12 UTILITIES

Implementation of the No-action, Alternative 1, or Alternative 2, in conjunction with the identified cumulative actions listed in Table 5.2-1 would not affect utility services within the region of influence because no adverse impacts were identified in Chapter 4 and there are no major proposed increases or changes in utility service demand. In addition, implementation of the No-action Alternative, Alternative 1, and Alternative 2 would not result in an increase in personnel that would increase utility demand.

5.3.13 WATER RESOURCES

Implementation of the No-action Alternative, Alternative 1 or Alternative 2 in conjunction with the identified cumulative actions listed in Table 5.2-1 would not result in significant impacts to water quality within the region of influence. For offshore training operations, the Navy would comply with the *Oil and Hazardous Substance Release and Contingency Plan* (40 CFR 300) developed for Navy activities within the HRC. When evaluated individually or cumulatively, these projects have either no impact or only short-term impacts on water quality. Water quality impacts associated with implementation of the No-action Alternative, Alternative 1, or Alternative 2 are transitory in nature and would not reach a level of significance even in conjunction with the impacts of the other actions considered in a regional context (refer to Section 5.3.6, Hazardous Materials).

6.0 Protective Measures Related to Acoustic Effects

6.0 PROTECTIVE MEASURES RELATED TO ACOUSTIC EFFECTS

Effective training in the Hawaii Range Complex (HRC) dictates that ship, submarine, and aircraft participants utilize their sensors and exercise weapons to their optimum capabilities as required by the mission. The Navy recognizes that such use has the potential to cause behavioral disruption of some marine mammal species in the vicinity of an exercise (as outlined in Chapter 4.0). Although any disruption of natural behavioral patterns is not likely to be to a point where such behavioral patterns are abandoned or significantly altered, this chapter presents the Navy's protective measures, outlining steps that would be implemented to protect marine mammals and Federally-listed species during operations. It should be noted that these protective measures have been standard operating procedures for unit level antisubmarine warfare (ASW) training since 2004. In addition, the Navy coordinated with the National Marine Fisheries Service (NMFS) to further develop measures for protection of marine mammals during the period of the National Defense Exemption, and those mitigations for mid-frequency active sonar are detailed in this section. This chapter also presents a discussion of other measures that have been considered and rejected because they are either: (1) not feasible; (2) present a safety concern; (3) provide no known or ambiguous protective benefit; or (4) impact the effectiveness of the required ASW training military readiness activity.

6.1 MID-FREQUENCY ACTIVE SONAR OPERATIONS

6.1.1 GENERAL MARITIME PROTECTIVE MEASURES: PERSONNEL TRAINING

1. All lookouts onboard platforms involved in ASW training events will review the NMFS-approved Marine Species Awareness Training material prior to use of mid-frequency active sonar.

2. All Commanding Officers, Executive Officers, and officers standing watch on the Bridge will have reviewed the Marine Species Awareness Training material prior to a training event employing the use of mid-frequency active sonar.

3. Navy lookouts will undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (NAVEDTRA, 12968-B).

4. Lookout training will include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, Lookouts will complete the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). This does not forbid personnel being trained as lookouts from being counted as those listed in previous measures so long as supervisors monitor their progress and performance.

5. Lookouts will be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of protective measures if marine species are spotted.

6.1.2 GENERAL MARITIME PROTECTIVE MEASURES: LOOKOUT AND WATCHSTANDER RESPONSIBILITIES

1. 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.

2. All surface ships participating in ASW exercises will, in addition to the three personnel on watch noted previously, have at all times during the exercise at least two additional personnel on watch as lookouts.

3. Personnel on lookout and officers on watch on the bridge will have at least one set of binoculars available for each person to aid in the detection of marine mammals.

4. On surface vessels equipped with mid-frequency active sonar, pedestal mounted “Big Eye” (20x110) binoculars will be present and in good working order to assist in the detection of marine mammals in the vicinity of the vessel.

5. Personnel on lookout will employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-B).

6. After sunset and prior to sunrise, lookouts will employ Night Lookouts Techniques in accordance with the Lookout Training Handbook.

7. Personnel on lookout will be responsible for reporting all objects or anomalies sighted in the water (regardless of the distance from the vessel) to the Officer of the Deck, since any object or disturbance (e.g., trash, periscope, surface disturbance, discoloration) in the water may be indicative of a threat to the vessel and its crew or indicative of a marine species that may need to be avoided as warranted.

6.1.3 OPERATING PROCEDURES

1. A Letter of Instruction, Mitigation Measures Message, or Environmental Annex to the Operational Order will be issued prior to the exercise to further disseminate the personnel training requirement and general marine mammal protective measures.

2. Commanding Officers will make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.

3. All personnel engaged in passive acoustic sonar operation (including aircraft, surface ships, or submarines) will monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action.

4. During mid-frequency active sonar operations, personnel will utilize all available sensor and optical systems (such as night vision goggles) to aid in the detection of marine mammals.

5. Navy aircraft participating in exercises at sea will conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.

6. Aircraft with deployed sonobuoys will use only the passive capability of sonobuoys when marine mammals are detected within 200 yards of the sonobuoy.

7. Marine mammal detections will be immediately reported to assigned Aircraft Control Unit for further dissemination to ships in the vicinity of the marine species as appropriate where it is reasonable to conclude that the course of the ship will likely result in a closing of the distance to the detected marine mammal.

8. Safety Zones—When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) within 1,000 yards of the sonar dome (the bow), the ship or submarine will limit active transmission levels to at least 6 decibels (dB) below normal operating levels.

    (i) Ships and submarines will continue to limit maximum transmission levels by this 6-dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards beyond the location of the last detection.

    (ii) Should a marine mammal be detected within or closing to inside 500 yards of the sonar dome, active sonar transmissions will be limited to at least 10 dB below the equipment's normal operating level. Ships and submarines will continue to limit maximum ping levels by this 10-dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards beyond the location of the last detection.

    (iii) Should the marine mammal be detected within or closing to inside 200 yards of the sonar dome, active sonar transmissions will cease. Sonar will not resume until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 2,000 yards beyond the location of the last detection.

    (iv) Special conditions applicable for dolphins and porpoises only: If, after conducting an initial maneuver to avoid close quarters with dolphins or porpoises, the Officer of the Deck concludes that dolphins or porpoises are deliberately closing to ride the vessel's bow wave, no further mitigation actions are necessary while the dolphins or porpoises continue to exhibit bow wave riding behavior.

    (v) If the need for power-down should arise as detailed in “Safety Zones” above, the Navy shall follow the requirements as though they were operating at 235 dB—the normal operating level (i.e., the first power-down will be to 229 dB, regardless of at what level above 235 sonar was being operated).

9. Prior to start up or restart of active sonar, operators will check that the Safety Zone radius around the sound source is clear of marine mammals.

10. Sonar levels (generally)—Navy will operate sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.

11. Helicopters shall observe/survey the vicinity of an ASW Operation for 10 minutes before the first deployment of active (dipping) sonar in the water.

12. Helicopters shall not dip their sonar within 200 yards of a marine mammal and shall cease pinging if a marine mammal closes within 200 yards after pinging has begun.

13. Submarine sonar operators will review detection indicators of close-aboard marine mammals prior to the commencement of ASW operations involving active mid-frequency sonar.

14. Increased vigilance during major ASW training exercises with tactical active sonar when critical conditions are present.

Based on lessons learned from strandings in Bahamas 2000, Madeiras 2000, Canaries 2002 and Spain 2006, beaked whales are of particular concern since they have been associated with mid-frequency active sonar operations. Navy should avoid planning major ASW training exercises with mid-frequency active sonar in areas where they will encounter conditions which, in their aggregate, may contribute to a marine mammal stranding event.

The conditions to be considered during exercise planning include:

(i) Areas of at least 1,000-meter depth near a shoreline where there is a rapid change in bathymetry on the order of 1,000-6,000 meters occurring across a relatively short horizontal distance (e.g., 5 nautical miles [nm]).

(ii) Cases for which multiple ships or submarines (≥ 3) operating mid-frequency active sonar in the same area over extended periods of time (≥ 6 hours) in close proximity (≤ 10 nm apart).

(iii) An area surrounded by land masses, separated by less than 35 nm and at least 10 nm in length, or an embayment, wherein operations involving multiple ships/subs (≥ 3) employing mid-frequency active sonar near land may produce sound directed toward the channel or embayment that may cut off the lines of egress for marine mammals.

(iv) Though not as dominant a condition as bathymetric features, the historical presence of a significant surface duct (i.e., a mixed layer of constant water temperature extending from the sea surface to 100 or more feet).

If the major exercise must occur in an area where the above conditions exist in their aggregate, these conditions must be fully analyzed in environmental planning documentation. The Navy will increase vigilance by undertaking the following additional protective measure:

A dedicated aircraft (Navy asset or contracted aircraft) will undertake reconnaissance of the embayment or channel ahead of the exercise participants to detect marine mammals that may be in the area exposed to active sonar. Where practical, advance survey should occur within about 2 hours prior to mid-frequency active sonar use, and periodic surveillance should continue for the duration of the exercise. Any unusual conditions (e.g., presence of sensitive species, groups of species milling out of habitat, any stranded animals) shall be reported to the Office in Tactical Command, who should give consideration to delaying, suspending, or altering the exercise.

All safety zone power down requirements described above apply.

The post-exercise report must include specific reference to any event conducted in areas where the above conditions exist, with exact location and time/duration of the event, and noting results of surveys conducted.

6.1.4 COORDINATION AND REPORTING

1. The Navy will coordinate with the local NMFS Stranding Coordinator for any unusual marine mammal behavior and any stranding, beached live/dead or floating marine mammals that may occur at any time during or within 24 hours after completion of mid-frequency active sonar use associated with ASW training activities.

2. The Navy will submit a report to the Office of Protected Resources, NMFS, within 120 days of the completion of a Major Exercise. This report must contain a discussion of the nature of the effects, if observed, based on both modeled results of real-time events and sightings of marine mammals.

3. If a stranding occurs during an ASW exercise, NMFS and the Navy will coordinate to determine if mid-frequency active sonar should be temporarily discontinued while the facts surrounding the stranding are collected.

6.1.5 ALTERNATIVE PROTECTIVE MEASURES CONSIDERED BUT ELIMINATED

Potential marine mammal acoustic exposures that may result in harassment and/or a behavioral reaction or rarely injury (tissue damage or Permanent Threshold Shift [PTS]) are further reduced by the protective measures described above. Therefore, the Navy concludes that the Proposed Action and protective measures achieve the least practical adverse impact on species or stocks of marine species.

Several additional measures were analyzed and dismissed from primary consideration given unknown, questionable, or limited effectiveness as a protective measure, known or likely detrimental consequences to personnel safety and the effectiveness of the military readiness activity, and based on the practicality of implementation. These measures include:

- Using non-Navy personnel onboard Navy vessels to provide surveillance of ASW or other exercise events.

- Security clearance issues would have to be overcome to allow non-Navy observers onboard exercise participants.
- Use of non-Navy observers is not necessary given that Navy lookouts are extensively trained in spotting items at or near the water surface. Navy lookouts receive more hours of training, and utilize their skills more frequently, than many third party trained personnel.
- Use of Navy lookouts is the most effective means to ensure quick and effective communication within the command structure and facilitate implementation of protective measures if marine species are spotted. A critical skill set of effective Navy training is communication. Navy lookouts are trained to act swiftly and decisively to ensure that information is passed to the appropriate supervisory personnel.
- Navy and NMFS have not developed the necessary lengthy and detailed procedures that would be required to facilitate the integration of information from non-Navy observers into the command structure.
- Some training events will span one or more 24-hour period with operations underway continuously in that timeframe. It is not feasible to maintain non-Navy surveillance of these operations given the number of non-Navy observers that would be required onboard.
- Surface ships having active mid-frequency sonar have limited berthing capacity. Exercise planning includes careful consideration of this limited capacity in the placement of exercise controllers, data collection personnel, and Afloat Training Group personnel on ships involved in the exercise. Inclusion of non-Navy observers onboard these ships would require that in some cases, there would be no additional berthing space for essential Navy personnel required to fully evaluate and efficiently use the training opportunity to accomplish the exercise objectives.

• Visual monitoring or surveillance using non-Navy observers from non-military aircraft or vessels to survey before, during, and after exercise events.

- Use of non-Navy observers in the air or on civilian vessels compromises security due to the requirement to provide advance notification of specific times/locations of Navy platforms (this information is Classified).
- The areas where training events will mainly occur (the representative areas modeled) cover approximately 170,000 square nautical miles. Contiguous ASW events may cover many hundreds of square miles. The number of civilian ships and/or aircraft required to monitor the area of these events would be considerable. It is, thus, not feasible to survey or monitor the large exercise areas in the time required to ensure these areas are devoid of marine mammals. In addition, marine mammals may move into or out of an area, if surveyed before an event, or an animal could move into an area after an exercise took place. Given that there are no adequate controls to account for these or other possibilities and there are no identified research objectives, there is no utility to performing either a before or an after-the-event survey of an exercise area.
- Survey during an event raises safety issues with multiple, slow civilian aircraft operating in the same airspace as military aircraft engaged in combat training activities. In addition, most of the training events take place far from land, limiting

both the time available for civilian aircraft to be in the exercise area and presenting a concern should aircraft mechanical problems arise.

- Scheduling civilian vessels or aircraft to coincide with training events would impact training effectiveness since exercise event timetables cannot be precisely fixed and are instead based on the free-flow development of tactical situations. Waiting for civilian aircraft or vessels to complete surveys, refuel, or be on station would slow the unceasing progress of the exercise and impact the effectiveness of the military readiness activity.
- The vast majority of HRC training events involve a Navy aerial asset with crews specifically training to hone their detection of objects in the water. The capability of sighting from both surface and aerial platforms provides excellent survey capabilities using the Navy's existing exercise assets.
- Multiple events may occur simultaneously in areas at opposite ends of the HRC and then continue for up to 96 hours. There are not enough qualified third-party personnel to accomplish the monitoring task.
- There is no identified research design, sampling procedures, or purpose for any survey or monitoring effort.

- Seasonal, problematic complex/steep bathymetry, or habitat avoidance.
  - The habitat requirements for most of the marine mammals in the Hawaiian Islands are unknown. Accordingly, there is no information available on possible alternative exercise locations or environmental factors that would otherwise be less important to marine mammals in the Hawaiian Islands. In addition, exercise locations were very carefully chosen by exercise planners based on training requirements and the ability of ships and submarines to operate safely. Moving the exercise events to alternative locations would impact the effectiveness of the training and has no known utility.
- Using active sonar with output levels as low as possible consistent with mission requirements and use of active sonar only when necessary.
  - Operators of sonar equipment are always cognizant of the environmental variables affecting sound propagation. In this regard the sonar equipment power levels are always set consistent with mission requirements.
  - Active sonar is only used when required by the mission since it has the potential to alert opposing forces to the sonar platform's presence. Passive sonar and all other sensors are used in concert with active sonar to the maximum extent practical when available and when required by the mission.
- Suspending the exercise at night, periods of low visibility, and in high sea-states when marine mammals are not readily visible.
  - It is imperative that the Navy be able to operate at night, in periods of low visibility, and in high sea-states. The Navy must train as we are expected to fight, and adopting this prohibition would eliminate this critical military readiness requirement.

- Scaling down the exercise to meet core aims.
  - Training exercises are always constrained by the availability of funding, resources, personnel, and equipment with the result being they are always scaled down to meet only the core requirements.
- Limiting the active sonar event locations.
  - Areas where events are scheduled to occur are carefully chosen to provide for the safety of operations and to allow for the realistic tactical development of the exercise scenario. Otherwise limiting the exercise to a few areas would adversely impact the effectiveness of the training.
  - Limiting the exercise areas would concentrate all sonar use, resulting in unnecessarily prolonged and intensive sound levels vice the more transient exposures predicted by the current planning that makes use of multiple exercise areas.
- Passive Acoustic Monitoring.
  - As noted in the preceding section, passive detection capabilities are used to the maximum extent practicable consistent with the mission requirements to alert exercise participants to the presence of marine mammals in an event location.
- Using ramp-up to attempt to clear an area prior to the conduct of exercises.
  - Ramp-up procedures involving slowly increasing the sound in the water to necessary levels, have been utilized in other non-Department of Defense activities. Ramp-up procedures are not a viable alternative for training exercises, as the ramp-up would alert opponents to the participants' presence and not allow the Navy to train, thus adversely impacting the effectiveness of the military readiness activity.
  - Ramp-up for sonar as a protective measure is also an unproven technique. The implicit assumption is that animals would have an avoidance response to the low power sonar and would move away from the sound and exercise area; however, there is no data to indicate this assumption is correct. Given there is no data to indicate that this is even minimally effective and because ramp-up would have an impact on the effectiveness of the military readiness activity, it was eliminated from further consideration.
- Reporting marine mammal sightings to augment scientific data collection.
  - Ships, submarines, aircraft, and personnel engaged in training events are intensively employed throughout the duration of the exercise. Their primary duty is accomplishment of the exercise goals, and they should not be burdened with additional duties, unrelated to that task. Any additional workload assigned that is unrelated to their primary duty would adversely impact the effectiveness of the military readiness activity they are undertaking.

6.1.6 CONSERVATION MEASURES

The Navy will continue to fund ongoing marine mammal research in the field of acoustic responses and population dynamics, abundance, and density. Results of conservation efforts by the Navy in other locations will also be used to support efforts in the HRC. The Navy is coordinating long-term monitoring/studies of marine mammals on various established ranges and operating areas.

The Navy is implementing a long-term monitoring program of marine mammal populations including abundance and distribution in the HRC, including evaluation of trends and response to anthropogenic sound sources. The Navy will continue its internal Navy marine mammal research and the Navy's contribution to university/external research to improve the state of the science regarding marine species biology and acoustic effects. In addition, the Navy will continue to share data with NMFS and inform NMFS on current research and development efforts.

The Navy has contracted with a consortium of researchers from Duke University, University of North Carolina at Wilmington, University of St. Andrews, and the NMFS Northeast Fisheries Science Center to conduct a pilot study analysis and develop a proposed survey and monitoring plan that lays out the recommended approach for surveys (aerial/shipboard, frequency, spatial extent, etc.) and data analysis (standard line-transect, spatial modeling, etc.) necessary to establish a baseline of protected species distribution and abundance and monitor for changes that might be attributed to ASW operations on the Atlantic Fleet Undersea Warfare Training Range, Southern California, and Hawaiian range areas.

6.2 UNDERWATER DETONATIONS

To ensure protection of marine mammals and sea turtles during underwater explosives training and Mining Operations, the operating area must be determined to be clear of marine mammals and sea turtles prior to detonation. Implementation of the following protective measures continue to ensure that marine mammals would not be exposed to temporary threshold shift (TTS), PTS, or injury from physical contact with training mine shapes during major range events.

6.2.1 DEMOLITION AND SHIP MINE COUNTERMEASURES OPERATIONS (UP TO 20 POUNDS)

6.2.1.1 Exclusion Zones

All mine warfare and mine countermeasure operations involving the use of explosive charges must include exclusion zones for marine mammals and sea turtles to prevent physical and/or acoustic effects to those species. These exclusion zones shall extend in a 700-yard arc radius around the detonation site.

6.2.1.2 Pre-Exercise Surveys

For Demolition and Ship Mine Countermeasures Operations, pre-exercise survey shall be conducted within 30 minutes prior to the commencement of the scheduled explosive event. The survey may be conducted from the surface, by divers, and/or from the air, and personnel shall be alert to the presence of any marine mammal or sea turtle. Should such an animal be present within the survey area, the exercise shall be paused until the animal voluntarily leaves the area.

6.2.1.3 Post-Exercise Surveys

Surveys within the same radius shall also be conducted within 30 minutes after the completion of the explosive event.

6.2.1.4 Reporting

Any evidence of a marine mammal or sea turtle that may have been injured or killed by the action shall be reported immediately to Commander, Pacific Fleet and Commander, Navy Region Southwest, Environmental Director.

6.2.1.5 Mining Operations

Mining Operations involve aerial drops of inert training shapes on floating targets. Aircrews are scored for their ability to accurately hit the target. Although this operation does not involve live ordnance, marine mammals have the potential to be injured if they are in the immediate vicinity of a floating target; therefore, the safety zone shall be clear of marine mammals and sea turtles around the target location. Pre- and post-surveys and reporting requirements outlined for underwater detonations shall be implemented during Mining Operations. To the maximum extent feasible, the Navy shall retrieve inert mine shapes dropped during Mining Operations.

6.2.2 SINKING EXERCISE AND AIR-TO-SURFACE MISSILE SITE SELECTION

The selection of sites suitable for Sinking Exercises (SINKEXs) involves a balance of operational suitability, requirements established under the Marine Protection, Research and Sanctuaries Act (MPRSA) permit granted to the Navy (40 Code of Federal Regulations 229.2), and the identification of areas with a low likelihood of encountering Endangered Species Act listed species. To meet operational suitability criteria, locations must be within a reasonable distance of the target vessels' originating location. The locations should also be close to active military bases to allow participating assets access to shore facilities. For safety purposes, these locations should also be in areas that are not generally used by non-military air or watercraft. The MPRSA permit requires vessels to be sunk in waters which are at least 1,000 fathoms (3,000 meters) deep and at least 50 nm from land.

In general, most listed species prefer areas with strong bathymetric gradients and oceanographic fronts for significant biological activity such as feeding and reproduction. Typical locations include the continental shelf and shelf-edge. Sites in W-291 and on SOAR used for SINKEX and Air-to-Surface Missile (ASM) Operation are not known to contain the bathymetric features, which create prime listed species habitats.

6.2.2.1 Mitigation Plan

The Navy has developed a mitigation plan to maximize the probability of sighting any ships or protected species in the vicinity of an exercise. In order to minimize the likelihood of taking any threatened or endangered species that may be in the area, the following monitoring plan would be adhered to:

1. All weapons firing would be conducted during the period 1 hour after official sunrise to 30 minutes before official sunset.

2. Extensive range clearance operations would be conducted in the hours prior to commencement of the exercise, ensuring that no shipping is located within the hazard range of the longest-range weapon being fired for that event.

3. Prior to conducting the exercise, remotely sensed sea surface temperature maps would be reviewed. SINKEX and ASM Operations would not be conducted within areas where strong temperature discontinuities are present, thereby indicating the existence of oceanographic fronts. These areas would be avoided because concentrations of some listed species, or their prey, are known to be associated with these oceanographic features.

4. An exclusion zone with a radius of 1.0 nm would be established around each target. This exclusion zone is based on calculations using a 449-kilogram H6 net explosive weight high explosive source detonated 5 feet below the surface of the water, which yields a distance of 0.85 nm (cold season) and 0.89 nm (warm season) beyond which the received level is below the 182 dB re: 1Pa sec^2 threshold established for the *WINSTON S. CHURCHILL* (DDG 81) shock trials. An additional buffer of 0.5 nm would be added to account for errors, target drift, and animal movements. Additionally, a safety zone, which extends from the exclusion zone at 1.0 nm out an additional 0.5 nm, would be surveyed. Together, the zones extend out 2 nm from the target.

5. A series of surveillance over-flights would be conducted within the exclusion and the safety zones, prior to and during the exercise, when feasible. Survey protocol would be as follows:

   a. Overflights within the exclusion zone would be conducted in a manner that optimizes the surface area of the water observed. This may be accomplished through the use of the Navy's Search and Rescue Tactical Aid, which provides the best search altitude, ground speed, and track spacing for the discovery of small, possibly dark objects in the water based on the environmental conditions of the day. These environmental conditions include the angle of sun inclination, amount of daylight, cloud cover, visibility, and sea state.

   b. All visual surveillance activities would be conducted by Navy personnel trained in visual surveillance. At least one member of the mitigation team would have completed the Navy's marine mammal training program for lookouts.

   c. In addition to the overflights, the exclusion zone would be monitored by passive acoustic means, when assets are available. This passive acoustic monitoring would be maintained throughout the exercise. Potential assets include sonobuoys, which can be utilized to detect any vocalizing marine mammals (particularly sperm whales) in the vicinity of the exercise. The sonobuoys would be re-seeded as necessary throughout the exercise. Additionally, passive sonar onboard submarines may be utilized to detect any vocalizing marine mammals in the area. The Officer Conducting the Exercise (OCE) would be informed of any aural detection of marine mammals and would include this information in the determination of when it is safe to commence the exercise.

   d. On each day of the exercise, aerial surveillance of the exclusion and safety zones would commence 2 hours prior to the first firing.

   e. The results of all visual, aerial, and acoustic searches would be reported immediately to the OCE. No weapons launches or firing would commence until the OCE declares the safety and exclusion zones free of marine mammals and threatened and endangered species.

f. If a protected species observed within the exclusion zone is diving, firing would be delayed until the animal is re-sighted outside the exclusion zone, or 30 minutes have elapsed. After 30 minutes, if the animal has not been re-sighted it would be assumed to have left the exclusion zone. This is based on a typical dive time of 30 minutes for traveling listed species of concern. The OCE would determine if the listed species is in danger of being adversely affected by commencement of the exercise.

g. During breaks in the exercise of 30 minutes or more, the exclusion zone would again be surveyed for any protected species. If protected species are sighted within the exclusion zone, the OCE would be notified, and the procedure described above would be followed.

h. Upon sinking of the vessel, a final surveillance of the exclusion zone would be monitored for 2 hours, or until sunset, to verify that no listed species were harmed.

6. Aerial surveillance would be conducted using helicopters or other aircraft based on necessity and availability. The Navy has several types of aircraft capable of performing this task; however, not all types are available for every exercise. For each exercise, the available asset best suited for identifying objects on and near the surface of the ocean would be used. These aircraft would be capable of flying at the slow safe speeds necessary to enable viewing of marine vertebrates with unobstructed, or minimally obstructed, downward and outward visibility. The exclusion and safety zone surveys may be cancelled in the event that a mechanical problem, emergency search and rescue, or other similar and unexpected event preempts the use of one of the aircraft onsite for the exercise.

7. Every attempt would be made to conduct the exercise in sea states that are ideal for marine mammal sighting, Beaufort Sea State 3 or less. In the event of a 4 or above, survey efforts would be increased within the zones. This would be accomplished through the use of an additional aircraft, if available, and conducting tight search patterns.

8. The exercise would not be conducted unless the exclusion zone could be adequately monitored visually.

9. In the unlikely event that any listed species are observed to be harmed in the area, a detailed description of the animal would be taken, the location noted, and if possible, photos taken. This information would be provided to National Oceanic and Atmospheric Administration (NOAA) Fisheries via the Navy's regional environmental coordinator for purposes of identification.

10. An after action report detailing the exercise's time line, the time the surveys commenced and terminated, amount, and types of all ordnance expended, and the results of survey efforts for each event would be submitted to NOAA Fisheries.

6.3 CONDITIONS ASSOCIATED WITH THE BIOLOGICAL OPINION

The Navy will comply with the reasonable and prudent measures and terms and conditions issued by NMFS in their [enter Date] Biological Opinion for HRC training operations. In particular, the terms and conditions specify a monitoring program and process for feedback to NMFS following the completion of each exercise event.

6.4 COMPARISON OF ENDANGERED SPECIES RECOVERY PLANS

Recovery plans are developed by the U.S. Fish and Wildlife Service and NMFS to help guide actions that promote the recovery of threatened and endangered species to the point that they may be down-listed and eventually de-listed. Where de-listing may not be reasonably possible given population size or habitat constraints, stopping the decline of the species and establishing a stable population may be interim goals. Recovery plans in general discuss the current status of the species or population, threats to their continued existence, and actions to promote recovery. In many instances one of the primary recovery needs is information on population size and distribution and other basic information such as sex ratios, birth rate/fecundity, recruitment, mortality, hearing sensitivity, and sound production.

Twenty-seven recovery plans for endangered or threatened species have been completed, drafted or are undergoing revision by NMFS. Of these, 10 recovery plans cover species evaluated in this Draft Environmental Impact Statement (DEIS): blue whales (*Balaenoptera musculus*), fin whales (*B. physalus*), humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), Hawaiian monk seals (*Monachus schauinslandi*), green turtles (*Chelonia mydas*), hawksbill turtles (*Eretmochelys imbricata*), loggerhead turtles (*Caretta caretta*), olive ridley turtles (*Lepidochelys olivacea*), and leatherback turtles (*Dermochelys coriacea*). Many of these plans are out of date and are in need of revision

With respect to this DEIS a review of the applicable recovery plans found that many plans identified in-water effects such as anthropogenic sound or underwater detonations and ship strikes as possible threats to recovery. In some cases all anthropogenic sources were lumped together and in others military and civilian sources were broken out separately.

Based on modeling results in this DEIS fin whales, sei whales, humpback whales, sperm whales and Hawaiian monk seals may be exposed to acoustic energy that could result in TTS or behavioral modification. Due to the lack of density data for blue whales and North Pacific right whales (*Eubalaena japonicus*)[*] they were not included in the acoustic effects exposure model. There are few sightings for these two species in the Hawaiian Islands area and they are not expected to be exposed to mid-frequency active sonar.

* There is no current or draft recovery plan for North Pacific right whales.

For the five species of sea turtles potentially occurring within the HRC, available information suggests that sea turtles are likely not able to hear mid-frequency sounds (2.6 kilohertz [kHz] and 3.3 kHz) in the range produced by active tactical sonars.

The following sections outline the applicable threats identified in each plan and the mitigation measures adopted by the Navy for the actions covered by this DEIS.

6.4.1 RECOVERY PLAN FOR THE BLUE WHALE (*Balaenoptera musculus*) – (1998)

Anthropogenic noise was discussed under Habitat Degradation (p.16) and focused on the low-frequency sound transmitted during the Acoustic Thermometry of Ocean Climate (ATOC) experiment conducted in the mid-1990s. Whales observed during the trials were found to be distributed nominally further from the source when it was active than when it was not. No other changes in behavior or distribution were observed. ATOC and the North Pacific Acoustic Laboratory are not being considered in the HRC DEIS.

Under Military Operations Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) and ship shock trials were used to illustrate potential effects. However, neither observed nor potential effects were discussed. Detection of two blue whales in the vicinity of the ship shock trial resulted in the relocation of the trial to an area 9 miles from the whales. Scientific research intended to determine whether exposure to low frequency sounds elicited disturbance reactions from feeding blue or fin whales was conducted in 1997. In 19 focal animal observations (4 blue whales and 15 fin whales), no overt behavioral responses were observed. No changes in whale distribution could be related to LFA operations; whale distributions closely tracked the distribution of food. One preliminary analysis of whale sounds detections indicated a slight decrease in whale calling activity during LFA operations, but this was not confirmed by a second analysis. SURTASS LFA is not being considered in the HRC DEIS.

Military vessel traffic was cited as contributory to the overall issue of vessel traffic and ship strikes.

Protective measures—Except for potential ship strikes none of the threats listed above for blue whales is applicable to training activities within the HRC. Potential ship strikes would be mitigated by the use of trained observers aboard antisubmarine warfare (ASW) platforms, vessels associated with sinking exercise (SINKEX), and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. Based on available sighting data and the protective measures outlined in Chapter 6.0, it is unlikely that blue whales would be subject to vessel strikes within the HRC, thus fulfilling Recovery Action 4.2, Identify and implement methods to reduce ship collisions with blue whales.

6.4.2 DRAFT RECOVERY PLAN FOR THE FIN WHALE (*Balaenoptera physalus*)—(2006)

Ship Strikes (p. I-25) was a source of mortality for fin whales off the U.S. west coast from 1990 through 2005.

Although recent military activities (G.9 Military Operations, p. I-28) in the North Pacific are not known to have had impacts on fin whales, there was concern that due to "…the large scale and diverse nature of military activities in this ocean basin …there is always potential for disturbing, injuring, or killing these and other whales."

As noted above for blue whales, the issue of SURTASS LFA was also raised for fin whales.

Protective measures—The effect of SURTASS LFA on fin whales is not applicable to training activities within the HRC. Potential ship strikes would be mitigated by the use of trained observers aboard ASW platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. Based on available sighting data and the protective measures outlined in Chapter 6 of this DEIS, it is unlikely that fin whales would be subject to vessel strikes within the HRC, thus addressing Recovery Action 6.3 - Identify and implement measures to reduce the frequency and severity of ship collisions and gear interactions with fin whales. The use of tactical active sonars within the HRC would be governed by the protective measures outlined in Chapter 6.1 of this DEIS which include the requirement for trained observers, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. These protective measures address Recovery Action 7.2, Implement appropriate measures to reduce the exposure of fin whales to human-generated noise judged to be potentially detrimental.

6.4.3 FINAL RECOVERY PLAN FOR THE HUMPBACK WHALE (*Megaptera novaeangliae*) – (1991)

Although not explicitly identified in Section C - Collisions with Ships (p. 26), Navy ships should be included as part of the overall level of vessel traffic in Hawaiian waters which is identified as a potential impact.

In Section D. Acoustic Disturbance, 1. Noise from ships, boats and aircraft, Noise in general was identified as a potential adverse impact to humpback whales. At the time it was speculated that different vessel types and sizes had different acoustic effects depending on their signatures. In addition noise from military airplanes and other exercises were identified as possible sources of disturbance. The following statements from the Plan have been overcome by events but are provided for historical context. "In Hawaii, aerial exercises are executed from Hickam Air Force Base, Kaneohe Marine Corps Air Station, and Barbers Point Naval Air Station on Oahu. The major impact of tactical military aircraft is their use of Kahoolawe Island as a target. Concerns about the effect of military activities on humpback whales were addressed in a consultation between the U.S. Navy and NMFS regarding the use of Kahoolawe as a target island in 1979. Since then, there have been no reported instances of aircraft-delivered ordnance missing the island. Herman et al. (1980) suggested that humpback whales arriving in Hawaiian waters may be disturbed by military aircraft flying low over portions of the Auau Channel between the Islands of Hawaii and Maui. Other ordnance ranges in humpback wintering areas are Kaula Island, Hawaii; Vieques, Puerto Rico; and Farallon de Medinilla, Commonwealth of the Northern Mariana Islands." While there may have been some impact from the cumulative noise sources of vessels and aircraft the effect seems to have been minimal given the current recovery of the Hawaiian population of humpback whales and their growth in numbers over the past 30 years.

Protective measures—Ship strike was identified as a potential threat, but ship strike mitigation was not explicitly noted in the Plan. For activities covered by this DEIS potential ship strikes would be mitigated by the use of trained observers aboard ASW platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. With respect to underwater noise (Recovery Objective 1.31 11 Reduce disturbance from human-produced underwater noise in Hawaiian waters and in other important habitats when humpback whales are present), the use of tactical active sonars within the HRC would be governed by the protective measures outlined in Chapter 6.1. These include the requirement for trained observers, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. In addition, activities involving explosives or live fire will require trained observers aboard weapons platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. Consideration of bottom topography, oceanographic conditions, and species habitat preferences will also be considered.

6.4.4 DRAFT RECOVERY PLAN FOR THE SPERM WHALE (*Physeter macrocephalus*) – 2006

Potential threats identified in Sections G.2. and G.8. discussed anthropogenic sounds and in particular pingers, sonars, and vessel noise (cavitation).

Section G.2. Anthropogenic Noise (p. I-26) "…Sperm whales are known to respond, often dramatically, to unfamiliar noise. Whales exposed to the sounds of pingers used in calibration systems to locate hydrophone arrays temporarily fell silent (Watkins and Schevill 1975). This response to sounds in the frequency range of 6-13 kHz was interpreted as one of listening, rather than of fear. A stronger response was observed in sperm whales exposed to the intense sonar signaling and ship propeller noise from military operations in the Caribbean Sea during the U.S. invasion of Grenada in 1983. The whales fell silent, changed their activities, scattered, and moved away from the sound sources (Watkins et al. 1985). They also showed longer-term responses by becoming quieter and seemingly more wary of a research vessel that had visited the same area in previous years (Watkins et al. 1985).

There is currently no evidence of long-term changes in behavior or distribution as a result of occasional exposure to pulsed acoustic stimuli."

6.4.4.1 G.8 Military Operations (p.I-32)

"…Sperm whales are potentially affected by military operations in a number of ways. They can be struck by vessels and disturbed by sonar and other anthropogenic noise. In addition, their deep diving and large size make sperm whales potential false targets in submarine warfare (or target practice). Evidence suggests that strandings of another deep-diving, pelagic toothed whale, Cuvier's beaked whale (*Ziphius cavirostris*) is related to tests of Navy mid-range sonar and possibly LFA sonar in Greece, the Bahamas, and the Canary Islands (Frantizis 1998; Anon. 2001; Jepson et al. 2003; NOAA and U.S. Navy 2001; Freitas 2004; Fernandez 2004; Fernandez et al. 2005). The extremely loud signals (maximum output 230 decibels re 1 micropascal [μPa]) are in the frequency range of 250-3,000 hertz (Frantzis 1998), which is well within the likely range of sperm whale hearing. Similarly, mid-frequency sonar (e.g., U.S. Navy 53C) can produce equally loud sounds at frequencies of 2,000-8,000 hertz (Evans and England

2001), which are also likely to be heard by sperm whales. Clicks produced by sperm whales (and presumably heard by them) are in the range of < 100 hertz to as high as 30 kHz, often with most of the energy in the 2 to 4 kHz range (Watkins 1980). There have been no sperm whale strandings attributed to Navy sonar. However, the large scale and diverse nature of military activities in large ocean basins indicates that there is always potential for disturbing, injuring, or killing these and other whales."

The applicable recovery action is found under Recovery Actions 7.0. Determine and Minimize Any Detrimental Effects of Anthropogenic Noise in the Oceans (p. IV-2).

7.1 Support ongoing and additional studies to evaluate the effects of sound on sperm whales.

7.2 Implement appropriate regulations on sound-production activities which are found to be potentially detrimental to sperm whales, until otherwise demonstrated.

Protective measures - (Chapter 6.0) would be implemented to mitigate the use of tactical active sonars within the HRC. These include the requirement for trained observers, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. In addition, activities involving explosives or live fire will require trained observers aboard weapons platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. For SINKEX and Air to Surface Missile exercises an exclusion zone of 1.0 nm and an additional safety zone of 0.5 nm would be required. Consideration of bottom topography, oceanographic conditions, and species habitat preferences will also be considered.

These protective measures will further the recovery goals of this Plan even though no specific actions were identified in the Plan.

The Navy has and will continue to support as appropriate research that will help evaluate the effects of sound on sperm whales. While not under its purview the Navy has complied with applicable laws and regulations regarding sound in the oceans to the extent practicable and in compliance with national defense requirements.

6.4.5 RECOVERY PLAN FOR THE HAWAIIAN MONK SEAL (*Monachus schauinslandi*) – (DRAFT REVISION 2006)

No specific threats to monk seals from activities associated with the HRC were identified in the Plan.

Protective measures - (Chapter 6.0) would be implemented to mitigate the use of tactical active sonars within the HRC. These include the requirement for trained observers, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. In addition, activities involving explosives or live fire will require trained observers aboard weapons platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. For SINKEX and Air to

Surface Missile exercises an exclusion zone of 1.0 nm and an additional safety zone of 0.5 nm would be required. Consideration of bottom topography, oceanographic conditions, and species habitat preferences will also be considered.

These protective measures will further the recovery goals of this Plan even though no specific actions were identified in the Plan.

6.4.6 RECOVERY PLAN FOR THE U.S. PACIFIC POPULATIONS OF THE GREEN TURTLE (*Chelonia mydas*) – (1998)

Construction Blasting (p. 45) was identified as a threat to sea turtles, but not as a current threat in Hawaii. The following narrative did not explicitly identify Navy activities associated with the HRC as having a potential effect.

"Blasting can injure or kill sea turtles in the immediate area. The use of dynamite to construct or maintain harbors, break up reef and rock formations for improved nearshore access, etc. can decimate coral reefs, eliminating food and refuge for sea turtles. Some types of dynamiting have minimal impact to marine life, such as placing explosive in pre-drilled holes (drilling and shooting) prior to detonation. This is the standard practice to secure armor rock. (see Recovery – Section 2.2.7)"

In Section 2.2.7 under Recovery, the following actions were identified:

"Prevent the degradation or destruction of reefs by dynamite fishing and construction blasting. Blasting of any nature physically damages reefs and may kill turtles. It must be monitored and/or restricted."

<u>Protective measures</u> for sea turtles from underwater demolitions are listed in Chapter 6.2, Underwater Detonations. In general during underwater explosives training and mining operations, the operating area must be determined to be clear of marine mammals and sea turtles prior to detonation. For demolition and ship mine countermeasures operations charge size is limited to 20 lbs. and exclusion zones are established to prevent physical and/or acoustic effects. Pre exercise surveys are conducted by surface vessels, divers, and aircraft (when available) to alert operators of any protected species within the exclusion zone. If a sea turtle or marine mammal is observed, the exercise is postponed until the animal voluntarily leaves the area. Bottom topography is selected to minimize any potential damage to reef structures or other hard substrate that include turtle resting habitat or foraging areas (e.g. patches of sandy bottom substrate away from coral reef structures).

In addition, activities involving explosives or live fire will require trained observers aboard weapons platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. For SINKEX and Air to Surface Missile exercises an exclusion zone of 1.0 nm and an additional safety zone of 0.5 nm would be required.

In the event that green turtles are observed within the operating area the use of tactical active sonars within the HRC would be governed by the protective measures outlined in Chapter 6.1 which include the requirement for trained observers, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. These measures would minimize any potential auditory effects to green turtles that may be found within the HRC operating areas.

These protective measures address Recovery section 2.2.7 and the Implementation Schedule on p. 83.

6.4.7 RECOVERY PLAN FOR U.S. PACIFIC POPULATIONS OF THE HAWKSBILL TURTLE (*Eretmochelys imbricata*) – 1998

No specific threats or applicable recovery actions were identified for the Navy with respect to activities described in the HRC DEIS.

<u>Protective measures</u> - Although no specific threats or recovery actions were ascribed to Navy activities within the HRC in the Recovery Plan the following measures further the recovery goals of the Plan. In the event that hawksbill turtles are observed within the operating area the use of tactical active sonars within the HRC would be governed by the protective measures outlined in Chapter 6.1 which include the requirement for trained observers, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. These measures would minimize any potential auditory effects to hawksbill turtles that may be found within the HRC operating areas.

In addition, activities involving explosives or live fire will require trained observers aboard weapons platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. For SINKEX and Air to Surface Missile exercises an exclusion zone of 1.0 nm and an additional safety zone of 0.5 nm would be required.

6.4.8 RECOVERY PLAN FOR U.S. PACIFIC POPULATIONS OF THE LOGGERHEAD TURTLE (*Caretta caretta)* – 1998

There is no known nesting of loggerhead turtles in Hawaii according to the Recovery Plan. Nearly all observations of loggerheads now come from incidental catch records associated with pelagic longline fishing originating from Hawaiian ports. No specific threats or applicable recovery actions were identified for the Navy with respect to activities described in the HRC DEIS.

<u>Protective measures</u> - Although no specific threats or recovery actions were ascribed to Navy activities within the HRC in the Recovery Plan the following measures further the recovery goals of the Plan. In the event that loggerhead turtles are observed within the operating area the use of tactical active sonars within the HRC would be governed by the protective measures outlined

in Chapter 6.1 which include the requirement for trained observers, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. These measures would minimize any potential auditory effects to loggerhead turtles that may be found within the HRC operating areas.

In addition, activities involving explosives or live fire will require trained observers aboard weapons platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. For SINKEX and Air to Surface Missile exercises an exclusion zone of 1.0 nm and an additional safety zone of 0.5 nm would be required.

6.4.9 RECOVERY PLAN FOR U.S. PACIFIC POPULATIONS OF THE OLIVE RIDLEY TURTLE (*Lepidochelys olivacea*) – (1998)

No specific threats or applicable recovery actions were identified for the Navy with respect to activities described in the HRC DEIS.

In the Hawaiian Islands, a single nesting was recorded along Paia Bay, Maui in September 1985; however, there was no successful hatching associated with this event (Balazs and Hau 1986; National Ocean Service, 2001). Since there are no other known nesting records for the central Pacific Ocean, the above nesting attempt should be considered an anomaly (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1998e). Olive ridleys are frequently captured by pelagic longline fishermen in deep, offshore waters of the HRC, especially during spring and summer. Inside the 55-fathom isobath, olive ridley occurrence in the HRC is rare year round.

Protective measures - Although no specific threats or recovery actions were ascribed to Navy activities within the HRC in the Recovery Plan the following measures further the recovery goals of the Plan. In the event that olive ridley turtles are observed within the operating area he use of tactical active sonars within the HRC would be governed by the protective measures outlined in Chapter 6.1 which include the requirement for trained observers, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. These measures would minimize any potential auditory effects to olive ridley turtles that may be found within the HRC operating areas.

In addition, activities involving explosives or live fire will require trained observers aboard weapons platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. For SINKEX and Air to Surface Missile exercises an exclusion zone of 1.0 nm and an additional safety zone of 0.5 nm would be required.

6.4.10 RECOVERY PLAN FOR U.S. POPULATIONS OF THE LEATHERBACK TURTLE (*Dermochelys coriacea*) – (1998)

No specific threats or applicable recovery actions were identified for the Navy with respect to activities described in the HRC DEIS.

Satellite-tracking studies, a lack of Hawaiian stranding records, and occasional incidental captures of the species in the Hawaii-based longline fishery indicate that deep, oceanic waters are the most preferred habitats of leatherback turtles in the central Pacific Ocean. As a result, the area of year-round primary occurrence for the leatherback turtle encompasses all HRC waters beyond the 55-fathom isobath. Inshore of the 55-fathom isobath is the area of rare leatherback occurrence. This area is also the same year round. Leatherbacks were not sighted during any of the aerial surveys for which data were collected, all of which took place over waters lying close to the Hawaiian shoreline.

Protective measures - Although no specific threats or recovery actions were ascribed to Navy activities within the HRC in the Recovery Plan the following measures further the recovery goals of the Plan. In the event that leatherback turtles are observed within the operating area he use of tactical active sonars within the HRC would be governed by the protective measures outlined in Chapter 6.1 which include the requirement for trained observers, aircraft surveillance when available, the use of passive listening devices, safety zones, sonar power limit requirements, and consideration of bathymetry and oceanographic conditions. These measures would minimize any potential auditory effects to leatherback turtles that may be found within the HRC operating areas.

In addition, activities involving explosives or live fire will require trained observers aboard weapons platforms, vessels associated with SINKEX, and vessels used for mine countermeasures and demolition training and observers aboard aircraft when available. For SINKEX and Air to Surface Missile exercises an exclusion zone of 1.0 nm and an additional safety zone of 0.5 nm would be required.

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8.0 Glossary of Terms

8.0 GLOSSARY OF TERMS

Access—the right to transit to and from and to make use of an area.

Accretion—growth by gradual external addition.

Activity—an individual scheduled training function or action such as missile launching, bombardment, vehicle driving, or FCLP that, when combined with other functions or actions, generally makes up an operation.

Advisory Council on Historic Preservation—a 19-member body appointed, in part, by the President of the United States to advise the President and Congress and to coordinate the actions of Federal agencies on matters relating to historic preservation, to comment on the effects of such actions on historic and archaeological cultural resources, and to perform other duties as required by law (Public Law 89-655; 16 U.S. Code 470).

Aeronautical Chart—a map used in air navigation containing all or part of the following: topographic features, hazards and obstructions, navigation aids, navigation routes, designated airspace, and airports.

Aesthetic—a pleasing appearance, effect, or quality that allows appreciation of character-defining features, such as of the landscape.

Air Basin—a region within which the air quality is determined by the meteorology and emissions within it with minimal influence on and impact by contiguous regions.

Air Defense Identification Zone—the area of airspace over land or water, extending upward from the surface, within which the ready identification, the location, and the control of aircraft are required in the interest of national security.

Air Route Traffic Control Center (ARTCC)—a facility established to provide air traffic control service to aircraft operating on Instrument Flight Rules flight plans within controlled airspace and principally during the en route phase of flight. When equipment capabilities and controller workload permit, certain advisory/assistance services may be provided to aircraft operating under Visual Flight Rules.

Air Traffic Control—a service operated by appropriate authority to promote the safe, orderly, and expeditious flow of air traffic.

Air Traffic Control Assigned Airspace (ATCAA)—FAA-defined airspace not over an OPAREA within which specified activities, such as military flight training, are segregated from other IFR air traffic.

Airfield—usually an active and/or inactive airfield, or infrequently used landing strip, with or without a hard surface, without Federal Aviation Administration approved instrument approach procedures. An airfield has no control tower and is usually private.

Airport—usually an active airport with hard-surface runways of 3,000 feet or more, with Federal Aviation Administration approved instrument approach procedures regardless of runway length or composition. An airport may or may not have a control tower. Airports may be public or private.

Airspace, Controlled—airspace of defined dimensions within which air traffic control service is provided to Instrument Flight Rules flights and to Visual Flight Rules flights in accordance with the airspace classification. Controlled airspace is divided into five classes, dependent upon location, use, and degree of control: Class A, B, C, D, and E.

Airspace, Special Use—airspace of defined dimensions identified by an area on the surface of the earth wherein activities must be confined because of their nature and/or wherein limitations may be imposed upon non-participating aircraft.

Airspace, Uncontrolled—uncontrolled airspace, or Class G airspace, has no specific definition but generally refers to airspace not otherwise designated and operations below 365.7 meters (1,200 feet) above ground level. No air traffic control service to either Instrument Flight Rules or Visual Flight Rules aircraft is provided other than possible traffic advisories when the air traffic control workload permits and radio communications can be established.

Airspace—the space lying above the earth or above a certain land or water area (such as the Pacific Ocean); more specifically, the space lying above a nation and coming under its jurisdiction.

Airway—Class E airspace established in the form of a corridor, the centerline of which is defined by radio navigational aids.

Alert Area—a designated airspace in which flights are not restricted but there is concentrated student training or other unusual area activity of significance.

Alkaline—basic, having a pH greater than 7.

Alluvium—a general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during comparatively recent geologic time by a stream or other body of running water as a sorted or semi-sorted sediment in the bed of the stream or on its floodplain or delta, or as a cone or fan at the base of a maintained slope.

Altitude Reservation—altitude reservation procedures are used as authorization by the Central Altitude Reservation Function, an air traffic service facility, or appropriate air route traffic control center, under certain circumstances, for airspace utilization under prescribed conditions.

Aluminum Oxide (Al_2O_3)—a common chemical component of missile exhaust. Under natural conditions, the chemical is not a source of toxic aluminum; the U.S. Environmental Protection Agency has determined that nonfibrous Al_2O_3, as found in solid rocket motor exhaust, is nontoxic.

Ambient Air Quality Standards—legal limitations on pollutant concentration levels allowed to occur in the ambient air established by the U.S. Environmental Protection Agency or state agencies. Primary ambient air quality standards are designed to protect public health with an adequate margin of safety. Secondary ambient air quality standards are designed to protect public welfare-related values including property, materials, and plant and animal life.

Ambient Air—that portion of the encompassing atmosphere, external to buildings, to which the general public has access.

Amplitude—the maximum departure of the value of a sound wave from the average value.

Annual Average Daily Traffic (AADT)—the total volume passing a point or segment of a highway facility in both directions for 1 year divided by the number of days in the year.

Anthropogenic—human-related.

Aquaculture—the cultivation of the natural produce of water, such as fish or shellfish.

Aquifer—a subsurface formation, group of formations, or part of a formation (e.g., a huge, underground reservoir) that contains sufficient saturated permeable material to conduct groundwater and yield economical quantities of water to wells and springs.

Archaeology—a scientific approach to the study of human ecology, cultural history, prehistory and cultural processes, emphasizing systematic interpretation of material remains.

Archipelago—an expanse of water with many scattered islands; a group of islands.

Area of Potential Effect—the geographic area within which direct and indirect impacts generated by the Proposed Action and alternatives could reasonably be expected to occur and thus cause a change in historic, architectural, archaeological, or cultural qualities possessed by the property.

Artifact—any thing or item that owes its shape, form, or placement to human activity. In archaeological studies, the term is applied to portable objects (e.g., tools and the by-products of their manufacture).

Artisanal—non-industrialized.

Asbestos—a carcinogenic substance formerly used widely as an insulation material by the construction industry; often found in older buildings.

Asbestos-containing Material (ACM)—any material containing more than 1 percent asbestos.

Atoll—a coral island consisting of a reef surrounding a lagoon.

Attainment Area—an air quality control region that has been designated by the U.S. Environmental Protection Agency and the appropriate state air quality agency as having ambient air quality levels as good as or better than the standards set forth by the National Ambient Air Quality Standards, as defined in the Clean Air Act. A single geographic area may have acceptable levels of one criteria air pollutant, but unacceptable levels of another; thus, an area can be in attainment and non-attainment status simultaneously.

Average Daily Traffic (ADT)—the total volume of traffic passing a given point or segment of a roadway in both directions divided by a set number of days.

A-weighted Sound Level—a number representing the sound level which is frequency-weighted according to a prescribed frequency response established by the American National Standards Institute (ANS1.4-19711) and accounts for the response of the human ear.

Azimuth—a distance in angular degrees in a clockwise direction from the north point.

Backyard Range—a range within a radius of one hour’s drive (50-65 miles) of a unit, such that training there can be considered non-deployed for personnel tempo (PERSTEMPO) purposes.

Basement Rock—rock generally with complex structure beneath the dominantly sedimentary rocks.

Bedrock—the solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Benthic Communities—of or having to do with populations of bottom-dwelling flora or fauna of oceans, seas, or the deepest parts of a large body of water.

Benthopelagic—living and feeding near the sea floor as well as in midwaters or near the surface.

Benthos—the sea floor.

Bioaccumulation—building up of a substance, such as PCBs, in the systems of living organisms (and thus, a food web) due to ready solubility in living tissues.

Biological Diversity—the complexity and stability of an ecosystem, described in terms of species richness, species evenness, and the direct interaction between species such as competition and predation.

Biological Resources—a collective term for native or naturalized vegetation, wildlife, and the habitats in which they occur.

Booster—an auxiliary or initial propulsion system that travels with a missile or aircraft and that may not separate from the parent craft when its impulse has been delivered; may consist of one or more units.

Brackish—slightly salty; applicable to waters whose saline content is intermediate between that of streams and sea water.

Calcareous—containing calcium carbonate.

Candidate Species—a species of plant or animal for which there is sufficient information to indicate biological vulnerability and threat, and for which proposing to list as "threatened" or "endangered" is or may be appropriate.

Caprock—a natural overlying rock layer that is usually hard to penetrate.

Carbon Dioxide (CO_2)—a colorless, odorless, incombustible gas which is a product of respiration, combustion, fermentation, decomposition and other processes, and is always present in the atmosphere.

Carbon Monoxide—a colorless, odorless, poisonous gas produced by incomplete fossil-fuel combustion; it is one of the six pollutants for which there is a national ambient standard (see Criteria Pollutants).

Cetacean—an order of aquatic, mostly marine, animals including the whales, dolphins, porpoise, and related forms with large head, fishlike nearly hairless body, and paddle-shaped forelimbs.

Class A Airspace (also Positive Controlled Area)—airspace designated in Federal Aviation Administration Regulation Part 71 within which there is positive control of aircraft

Coastal Zone—a region beyond the littoral zone occupying the area near the coastline in depths of water less than 538.2 feet. The coastal zone typically extends from the high tide mark on the land to the gently sloping, relatively shallow edge of the continental shelf. The sharp increase in water depth at the edge of the continental shelf separates the coastal zone from the offshore zone. Although comprising less than 10 percent of the ocean's area, this zone contains 90 percent of all marine species and is the site of most large commercial marine fisheries. This may differ from the way the term "coastal zone" is defined in the State Coastal Zone Management Program (HRS Chapter 205 A).

Community—an ecological collection of different plant and animal populations within a given area or zone.

Component (Cultural Resources)—a location or element within a settlement or subsistence system. Archaeological sites may contain several components that reflect the use of the locality by different groups in different time periods.

Continental Shelf—a shallow submarine plain of varying width forming a border to a continent and typically ending in a steep slope to the oceanic abyss.

Continental Slope—the steep slope that starts at the shelf break about 150 to 200 meters (492 to 656 feet) and extends down to the continental rise of the deep ocean floor.

Continental United States (CONUS)—the United States and its territorial waters between Mexico and Canada, but excluding overseas states.

Control Area (CTA)—a controlled airspace extending upwards from a specified limit above the earth.

Controlled Access—area where public access is prohibited or limited due to periodic training operations or sensitive natural or cultural resources.

Controlled Airspace—airspace of defined dimensions within which air traffic control service is provided to Instrument Flight Rules flights and to Visual Flight Rules flights in accordance with the airspace classification. Controlled airspace is divided into five classes, dependent upon location, use, and degree of control: Class A, B, C, D, and E.

Controlled Firing Area (CFA)—airspace wherein activities are conducted under conditions so controlled as to eliminate hazards to non-participating aircraft and to ensure the safety of persons and property on the ground.

Copepod—a small, shrimp-like crustacean.

Coral Reef—a calcareous organic area composed of solid coral and coral sand.

Cosmology—a branch of metaphysics that deals with the nature, or natural order, of the universe.

Council on Environmental Quality (CEQ)—established by the National Environmental Policy Act, the CEQ consists of three members appointed by the President. A CEQ regulation (Title 40 Code of Federal Regulations 1500-1508, as of July 1, 1986) describes the process for implementing the National Environmental Policy Act, including preparation of environmental assessments and environmental impact statements, and the timing and extent of public participation.

Co-Use—Scheduled uses that safely allow other units to transit the area or conduct activities.

Criteria Pollutants—pollutants identified by the U.S. Environmental Protection Agency (required by the Clean Air Act to set air quality standards for common and widespread pollutants); also established under state ambient air quality standards. There are standards in effect for six criteria pollutants: sulfur dioxide, carbon monoxide, particulate matter, nitrogen dioxide, ozone, and lead.

Cultural Resources—prehistoric and/or historic sites, structures, districts, artifacts, or any other physical evidence of human activity considered of importance to a culture, subculture, or community for scientific, traditional, religious, or any other reason.

Culture—a group of people who share standards of behavior and have common ways of interpreting the circumstances of their lives.

Cumulative Impact—the impact of 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.

Current—a horizontal movement of water or air.

C-weighted—utilized to determine effects of high-intensity impulsive sound on human populations, a scale providing unweighted sound levels over a frequency range of maximum human sensitivity.

Danger Area—(1) In air traffic control, an airspace of defined dimensions within which activities dangerous to the flight of aircraft may exist at specified times**; (**2) (DoD only) A specified area above, below, or within which there may be potential danger.

Danger Zone—at the Pacific Missile Range Facility (PMRF), an offshore area to protect submerged cables that is designated in accordance with U.S. Army Corps of Engineers regulations into which entry by any craft is prohibited except with the permission of the Commanding Officer, PMRF. See Code of Federal Regulations, Title 33, Parts 204 to 225a.

Decibel (dB)—the accepted standard unit of measure for sound pressure levels. Due to the extremely large range of measurable sound pressures, decibels are expressed in a logarithmic scale.

Degradation—the process by which a system will no longer deliver acceptable performance.

Demersal—living close to the seafloor.

Direct Effects—immediate consequences of program activities.

Direct Impact—effects resulting solely from program implementation.

District—National Register of Historic Places designation of a geographically defined area (urban or rural) possessing a significant concentration, linkage, or continuity of sites, structures, or objects united by past events (theme) or aesthetically by plan of physical development.

Diurnal—active during the daytime.

Dunes—hills and ridges of sand-size particles (derived predominantly from coral and seashells) drifted and piled by the wind. These dunes are actively shifting or are so recently fixed or stabilized that no soil horizons develop; their surface typically consists of loose sand.

Easement—a right of privilege (agreement) that a person or organization may have over another's property; an interest in land owned by another that entitles the holder of the easement to a specific limited use; a recorded right of use by the United States over property of the State of Hawaii to limit exposure to safety hazards.

Ecosystem—all the living organisms in a given environment with the associated non-living factors.

Effects—a change in an attribute, which can be caused by a variety of events, including those that result from program attributes acting on the resource attribute (direct effect); those that do not result directly from the action or from the attributes of other resources acting on the attribute being studied (indirect effect); those that result from attributes of other programs or other attributes that change because of other programs (cumulative effects); and those that result from natural causes (for example, seasonal change).

Effluent—an outflowing branch of a main stream or lake; waste material (such as smoke, liquid industrial refuse, or sewage) discharged into the environment.

Electromagnetic Radiation (EMR)—waves of energy with both electric and magnetic components at right angles to one another.

Electronic Countermeasures (ECM)—includes both active jamming and passive techniques. Active jamming includes noise jamming to suppress hostile radars and radios, and deception jamming, intended to mislead enemy radars. Passive ECM includes the use of chaff to mask targets with multiple false echoes, as well as the reduction of radar signatures through the use of radar-absorbent materials and other stealth technologies.

En Route Airways—a low-altitude (up to, but not including 5,486.4 meters [18,000 feet] mean sea level) airway based on a center line that extends from one navigational aid or intersection to another navigational aid (or through several navigational aids and intersections) specified for that airway.

En Route Jet Routes—high altitude (above 18,000 feet mean sea level) airway based on a center line that extends from one navigational aid or intersection to another navigational aid (or through several navigational aids and intersections) specified for that airway.

Encroachment—the placement of an unauthorized structure or facility on someone's property or the unauthorized use of property.

Endangered Species—a plant or animal species that is threatened with extinction throughout all or a significant portion of its range.

Endemic—plants or animals that are native to an area or limited to a certain region.

Environmental Justice—an identification of potential disproportionately high and adverse impacts on low-income and/or minority populations that may result from proposed Federal actions (required by Executive Order 12898).

Epibenthic—living on the ocean floor.

Epipelagic—living in the ocean zone from the surface to 109 fathoms (656 feet).

Erosion—the wearing away of a land surface by water, wind, ice, or other geologic agents.

Estuary—a water passage where the tide meets a river current; an arm of the sea at the lower end of a river; characterized by brackish water.

Event—a significant operational employment during which training is accomplished. “Event” is a Navy approved employment schedule term. The event may be primarily designated as operational, such as TRANSIT, MIO, or STRIKEOPS during which training may take place. Training events may be periods of operational employment that are also considered major training events such as COMPTUEX (Composite training unit exercise), JTFEX (Joint training fleet exercise), or other exercises such as BRIGHT STAR, COBRA GOLD, or UNIFIED ENDEAVOR.

Exclusive Use—scheduled solely for the assigned unit for safety reasons.

Exotic—not native to an area.

Explosive Ordnance Disposal (EOD)—the process of recovering and neutralizing domestic and foreign conventional, nuclear and chemical/biological ordnance and improvised explosive devices; a procedure in Explosive Ordnance Management.

Explosive Safety Quantity-Distance (ESQD)—the quantity of explosive material and distance separation relationships providing defined types of protection based on levels of risk considered acceptable.

Facilities—physical elements that can include roads, buildings, structures, and utilities. These elements are generally permanent or, if temporary, have been placed in one location for an extended period of time.

Fathom—a unit of length equal to 6 feet; used to measure the depth of water.

Feature—in archaeology, a non-portable portion of an archaeological site, including such facilities as fire pits, storage pits, stone circles, or foundations.

Federal Candidate Species—taxa for which the U.S. Fish and Wildlife Service has on file sufficient information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened species.

Fee Simple Land—land held absolute and clear of any condition or restriction, and where the owner has unconditional power of disposition.

Feral—having escaped from domestication and become wild.

Fleet Area Control and Surveillance Facility (FACSFAC)—Navy facility that provides air traffic control services and controls and manages Navy-controlled off-shore operating areas and instrumented ranges.

Fleet Readiness Training Plan (FRTP)—the 27-month cycle that replaces the Interdeployment Training Cycle (IDTC). The FRTP includes four phases prior to deployment: Maintenance, Unit Level Training, Integrated Training, and Sustainment.

Fleet Response Plan/Fleet Readiness Program (FRP)—the Fleet Response Plan was the Navy's response to the 2002/2003 international situations in Afghanistan and Iraq. The Fleet Readiness Program was later developed by the Fleet commanders. Both names refer to the same operational construct. The FRP is designed to more rapidly develop and then sustain readiness in ships and squadrons so that, in a national crisis or contingency operation, the Navy can quickly surge significant combat power to the scene.

Flight Information Region (FIR)—an airspace of defined dimensions within which flight information service and alerting service are provided. Flight information service is provided for the purpose of giving advice and information useful for the safe and efficient conduct of flights, and alerting service is provided to notify appropriate organizations regarding aircraft in need of search and rescue aid and to assist such organizations as required.

Flight Level—a level of constant atmospheric pressure related to a reference datum of 29.92 inches of mercury stated in three digits that represent hundreds of feet. For example, flight level 250 represents a barometric altimeter indication of 25,000 feet; flight level 255 represents an indication of 25,500 feet.

Flight Termination—action taken in certain post-launch situations, such as a missile veering off of its predicted flight corridor; accomplished by stopping the propulsive thrust of a rocket motor via explosive charge. At this point, the missile continues along its current path, falling to earth under gravitational influence.

Floodplain—the lowland and relatively flat areas adjoining inland and coastal waters including flood prone areas of offshore islands; includes, at a minimum, that area subject to a 1 percent or greater chance of flooding in any given year (100-year floodplain).

Free Flight—a joint initiative of the aviation industry and the Federal Aviation Administration to allow aircraft to take advantage of advanced satellite voice and data communication to provide faster and more reliable transmission to enable reductions in vertical, lateral, and longitudinal separation of aircraft, more direct flights and tracts, and faster altitude clearance. It will allow pilots, whenever practicable, to choose their own route and file a flight plan that follows the most efficient and economical route, rather than following the published preferred instrument flight rules routes.

Frequent User—a unit that conducts training and exercises in the training areas on a regular basis but does not maintain a permanent presence.

Fugitive Dust—any solid particulate matter that becomes airborne, other than that emitted from an exhaust stack, directly or indirectly as a result of the activities of man. Fugitive dust may include emissions from haul roads, wind erosion of exposed soil surfaces, and other activities in which soil is either removed or redistributed.

Ground Hazard Area—the land area contained in an arc within which all debris from a terminated launch will fall. For example, the arc for a Strategic Target System launch is described such that the radius is approximately 3,048 meters (10,000 feet) to the northeast, 2,774 meters (9,100 feet) to the east, and 2,743 meters (9,000 feet) to the south of the launch point. For the Vandal launch, the arc is 1,829 meters (6,000 feet).

Groundwater Table—the highest part of the soil or underlying rock material that is wholly saturated with water.

Groundwater—water within the earth that supplies wells and springs; specifically, water in the zone of saturation where all openings in rocks and soil are filled, the upper surface of which forms the water table.

Habitat—the area or type of environment in which a species or ecological community normally occurs.

Hazardous Air Pollutants (HAPs)—other pollutants, in addition to those addressed by the NAAQS, that present the threat of adverse effects to human health or to the environment as covered by Title III of the Clean Air Act. Incorporates, but is not limited to, the pollutants controlled by the National Emissions Standards for Hazardous Air Pollutants (NESHAP) program.

Hazardous Material (HAZMAT)—generally, a substance or mixture of substances capable of either causing or significantly contributing to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness; it may pose a threat or a substantial present or potential risk to human health or the environment. HAZMAT use is regulated by the U.S. Department of Transportation, the Occupational Safety and Health Administration, and the Emergency Right-to-Know Act.

Hazardous Waste—a waste, or combination of wastes, which, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may either cause or significantly contribute to an increase in mortality or an increase in serious irreversible illness or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

Heiaus—the temple platforms, shrines, and enclosures that Hawaiians constructed for purposes of worship. Built on carefully fitted stones and considered sacred ground, heiaus contained assorted buildings for various religious rites practiced by the various kahuna (sacred priests and priestesses). Most heiaus were damaged in 1819 with the overthrow of the ancient religion and kapu system; however, several have been restored.

Hertz (Hz)—the standard radio equivalent of frequency in cycles per second of an electromagnetic wave. Kilohertz (kHz) is a frequency of 1,000 cycles per second. Megahertz (MHz) is a frequency of 1 million cycles per second.

Historic Properties—under the National Historic Preservation Act, these are properties of national, state, or local significance in American history, architecture, archaeology, engineering, or culture, and worthy of preservation

Home Lands—as required by the Hawaiian Homes Commission Act (passed by Congress in 1921), areas set aside for the state to lease residential, farm, and pastoral homestead lots for $1 per year to native Hawaiians.

Host—the Facilities Host holds plant account of all Class I (Land) and most Class II (Buildings) property. The Operational Host determines and executes operational policy for the range/range complex.

Hydraulic Conductivity—the rate in gallons per day water flow through a cross section of one square foot under a unit hydraulic gradient, at the prevailing temperature.

Hydrocarbons—any of a vast family of compounds containing hydrogen and carbon, including fossil fuels.

Hydrochloric Acid (HCl)—a common chemical component of missile exhaust believed to injure plant leaves and affect wildlife.

Hydrology—the science dealing with the properties, distribution, and circulation of water on the face of the land (surface water) and in the soil and underlying rocks (groundwater).

Hydrophone—an instrument for listening to sound transmitted through water.

Impact Area—the identified area within a range intended to capture or contain ammunition, munitions, or explosives and resulting debris, fragments, and components from various weapon system employments.

Impacts (effects)—an assessment of the meaning of changes in all attributes being studied for a given resource; an aggregation of all the adverse effects, usually measured using a qualitative and nominally subjective technique. In this Environmental Impact Statement, as well as in the Council on Environmental Quality regulations, the word impact is used synonymously with the word effect.

Indurated—rendered hard, as in dunes where surface sand is loose, but subsurface areas become increasingly compact (see lithified).

Infrastructure—the system of public works of a country, state, or region, such as utilities or communication systems; physical support systems and basic installations needed to operate a particular area or facility.

Inhibited Red Fuming Nitric Acid (IRFNA)—a liquid hypergolic propellant utilized as an oxidizer (as in the Lance). This reddish-brown acid is highly corrosive, spontaneously reacting with UDMH and certain other organic substances. It also dissolves in water, and care must be taken regarding its induced boiling effects. Its highly toxic, characteristically pungent vapors irritate skin and eyes.

Instrument Flight Rules (IFR)—rules governing the procedures for conducting instrument flight; it is a term used by pilots and controllers to indicate type of flight plan.

Interdeployment Readiness Cycle—the period by which Naval units progress through maintenance/unit level training, integrated training, and sustainment training stages prior to being deployed with the Fleet to support the gaining CINC.

Intermittent User—a unit that conducts training and exercises in the training areas throughout the year, but not on a regularly scheduled basis, and does not maintain a permanent presence.

International Waters—sea areas beyond 12 nm of the U.S. shoreline.

Interpretive Trail—a guided or self-guided nature walk, designed to attract interest and communicate an understanding of the environment in which it is located (including, where appropriate, the effects of human activity).

Intertidal Zone—occupies the space between high and low tide, also referred to as the littoral zone; found closest to the coastal fringe and thus only occurring in shallow depths.

Ionizing Radiation—particles or photons that have sufficient energy to produce direct ionization in their passage through a substance. X-rays, gamma rays, and cosmic rays are forms of ionizing radiation.

Isobath—the line on a marine map or chart joining points of equal depth, usually in fathoms below mean sea level.

Jet Routes—a route designed to serve aircraft operating from 5,486 meters (18,000 feet) up to and including flight level 450, referred to as J routes with numbering to identify the designated route.

Land/Sea Use—the exclusive or prioritized commitment of a land/sea area, and any targets, systems, and facilities therein, to a continuing purpose that could include a grouping of operations, buffer zone, environmental mitigation, etc. The land/sea area may consist of a range/range complex, grouping of similar facilities, or natural resource-based area with no facilities.

Lead—a heavy metal which can accumulate in the body and cause a variety of negative effects; one of the six pollutants for which there is a national ambient air quality standard (see Criteria Pollutants).

Lead-based Paint—paint on surfaces with lead in excess of 1.0 milligram per square centimeter as measured by X-ray fluorescence detector, or 0.5 percent lead by weight.

Leina-a-ka-uhane—as identified in traditional Hawaiian religious cosmology, a place (generally cliffs or seacoast promontories) from which the spirits of the dead plunge into eternity and are divided into one of three spiritual realms: the realm of the wandering spirits; the realm of the ancestral spirits; or the realm of the endless night.

Leptocephalic—small, elongate, transparent, planktonic.

Level of Service—describes operational conditions within a traffic stream and how they are perceived by motorists and/or passengers; a monitor of highway congestion that takes into account the average annual daily traffic, the specified road segment's number of lanes, peak hour volume by direction, and the estimated peak hour capacity by a roadway's functional classification, area type, and signal spacing.

Lithified—the conversion of a newly deposited sediment into an indurated rock.

Littoral—species found in tide pools and near-shore surge channels.

Loam—a loose soil composed of a mixture of clay, silt, sand, and organic matter.

Long-Term Sustainability of DoD Ranges—the ability to indefinitely support national security objectives and the operational readiness of the Armed Forces, while still protecting human health and the environment.

Major Range Event—a significant operational employment of live, virtual, and/or constructive forces during which live training is accomplished. A training event is a major field exercise with multiple training objectives, usually occurring over an extended period of days or weeks. An event can have multiple training operations (sub-events each with its own mission, objective and time period. Examples include C2X, JTFEX, SACEX, and CAX. Events (JTFEX) are composed of specific operations (e.g., Air-to-Air Missile), which consist of individual activities (e.g., missile launch).

Maneuver Area—range used for maneuver element training.

Maneuver Element—basic element of a larger force independently capable of maneuver. Normally, a Marine Division recognizes its infantry battalions, tank battalion, and light armored reconnaissance (LAR) battalion as maneuver elements. A rifle (or tank/LAR) battalion would recognize its companies as maneuver elements. A rifle (or tank/LAR) company would recognize its platoons as maneuver elements. Maneuver below the platoon level is not normally possible since fire and movement can be combined only at the platoon level or higher. The Army and National Guard recognize a squad and platoon as maneuver elements.

Maneuver—employment of forces on the battlefield through movement in combination with fire, or fire potential, to achieve a position of advantage with respect to the enemy in order to accomplish the mission.

Marine Corps Ground Unit—Marine Expeditionary Unit (MEU) Ground Combat Element, or Battalion Landing Team (BLT), composed of an infantry battalion of about 1,200 personnel reinforced with artillery, amphibious assault vehicles, light armored reconnaissance (LAR) assets and other units as the mission and circumstances require. (The analysis will scale units of different size or composition from this BLT standard unit to include a 12-man Special Operations platoon.)

Maritime—of, relating to, or bordering on the sea.

Material Safety Data Sheet (MSDS)—presents information, required under Occupational Safety and Health Act standards, on a chemical's physical properties, health effects, and use precautions.

Medical Evacuation (MEDIVAC)—emergency services, typically aerial, designed to remove the wounded or severely ill to medical facilities.

Mesopelagic—the oceanic zone from 109 to 547 fathoms (656 to 3,280 feet).

Migration—repeated departure and return of individuals and their offspring to and from an area.

Migratory Birds—avians characterized by their practice of passing, usually periodically, from one region or climate to another.

Military Operating Area (MOA)—airspace below 18,000 feet used to separate or segregate certain non-hazardous military flight activities from IFR traffic and to identify for VFR traffic where these activities are conducted.

Military Training Route (MTR)—an airspace corridor established for military flight training at airspeeds in excess of 250 nautical miles/hour.

Minority—minority populations, as reported by the 2000 Census of Population and Housing, includes Black, American Indian, Eskimo or Aleut, Asian or Pacific Islander, Hispanic, or other.

Mitigation—a method or action to reduce or eliminate adverse environmental impacts. Such measures may avoid impacts by not taking a certain action or parts of an action; minimize impacts by limiting the magnitude of an action; rectify impacts by restoration measures; reduce or eliminate impacts over time by preservation or maintenance measures during the action; or compensate for impacts by replacing or providing substitute resources or environments.

Mobile Sources—any movable source that emits any regulated air pollutant.

Mortality—the number of deaths in a given time or place.

Munitions Constituents—any materials originating from unexploded ordnance, discarded military munitions, or other military munitions, including explosive and non-explosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions.

National Airspace System—the common network of U.S. airspace; air navigation facilities, equipment and services, airports or landing areas; aeronautical charts, information and services; rules, regulations and procedures, technical information, and manpower and material. Included are system components shared jointly with the military.

National Ambient Air Quality Standards (NAAQS)—as set by the Environmental Protection Agency under Section 109 of the Clean Air Act, nationwide standards for limiting concentrations of certain widespread airborne pollutants to protect public health with an adequate margin of safety (primary standards) and to protect public welfare, including plant and animal life, visibility and materials (secondary standards). Currently, six pollutants are regulated by primary and secondary NAAQS: carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide (see Criteria Pollutants).

National Environmental Policy Act (NEPA)—Public Law 91-190, passed by Congress in 1969. The Act established a national policy designed to encourage consideration of the influences of human activities, such as population growth, high-density urbanization, or industrial development, on the natural environment. The National Environmental Policy Act procedures require that environmental information be made available to the public before decisions are made. Information contained in the National Environmental Policy Act documents must focus on the relevant issues in order to facilitate the decision-making process.

National Register Eligible Property—property that has been determined eligible for the National Register of Historic Places listing by the Secretary of the Interior, or one that has not yet gone through the formal eligibility determination process but which meets the National Register of Historic Places criteria for section review purposes; eligible properties are treated as if they were already listed.

National Register of Historic Places (National Register)—a register of districts, sites, buildings, structures, and objects important in American history, architecture, archaeology, and culture, maintained by the Secretary of the Interior under authority of Section 2 (b) of the Historic Sites Act of 1935 and Section 101 (a)(1) of the National Historic Preservation Act of 1966, as amended.

National Wildlife Refuge—a part of the national network of refuges and wetlands managed by the U.S. Fish and Wildlife Service in order to provide, preserve, and restore lands and waters sufficient in size, diversity and location to meet society's needs for areas where the widest possible spectrum of benefits associated with wildlife and wildlands is enhanced and made available. This includes 504 wildlife refuges nationwide encompassing 92 million acres and ranging in size from one-half acre to thousands of square miles. Dedicated to protecting wildlife and their habitat, U.S. refuges encompass numerous ecosystems and are home to a wide variety of fauna, including large numbers of migratory birds and some 215 threatened or endangered species.

Native Americans—used in a collective sense to refer to individuals, bands, or tribes who trace their ancestry to indigenous populations of North America prior to Euro-American contact.

Native Species—plants or animals living or growing naturally in a given region and often referred to as indigenous.

Native Vegetation—often referred to as indigenous, these are plants living or growing naturally in a given region without agricultural or cultivational efforts.

Navigational Aid—any visual or electronic device, airborne or on the surface, which provides point-to-point guidance information or position data to aircraft in flight.

Neritic—relating to the shallow ocean waters, usually no deeper than 109 fathoms (656 feet).

Nitrogen Dioxide—gas formed primarily from atmospheric nitrogen and oxygen when combustion takes place at high temperatures.

Nitrogen Oxides (NO_X)—gases formed primarily by fuel combustion and which contribute to the formation of acid rain. In the presence of sunlight, hydrocarbons and NO_X combine to form ozone, a major constituent of photochemical smog.

Nitrogen Tetroxide—a dark brown, fuming liquid or gas with a pungent, acrid odor, utilized in rocket fuels.

Nonattainment Area—an area that has been designated by the U.S. Environmental Protection Agency or the appropriate state air quality agency as exceeding one or more of the national or state ambient air quality standards.

Non-directional Radio Beacon—an L/MF or UHF radio beacon transmitting non-directional signals whereby the pilot of an aircraft equipped with direction finding equipment can determine the aircraft's bearing to or from the radio beacon and “home” on or track to or from the station.

Non-ionizing Radiation—electromagnetic radiation at wavelengths whose corresponding photon energy is not high enough to ionize an absorbing molecule. All radio frequency, infrared, visible, and near ultraviolet radiation are non-ionizing.

Non-Point Source Pollution—diffuse pollution; that is, from a combination of sources; typically originates from rain and melted snow flowing over the land (runoff). As runoff contacts the land's surface, it picks up many pollutants in its path: sediment, oil and grease, road salt, fertilizers, pesticides, nutrients, toxics, and other contaminants. Runoff also originates from irrigation water used in agriculture and on landscapes. Other types of non-point pollution include changes to the natural flow of water in stream channels or wetlands.

Notice to Airmen (NOTAM)—a notice containing information, not known sufficiently in advance to publicize by other means, the establishment, condition, or change in any component (facility, service, or procedure of, or hazard in the National Airspace System), the timely knowledge of which is essential to personnel concerned with flight operations.

Notice to Mariners (NOTMAR)—a periodic notice regarding changes in aids to navigation, dangers to navigation and other information essential to mariners.

Operating Area (OPAREA)—ocean area not part of a range used by military personnel or equipment for training and weapons system Research, Development, Test & Evaluation (RDT&E).

Operation—a training exercise, R&D test, or field event. A combination of activities accomplished together for a scheduled period of time for an intended military mission or task. An operation can range in size from a single unit exercise to a Joint or Combined event with many participants (e.g., aircraft, ships, submarines, troops).

Operational Range—a range that is under the jurisdiction, custody, or control of the Secretary of Defense and is used for range activities; or although not currently being used for range activities, that is still considered by the Secretary to be a range and has not been put to a new use that is incompatible with range activities.

Ordnance—military supplies including weapons, ammunition, combat vehicles, and maintenance equipment.

Otto Fuel—a torpedo fuel.

Ozone (O_3)—a highly reactive form of oxygen that is the predominant component of photochemical smog and an irritating agent to the respiratory system. Ozone is not emitted directly into the atmosphere but results from a series of chemical reactions between oxidant precursors (NO_X and VOCs) in the presence of sunlight.

Ozone Layer—a naturally occurring layer of ozone 7 to 30 miles above the earth's surface (in the stratosphere) which filters out the sun's harmful ultraviolet radiation. It is not affected by photochemical smog found in the lower atmosphere, nor is there any mixing between ground level ozone and ozone in the upper atmosphere.

Paleontological Resources—fossilized organic remains from past geological periods.

Paleontology—the study of life in the past geologic time, based on fossil plants and animals.

Participant—an individual ship, aircraft, submarine, amphibious vehicle, or ground unit.

Particulate Matter, Fine Respirable—finely divided solids or liquids less than 10 microns in diameter which, when inhaled, remain lodged in the lungs and contribute to adverse health effects.

Particulate Matter, Total Suspended—finely divided solids or liquids ranging from about 0.1 to 50 microns in diameter which comprise the bulk of the particulate matter mass in the atmosphere.

Particulate Matter—particles small enough to be airborne, such as dust or smoke (see Criteria Pollutants).

Payload—any non-nuclear and possibly propulsive object or objects, weighing up to 272.2 kilograms (600 pounds), which are carried above the Strategic Target System third stage.

Pelagic Zone—commonly referred to as the open ocean.

Pelagic—of the ocean waters.

Peninsula—a portion of land nearly surrounded by water and generally connected with a larger body by an isthmus, although the isthmus is not always well defined.

Per Capita—per unit of population; by or for each person.

Permeability—a quality that enables water to penetrate.

Pesticide—any substance, organic, or inorganic, used to destroy or inhibit the action of plant or animal pests; the term thus includes insecticides, herbicides, fungicides, rodenticides, miticides, fumigants, and repellents. All pesticides are toxic to humans to a greater or lesser degree. Pesticides vary in biodegradability.

pH—a measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity.

Photosynthesis—the plant process by which water and carbon dioxide are used to manufacture energy-rich organic compounds in the presence of chlorophyll and energy from sunlight.

Physiography—geography dealing with the exterior physical features and changes of the earth (also known as physical geography).

Phytoplankton—plant-like organisms that drift with the ocean currents, with little ability to move through the water on their own. Predominately one-celled, phytoplankton float in the photic zone (sunlit surface waters of the ocean, which extends to only about 100 meters (330 feet) below the surface), where they obtain sunlight and nutrients, and serve as food for zooplankton and certain larger marine animals.

Pinniped—having finlike feet or flippers, such as a seal or walrus.

Plankton—free-floating, usually minute, organisms of the sea; includes larvae of benthic species.

Pliocene—of, relating to, or being the latest epoch of the Tertiary Period or the corresponding system of rocks; following the Pleistocene and prior to the Miocene.

PM-2.5 and PM-10—standards for measuring the amount of solid or liquid matter suspended in the atmosphere; refers to the amount of particulate matter less than or equal to 2.5 and 10 micrometers in diameter, respectively. The PM-2.5 and PM-10 particles penetrate to the deeper portions of the lungs, affecting sensitive population groups such as children and people with respiratory or cardiac diseases.

Point Source—a distinct and identifiable source, such as a sewer or industrial outfall pipe, from which a pollutant is discharged.

Population Density—the average number of individuals or organisms per unit of space or area.

Potable Water—water that is safe to drink.

Potentially Hazardous Debris—inert debris impacting the earth with a kinetic energy equal to or greater than 11 foot-pounds.

Prehistoric—literally, "before history," or before the advent of written records. In the old world writing first occurred about 5400 years ago (the Sumerians). Generally, in North America and the Pacific region, the prehistoric era ended when European explorers and mariners made written accounts of what they encountered. This time will vary from place to place.

Prohibited Area—designated airspace where aircraft are prohibited, except by special permission. Can also apply to surface craft.

Radar—a radio device or system for locating an object by means of radio waves reflected from the object and received, observed, and analyzed by the receiving part of the device in such a way that characteristics (such as distance and direction) of the object may be determined.

Range—a land or sea area designated and equipped for any or all of the following reasons:

Range Activity—an individual training or test function performed on a range or in an Operating Area. Examples include missile launching, bombardment, and vehicle driving. Activities, when combined with other functions, generally make up an operation. Individual RDT&E functions are also included in this category.

Range Complex—a geographically integrated set of ranges, operational areas, and associated special use airspace, designated and equipped with a command and control system and supporting infrastructure for freedom of maneuver and practice in munitions firing and live ordnance use against scored and/or tactical targets and/or Electronic Warfare tactical combat training environment.

Range Operation—a live training exercise, RDT&E test, or field maneuver conducted for a specific strategic, operational or tactical military mission, or task. A military action. The basic metric of range activity. Operations may occur independently, or multiple operations may be accomplished as part of a larger event. One operation consists of a combination of activities accomplished together. Operations can be characterized by their number (ops tempo) and type, participants, footprint and ordnance expended. The type of operation can include air, land, sea, and undersea warfare training or testing and can be identified by Naval Tactical Task. Participants can include a specific number and type of aircraft, ships, submarines, amphibious or other vehicles and personnel. Ordnance broadly encompasses all weapons, missiles, shells, and expendables (chaff and flares). An individual operation occurs over a given geographic footprint for a scheduled period of time, usually less than one day. An example is a Mining Operation. Each Mining Operation is discrete and relatively short in duration, but it may be combined with other operations in a single, larger event, like a JTFEX, which lasts for several days or weeks.

Range Safety Zone (RSZ)—area around air-to-ground ranges designed to provide safety of flight and personnel safety relative to dropped ordnance and crash sites. Land use restrictions can vary depending on the degree of safety hazard, usually decreasing in magnitude from the weapons impact area (including potential ricochet) to the area of armed over flight and aircraft maneuvering.

Readiness—the ability of forces, units, weapon systems, or equipment to deliver the outputs for which they were designed (includes the ability to deploy and employ without unacceptable delays).

Region of Influence—the geographical region that would be expected to be affected in some way by the Proposed Action and alternatives.

Relative Humidity—the ratio of the amount of water vapor actually present in the air to the greatest amount possible at the same temperature.

Relief—the difference in elevation between the tops of hills and the bottoms of valleys.

Remediation—all necessary actions to investigate and clean up any known or suspected discharge or threatened discharge of contaminants, including without limitation: preliminary assessment, site investigations, remedial investigations, remedial alternative analyses and remedial actions.

Restricted Area—a designated airspace in which flights are prohibited during published periods of use unless permission is obtained from the controlling authority.

Ruderal Vegetation—weedy and commonly introduced flora growing where natural vegetational cover has been interrupted or disturbed by man.

Runoff—the portion of precipitation on land that ultimately reaches streams, often with dissolved or suspended materials.

Safety Zone—administratively designated/implied areas designated to limit hazards to personnel and the public, and resolve conflicts between operations. Can include range safety zones, ESQDS, surface danger zones, special use airspace, HERO/HERP areas, etc.

Saline—consisting of or containing salt.

Sampling—the selection of a portion of a study area or population, the analysis of which is intended to permit generalization of the entire population. In archaeology, samples are often used to reduce the amount of land area covered in a survey or the number of artifacts analyzed from a site. Statistical sampling is generally preferred since it is possible to specify the bias or probability of error in the results, but judgmental or intuitive samples are sometimes used.

Scoping—a process initiated early during preparation of an Environmental Impact Statement to identify the scope of issues to be addressed, including the significant issues related to the Proposed Action. During scoping, input is solicited from affected agencies as well as the interested public.

Seamount—a peaked, underwater mountain that rises at least 3,281 feet above the ocean floor.

Seawall—a wall or embankment to protect the shore from erosion or to act as a breakwater.

Security Zone—area where public or non-operational support access is prohibited due to training operations of a classified or hazardous nature.

Sensitive Habitats—areas of special importance to regional wildlife populations or protected species that have other important biological characteristics (for example, wintering habitats, nesting areas, and wetlands).

Sensitive Receptor—an organism or population of organisms sensitive to alterations of some environmental factor (such as air quality or sound waves) that undergo specific effects when exposed to such alteration.

Shield Volcano—a broad, gently sloping volcanic cone of flat domicil shape, usually several tens of hundreds of square miles in extent, built chiefly of overlapping and interfingering basaltic lava flows.

Short-Term Public Exposure Guidance Level (SPEGL)—an acceptable concentration for unpredicted, single, short-term, emergency exposure of the general public, as published by the National Research Council.

Site—in archaeology, any location where human beings have altered the terrain or have discarded artifacts.

Solid Waste—municipal waste products and construction and demolition materials; includes non-recyclable materials with the exception of yard waste.

Sonobuoy—hydrophones, or floating sensors, which acoustically score bomb drops during a training exercise from the sound where a bomb impacts the surface of the ocean.

Sortie—a single operational training or RDT&E event conducted by one aircraft tin a range or operating area. A single aircraft sortie is one complete flight (i.e., one take-off and one final landing).

Special Use Airspace (SUA)—airspace within which the FAA can confine certain activities such as military flight operations and/or may impose limitations upon aircraft operations not part of those activities. SUA includes military operating areas, restricted areas, and warning areas.

Special Use Airspace—consists of several types of airspace used by the military to meet its particular needs. Special use airspace consists of that airspace wherein activities must be confined because of their nature, or wherein limitations are imposed upon aircraft operations that are not a part of these activities, or both. Special use airspace, except for Control Firing Areas, are chartered on instrument flight rules or visual flight rules charts and include hours of operation, altitudes, and the controlling agency.

Special Warfare Operations—operations that provide covert insertion and reconnaissance training for small special warfare units. Activities usually include reconnaissance and surveillance, helicopter raids, and direct action. Units consist of 5 to 20 specialists using helicopters, submarines, and small inflatable boats to gather intelligence, stage raids, and return to their host units.

Species—a taxonomic category ranking immediately below a genus and including closely related, morphologically similar individuals which actually or potentially interbreed.

Specific Absorption Rate—the time rate at which radio frequency energy is absorbed per unit mass of material, usually measured in watts per kilogram (W/kg).

Stakeholder—those people or organizations that are affected by or have the ability to influence the outcome of an issue. In general this includes regulators, the regulated entity, and the public. It also includes those individuals who meet the above criteria and do not have a formal or statutorily defined decision-making role.

State Historic Preservation Officer (SHPO)—the official within each state, authorized by the state at the request of the Secretary of the Interior, to act as liaison for purposes of implementing the National Historic Preservation Act.

State Jurisdictional Waters—sea areas within 3 nm of a state's continental and island shoreline.

Stationary Source—any building, structure, facility, installation, or other fixed source that emits any regulated air pollutant.

Stormwater—runoff produced during storms, generally diverted by rain spouts and stormwater sewerage systems. Stormwater has the potential to be polluted by such sources as yard trimmings and pesticides. A stormwater outfall refers to the mouth of a drain or sewer that channels this runoff.

Subsistence Economy—a community, usually based on farming and/or fishing, that provides all or most of the basic goods required by its members for survival, usually without any significant surplus for sale.

Subsistence—the traditional harvesting of natural resources for food, clothing, fuel, transportation, construction, art, crafts, sharing, and customary trade.

Subspecies—a geographically defined grouping of local populations which differs taxonomically from similar subdivisions of species.

Substrate—the layer of soil beneath the surface soil; the base upon which an organism lives.

Sulfur Dioxide—a toxic gas that is produced when fossil fuels, such as coal and oil, are burned.

Sustainable Range Management—management of an operational range in a manner that supports national security objectives, maintains the operational readiness of the Armed Forces, and ensures the long-term viability of operational ranges while protecting human health and the environment.

Sustaining the Capability—maintaining necessary skills, readiness and abilities.

Symbiotic—living in or on the host.

System of Systems—all communications, electronic warfare, instrumentation, and systems linkage supporting the range/range complex.

Taking—to harass, harm, pursue, hunt, shout, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. Taking can involve harming the habitat of an endangered species.

Talus—rock debris at the base of a cliff.

Targets—earthwork, materials, actual or simulated weapons platforms (tanks, aircraft, EW systems, vehicles, ships, etc.) comprising tactical target scenarios within the range/range complex impact areas. Could also include SEPTAR, AQM, BQM, MQM, etc.

Tenant—a unit that has an Inter-Service Support Agreement with the host for use of the training areas and that maintains a permanent presence.

Thermocline—a thin, narrow region in a thermally stratified body of water which separates warmer, oxygen-rich surface water from cold, oxygen-poor deep water and in which temperature decreases rapidly with depth. In tropical latitudes, the thermocline is present as a permanent feature and is located 200 to 1,000 feet (61 to 305 meters) below the surface.

Threatened Species—a plant or animal species likely to become endangered in the foreseeable future.

Topography—the configuration of a surface including its relief and the position of its natural and man-made features.

Trade Winds—winds blowing almost constantly in one direction. Especially a wind blowing almost continually from the equator from the northeast in the belt between the northern horse latitudes and the doldrums and from the southeast in the belt between the southern horse latitudes and the doldrums.

Traditional Resources—prehistoric sites and artifacts, historic areas of occupation and events, historic and contemporary sacred areas, material used to produce implements and sacred objects, hunting and gathering areas, and other botanical, biological, and geographical resources of importance to contemporary groups.

Transient—remaining a short time in a particular area.

Troposphere—the atmosphere from ground level to an altitude of 10 to 15 kilometers (6.2 to 9.3 miles) (see stratosphere).

Tsunami—a great sea wave produced by a submarine earthquake or volcanic eruption. Commonly misnamed tidal wave.

Turbid—the condition of being thick, cloudy, or opaque as if with roiled sediment; muddy.

Uncontrolled Airspace—airspace of defined dimensions in which no air traffic control services to either instrument flight rules or visual flight rules aircraft will be provided, other than possible traffic advisories when the air traffic control workload permits and radio communications can be established.

Understory—a vegetal layer growing near the ground and beneath the canopy of a taller layer.

Unique and Sensitive Habitats—areas of special importance to regional wildlife populations or protected species that have other important biological characteristics (for example, wintering habitats, nesting areas, and wetlands).

Unsymmetrical Dimethyl Hydrazine (UDMH)—a liquid hypergolic propellant utilized as a missile fuel (as in the Lance); clear and colorless, UDMH has a sharp ammonia-like or fishy odor, is toxic when inhaled, absorbed through the skin, or taken internally. It is dissolvable in water, but not sensitive to shock or friction; however, when in contact with IRFNA, or any other oxidizing material, spontaneous ignition occurs. In addition, UDMH vapors greater than 2 percent in air can be detonated by electric spark or open flame.

Upland—an area of land of higher elevation.

Upwelling—the replenishing process of upward movement to the surface of marine often nutrient-rich lower waters (a boon to plankton growth), especially along some shores due to the offshore drift of surface water as from the action of winds and the Coriolis force.

U.S. Territorial Waters—sea areas within 12 nm of the U.S. continental and island shoreline.

Viewshed—total area seen within the cone of vision from a single observer position, or vantage point; a collection of viewpoints with optimal linear paths of visibility.

Vista—a distant view through or along an avenue or opening.

Visual Flight Rules (VFR)—rules that govern the procedures for conducting flight under visual conditions; used by pilots and controllers to indicate type of flight plan.

Volatile Organic Compound (VOC)—one of a group of chemicals that react in the atmosphere with nitrogen oxides in the presence of heat and sunlight to form ozone; it does not include methane and other compounds determined by the Environmental Protection Agency to have negligible photochemical reactivity. Examples of volatile organic compounds include gasoline fumes and oil-based paints.

Warning Area—a designated airspace in which flights are not restricted but avoidance is advised during published times of use.

Wastewater—water that has been previously utilized; sewage.

Wetlands—lands or areas that either contain much soil moisture or are inundated by surface or groundwater with a frequency sufficient to support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include such areas as bogs, marshes, mud and tidal flats, sloughs, river overflows, seeps, springs, or swamps.

Yearly Average Day-Night Sound Level (LDN)—utilized in evaluating long-term environmental impacts from noise, this is an annual mean of the day-night sound level.

Zoning—the division of a municipality (or county) into districts for the purpose of regulating land use, types of buildings, required yards, necessary off-street parking, and other prerequisites to development. Zones are generally shown on a map, and the text of the zoning ordinance specifies requirements for each zoning category.

Zooplankton—animals that drift with the ocean currents, with little ability to move through the water on their own, ranging from one-celled organisms to jellyfish up to 1.8 meters (6 feet) wide. Zooplankton live in both surface and deep waters of the ocean; crustaceans make up about 70 percent. While some float about freely throughout their lives, many spend only the early part of their lives as plankton.

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9.0 References

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10.0 Distribution List

10.0 DISTRIBUTION LIST

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11.0 Agencies and Individuals Contacted

11.0 AGENCIES AND INDIVIDUALS CONTACTED

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12.0 Public Scoping Summary

12.0 PUBLIC SCOPING SUMMARY

General Summary of the Scoping Period

The scoping period for the Hawaii Range Complex Environmental Impact Statement (EIS)/Overseas EIS (OEIS) began with publication of a Notice of Intent on August 29, 2006. The scoping period lasted 46 days, concluding on October 13, 2006. Four scoping meetings were held on September 13, 14, 16, and 18 on the islands of Maui, Oahu, Hawaii, and Kauai, respectively. The scoping meetings were held in an open house format, presenting informational posters and written information and making Navy staff and project experts available to answer participants' questions. Additionally, a court reporter was available to record participants' oral comments. The interaction during the information sessions was productive and helpful to the Navy.

Scoping participants could submit comments in six ways:

- oral statements at the public meetings (as recorded in transcripts by the court reporter);
- written comments at the public meetings;
- faxed letters;
- written letters;
- electronic mail; and
- voice mails left on the project information line.

In total, the Navy received 353 comments. This summary gives an overview of comments received through these means during the scoping period. Comments are organized by issue area.

Air Quality

Comments in this category expressed concern about the effects of military activities on air quality, such as effects from emissions from ships and other off-shore engines, and suggested procedures the Navy could implement to decrease emissions. Other air quality comments requested the Navy analyze more global impacts of its activities, such as impacts to weather patterns, polar ice caps, and the atmosphere.

Airspace

Commenters asked how and where the Navy is proposing to increase its use of airspace and what risks could accompany increased use, such as the potential to interfere with commercial air traffic. Commenters also provided suggestions on how the Navy could decrease its impact on airspace use.

Alternatives

Most comments regarding alternatives suggested that the Navy consider other sites to conduct its activities. Several comments included suggestions of alternative technologies to sonar and alternative methods of conducting research on the effects of sonar on marine mammals.

Biological Resources—Marine

A significant number of comments received expressed concerns about impacts to marine life. Many of these comments specifically related to concerns about the effect of Navy sonar on marine life, such as marine mammals, fish, sea turtles, and sea invertebrates. Participants frequently requested that the EIS/OEIS consider alternative technologies to mid-frequency active sonar. Other commenters requested the Navy conduct further research and consider other studies conducted by agencies outside the Navy in order to identify sonar levels that can be used without potentially affecting marine life. Commenters also suggested that the Navy explore other parameters pertaining to sonar use to prevent injury to marine mammals. Another group of comments addressed protective and mitigation measures for marine mammals when sonar is used. For example, it was requested that the Navy employ better protective measures in future RIMPAC exercises, such as conducting more monitoring and enforcing larger safety zones around ships.

Other comments expressed concern about effects on marine resources not related to using sonar. These comments requested that the Navy analyze the potential for ships to introduce invasive species to Hawaii and suggested procedures to decrease that risk. Other commenters were concerned about impacts to the sea floor, coral reefs, and coastal zones from military equipment or technologies, such as unexploded ordnance and chemicals. Several comments expressed general concern about impacts to marine life, while others identified specific policies that must be considered in the Navy's analysis, such as the Marine Mammal Protection Act.

Biological Resources—Terrestrial

Participants commenting in this category expressed concern about Kauai's ability to sustain additional military activity. Others requested that the Navy learn more about the *aina* of the Island of Hawaii before continuing military activities. Some commenters were more specifically concerned about potential impacts to endangered plants at the Pacific Missile Range Facility on Kauai, erosion, invasive species, and increased fires. A few participants asked about the potential impacts of using Navy technologies, such as lasers.

Cultural Resources

Participants commenting on cultural resources were concerned that the military's presence and activities on the Hawaiian islands causes harm to native Hawaiian culture and religious beliefs. Other commenters expressed concern about impacts to recreational and subsistence fishing, an important activity for Hawaiians. A few comments requested that the Navy consider potential impacts to specific culturally significant sites, such as Nohili on Kauai, Haleakala on Maui, Pohakuloa on the Island of Hawaii, and Waimomi on Oahu.

Cumulative Impacts

Comments in this category expressed concern about the overall impact of past and present military activity in Hawaii and requested that the Navy initiate cleanup operations. Additional comments requested that the Navy study the impacts of other actions, such as initiation of Stryker Brigade activities, stationing of C-17s in Hawaii, expanded missile defense programs, the proposed Navy University Affiliated Research Center at the University of Hawaii, the expansion of a Navy communications center in Wahiawa, and the expansion of Fort Shafter.

Environmental Justice

Commenters requested that the EIS/OEIS identify any disproportionate impacts to disempowered groups of people. Participants also requested that the Navy analyze the potential impact of sonar on sea life, which is particularly important to the diets of Hawaiian people.

Hazardous Materials/Hazardous Waste

Comments regarding hazardous materials and waste in general included requests for the Navy to identify and clean up former and current contaminated sites. Other comments expressed concern about the potential effects of Navy technologies, such as nuclear energy and chemicals. Finally, comments made suggestions on how the Navy can manage waste on ships and maximize recycling and reuse.

Health and Safety

Several comments asked the Navy to analyze the potential health and safety impacts of a specific activity or technology, such as missile launches, lasers, electromagnetism, and gamma rays. Other comments asked about the potential social impacts of having more permanent and visiting military staff on the islands for Navy activities. One commenter asked that a procedure be developed to verify Navy compliance with health and safety regulations and to make this information easy for the public to access. Another commenter requested that the Navy notify people working near torpedo exercises when activities will be taking place in their area. A few commenters expressed concern that Hawaii may be at greater risk of being a target for attacks as a result of proposed activities.

Land Use

Comments regarding land use, for the most part, expressed concern about public access and other impacts to the beaches at the Pacific Missile Range Facility. Other comments identified specific policies and plans that the Navy must consider in its analysis, such as Coastal Zone Management laws and general plans in Hawaii.

Noise

Comments regarding concerns about noise were general in nature and inquired into the level of sound considered safe to the environment and how that assessment is made.

Miscellaneous

General comments related to respecting the earth and all its life. Several comments noted opposition to the United States' involvement in Iraq, wondered why returning soldiers are not provided adequate medical assistance, and expressed concerns about reinstating the draft. A few comments specifically requested that the Navy not become affiliated with the University of Hawaii. Others were concerned about the potential for increased military presence in Hawaii to increase tensions between the military and civilian communities.

Mitigation Measures

Most comments regarding mitigation measures focused on marine mammals. For example, it was requested that the Navy employ better protective measures in future Rim of the Pacific

Exercise (RIMPAC) exercises, such as conducting more monitoring and enforcing larger safety zones around ships. A few comments addressed mitigation for activities not related to marine mammals, such as mitigation for increased numbers of heavy military vehicles on Kauai's roads and bridges.

Policy/National Environmental Policy Act Process

Comments on the National Environmental Policy Act (NEPA) process were split between those which praised and criticized the format and content of the scoping meetings. Some comments praised the informative displays, the ability to build a rapport with the Navy, and the Navy's effort to notify Kauai residents before the RIMPAC. Criticisms of the scoping meeting format included participants not being able to speak in a public hearing format and not being able to interact directly with the decision makers for this NEPA process. Some comments suggested additional methods of notifying the public of future meetings or requested additional information.

Another group of comments expressed concerns with future steps in this NEPA process. These comments included requests that the Navy provide more information to the public, analyze current exercises along with proposed actions, revise its statement of purpose and need, consult with appropriate groups, hold additional community meetings, and ensure that the proposed action is consistent with existing laws and policies.

Program

Comments regarding the Navy's programs consisted of many questions about whether the Navy is planning to start specific programs or use certain materials and technologies, such as mood-altering techniques, missile defense, and certain laser technologies. Other commenters asked if the Navy uses certain areas for operations, such as Pohakuloa, and if the Navy is planning to expand the boundaries of any of the areas it currently uses. Several of these comments referred to residents' concern about initiating activities for the Stryker program on the islands. Other comments asked whether the Navy was involved in the development of the Superferry.

Purpose and Need for Proposed Action

Many of the comments regarding the purpose and need for the proposed action questioned the need for a greater military presence in Hawaii and suggested that the Navy consider alternate sites for its activities. Others suggested that military funds be redirected to other activities, such as education, alternative energy, and environmental restoration. Several were of a general nature and requested that the Navy to rethink its programs and purpose. Some communicated support of the Navy's proposal to increase activities and upgrade facilities. One scoping meeting participant acknowledged her understanding of the Navy's need to conduct sonar training and testing but said the Navy needed to balance that with preventing harm to marine mammals.

Socioeconomics

Several comments regarding socioeconomic concerns included general questions about the long-term cost of military activity. Some of these comments requested the EIS/OEIS analyze potential impacts to the tourism and fishing industries. Others more specifically requested the EIS/OEIS to analyze whether and to what extent increased military activity and increased numbers of military individuals will impact rent rates, local schools, and homelessness.

Transportation

Comments regarding transportation included concerns about the impacts of increased traffic congestion from additional military personnel and increased training activities. A few comments asked for the Navy to conduct a traffic analysis of a specific area, such as from Nawiliwili to Mana.

Utilities

Comments regarding utilities included general concern about the impacts of the proposed action on local utility usage, wastewater disposal, grading and drainage plans, solid waste disposal, and police, fire, and emergency services.

Water Resources

Comments regarding water resources included general concerns about the potential for water quality to be affected by military activities.

Table 12-1. Breakdown of Scoping Comments by Resource Area

Resource Area	Count	% of Total
Biological Resources—Marine	82	23.23%
Program	79	22.38%
Policy/National Environmental Policy Act Process	47	13.31%
Purpose and Need	35	9.91%
Health and Safety	28	7.93%
Socioeconomics	14	3.97%
Cultural Resources	11	3.12%
Land Use	10	2.83%
Airspace	7	1.98%
Miscellaneous	7	1.98%
Alternatives	6	1.70%
Cumulative Impacts	5	1.42%
Air Quality	4	1.13%
Biological Resources—Terrestrial	4	1.13%
Mitigation Measures	3	0.85%
Transportation	3	0.85%
Environmental Justice	2	0.57%
Hazardous Materials and Waste	2	0.57%
Utilities	2	0.57%
Noise	1	0.28%
Water Resources	1	0.28%
	353	

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13.0 Draft Environmental Impact Statement/ Overseas Environmental Impact Statement Comments and Responses

13.0 DRAFT ENVIRONMENTAL IMPACT STATEMENT/OVERSEAS ENVIRONMENTAL IMPACT STATEMENT COMMENTS AND RESPONSES

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14.0 Consultation Comments and Responses

14.0 CONSULTATION COMMENTS AND RESPONSES

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Appendix A
Cooperating Agencies Request and Acceptance Letters

APPENDIX A COOPERATING AGENCIES REQUEST AND ACCEPTANCE LETTERS

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, DC 20350-2000

IN REPLY REFER TO

5090
Ser
3 October 2006

Dr. William T. Hogarth
Assistant Administrator
National Oceanic and Atmospheric
Administration (NOAA) Fisheries
1315 East West Highway
Silver Springs, MD 20910

Dear Dr. Hogarth:

The Navy is initiating an Environmental Impact Statement (EIS) to study the environmental effects of increasing usage and enhancing the capability of the Hawaii Range Complex to achieve and maintain Fleet readiness, and to conduct current, emerging, and future training and research, development, test, and evaluation (RDT&E) operations. Under the No Action Alternative, the Navy would continue current levels of training operations, RDT&E activities, ongoing base operations and maintenance of the technical and logistical facilities that support these operations and activities, and the monitoring of marine mammals in the Hawaii Range Complex. The No Action Alternative also includes the biennial Rim of Pacific exercises.

Two action Alternatives are proposed. Alternative 1 includes the activities described in the No Action Alternative plus increased training necessary to support the Fleet Response Training Plan, Hawaii Range Complex improvements and modernization, planned RDT&E activities, and necessary force structure changes. Alternative 2 includes the activities described in Alternative 1 plus major events such as supporting three carrier strike groups training at the same time, increasing the tempo of training exercises, and additional RDT&E programs at Pacific Missile Range Facility (PMRF). Future RDT&E programs proposed as part of Alternative 2 would include directed energy programs involving lasers.

In order to adequately evaluate the potential environmental effects of this proposed action, the Navy and NMFS would need to work together on assessing acoustic effects to marine species protected under the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). As well, resources protected by the Hawaiian Islands Humpback Whale National Marine Sanctuary and marine areas of the Northwest Hawaiian Islands Marine National Monument will need to be considered. It is Navy's desire to formalize this relationship as outlined in the CEQ guidelines (40 CFR Part 1501).

As defined in 40 CFR 1501.5, the Navy is the lead agency for the Hawaii Range Complex EIS. As NOAA Fisheries has jurisdiction by law and special expertise over the protected marine species that will potentially be affected by the proposed action, the Navy is requesting that NOAA Fisheries be a cooperating agency as defined in 40 CFR 1501.6.

As the lead agency, the Navy will be responsible for the following:

- Preparing the environmental analysis, background information and all necessary permit applications associated with acoustic issues on the underwater ranges.
- Working with NMFS personnel to develop and refine the method of estimating potential effects to protected marine species, including threatened and endangered species.
- Determining the scope of the EIS/OEIS, including the alternatives evaluated.
- Circulating the appropriate NEPA documentation to the general public and any other interested parties.
- Scheduling and supervising public meetings held in support of the NEPA process. This shall include without limitation, compiling and responding to comments received at these meetings.
- Participating, as appropriate, in public meetings hosted by the NOAA Fisheries for receipt of public comment on protected species permit applications. This shall also include assistance in NOAA Fisheries' response to comments.
- Maintaining an administrative record and responding to any Freedom of Information Act (FOIA) requests relating to the EIS.

As the cooperating agency, the NOAA Fisheries would be asked to support the Navy in the following manner:

- Providing timely comments after the Agency Information Meeting (which will be held at the onset of the NEPA process) and on working drafts of the EIS documents. The Navy requests that comments on draft EIS documents be provided within 21 calendar days.

2

- Coordinating, to the maximum extent practicable, any public comment periods necessary in the MMPA permitting process with the Navy's NEPA public comment periods.
- Participating, as appropriate, in public meetings hosted by the Navy for receipt of public comment on the NEPA document and environmental analysis.
- Scheduling meetings requested by Navy in a timely manner.
- Adhering to the overall schedule as set forth by the Navy.

The Navy views this agreement as important to the successful completion of the NEPA process for the Hawaii Islands Complex EIS. It is the Navy's goal to complete the analysis as expeditiously as possible, while using the best scientific information available. NOAA Fisheries assistance will be invaluable in that endeavor.

My point of contact for this action is Ms. Karen M. Foskey, (703) 602-2859, email: Karen.foskey@navy.mil.

Sincerely,

J. A. SYMONDS
Director, Environmental
Readiness Division (OPNAV N45)

Copy to:
ASN (I&E)
DASN (E), (I&F)
OAGC (I&E)
Commander, Naval Installations Command
Commander, Navy Region Hawaii
Commander, Pacific Missile Range Facility
COMPACFLT N01CE
COMPACFLT, N7 (Mr. Long)

3

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, DC 20350-2000

IN REPLY REFER TO

5090
Ser N456C/6U838240
3 October 2006

Honorable Keith E. Eastin
Office of the Assistant Secretary of the Army
(Installation and Environment)
110 Army Pentagon, Room 3E464
Washington, D.C. 20310-0110

Dear Mr. Eastin:

The Navy is initiating an Environmental Impact Statement (EIS) to study the environmental effects of increasing usage and enhancing the capability of the Hawaii Range Complex to achieve and maintain Fleet readiness, and to conduct current, emerging, and future training and research, development, test, and evaluation (RDT&E) operations. Under the No Action Alternative, the Navy would continue current levels of training operations, RDT&E activities, ongoing base operations and maintenance of the technical and logistical facilities that support these operations and activities, and the monitoring of marine mammals in the Hawaii Range Complex. The No Action Alternative also includes biennial Rim of Pacific exercises.

Two action Alternatives are proposed. Alternative 1 includes the activities described in the No Action Alternative plus increased training necessary to support the Fleet Response Training Plan, Hawaii Range Complex improvements and modernization, planned RDT&E activities, and necessary force structure changes. Alternative 2 includes the activities described in Alternative 1 plus major events such as supporting three carrier strike groups training at the same time, increasing the tempo of training exercises, and additional RDT&E programs at Pacific Missile Range Facility (PMRF). Future RDT&E programs proposed as part of Alternative 2 would include directed energy programs involving lasers.

Your agency's special expertise is needed to adequately evaluate the potential environmental effects from the RDT&E and training activities in which Army would be involved at PMRF as proposed under this action. It is Navy's desire to formalize this relationship as outlined in the CEQ guidelines (40 CFR Part 1501).

As the lead agency, the Navy will be responsible for overseeing preparation of the EIS/OEIS that includes but is not limited to the following:

- Gathering all necessary background information and preparing the EIS.
- Determining the scope of the EIS, including the alternatives evaluated.
- Working with appropriate Army personnel to evaluate potential impacts of Army RDT&E system elements and training operations.
- Circulating the appropriate NEPA documentation to the general public and any other interested parties.
- Scheduling and supervising public meetings held in support of the NEPA process. This shall include without limitation, compiling and responding to comments received at these meetings.
- Maintaining an administrative record and responding to any Freedom of Information Act (FOIA) requests relating to the EIS.

As the cooperating agency, the Navy requests U.S. Army support the Navy in the following manner:

- Providing timely comments after the Agency Information Meeting (which will be held at the onset of the NEPA process) and on working drafts of the EIS documents. The Navy requests that comments on draft EIS documents be provided within 21 calendar days.
- Responding to Navy requests for information. Timely input will be critical to ensure a successful NEPA process.
- Participating, as appropriate, in public meetings hosted by the Navy for receipt of public comment on the NEPA document and environmental analysis.
- Scheduling meetings requested by Navy in a timely manner.

2

- Adhering to the overall schedule as set forth by the Navy.

The Navy views this agreement as important to the successful completion of the NEPA process for the Hawaii Islands Complex EIS. It is the Navy's goal to complete the analysis as expeditiously as possible, while using the best scientific information available. The assistance of the U.S. Army will be invaluable in that endeavor.

My point of contact for this action is Ms. Karen M. Foskey, (703) 602-2859, email: Karen.foskey@navy.mil.

Sincerely,

J. A. SYMONDS
Rear Admiral, U.S. Navy
Director, Environmental Readiness
Division (OPNAV N45)

Copy to:
ASN (I&E)
DASN (E), (I&F)
OAGC (I&E)
Commander, Naval Installations Command
Commander, Naval Region Hawaii
Commander, Pacific Missile Range Facility
COMPACFLT (N01CE)
COMPACFLT, N7 (Mr. Long)

3

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, DC 20350-2000

IN REPLY REFER TO

5090
Ser N456C/6U838238
03 October 2006

Mr. Crate Spears
Missile Defense Agency
Federal Office Building #2
ATTN: MDA-TER
7100 Defense Pentagon
Washington, DC 20301-7100

Dear Mr. Spears:

The Navy is initiating an Environmental Impact Statement (EIS) to study the environmental effects of increasing usage and enhancing the capability of the Hawaii Range Complex to achieve and maintain Fleet readiness, and to conduct current, emerging, and future training and research, development, test, and evaluation (RDT&E) operations. Under the No Action Alternative, the Navy would continue current levels of training operations, RDT&E activities, ongoing base operations and maintenance of the technical and logistical facilities that support these operations and activities, and the monitoring of marine mammals in the Hawaii Range Complex. The No Action Alternative also includes biennial Rim of Pacific exercises.

Two action Alternatives are proposed. Alternative 1 includes the activities described in the No Action Alternative plus increased training necessary to support the Fleet Response Training Plan, Hawaii Range Complex improvements and modernization, planned RDT&E activities, and necessary force structure changes. Alternative 2 includes the activities described in Alternative 1 plus major events such as supporting three carrier strike groups training at the same time, increasing the tempo of training exercises, and additional RDT&E programs at Pacific Missile Range Facility (PMRF). Future RDT&E programs proposed as part of Alternative 2 would include directed energy programs involving lasers.

Your agency's special expertise is needed to adequately evaluate the potential environmental effects from the RDT&E activities involving various system elements of the Ballistic Missile Defense System, including the Flexible Target Family, as proposed under this action. It is Navy's desire to formalize this relationship as outlined in the CEQ guidelines by requesting that the Missile Defense Agency be a cooperating agency as defined in 40 CFR 1501.6.

As defined in 40 CFR 1501.5, the Navy is the lead agency for the Hawaii Range Complex EIS. As the lead agency, the Navy will be responsible for the following:

- Gathering all necessary background information and preparing the EIS.
- Determining the scope of the EIS, including the alternatives evaluated.
- Working with Missile Defense Agency personnel to evaluate potential impacts of RDT&E of system elements of the Ballistic Missile Defense System.
- Circulating the appropriate NEPA documentation to the general public and any other interested parties.
- Scheduling and supervising public meetings held in support of the NEPA process. This shall include without limitation, compiling and responding to comments received at these meetings.
- Maintaining an administrative record and responding to any Freedom of Information Act (FOIA) requests relating to the EIS.

As the cooperating agency, the Navy requests the Missile Defense Agency support the Navy in the following manner:

- Providing timely comments after the Agency Information Meeting (which will be held at the onset of the NEPA process) and on working drafts of the EIS documents. The Navy requests that comments on draft EIS documents be provided within 21 calendar days.
- Responding to Navy requests for information. Timely input will be critical to ensure a successful NEPA process.
- Participating, as appropriate, in public meetings hosted by the Navy for receipt of public comment on the NEPA document and environmental analysis.
- Scheduling meetings requested by Navy in a timely manner.

2

- Adhering to the overall schedule as set forth by the Navy.

The Navy views this agreement as important to the successful completion of the NEPA process for the Hawaii Islands Complex EIS. It is the Navy's goal to complete the analysis as expeditiously as possible, while using the best scientific information available. The assistance of the Missile Defense Agency will be invaluable in that endeavor.

My point of contact for this action is Ms. Karen M. Foskey, (703) 602-2859, email: karen.foskey@navy.mil.

Sincerely,

J. A. SYMONDS
Rear Admiral, U.S. Navy
Director, Environmental Readiness
Division (OPNAV N45)

Copy to:
ASN (I&E)
DASN (E), (I&F)
OAGC (I&E)
Commander, Naval Installations Command
Commander, Navy Region Hawaii
Commander, Pacific Missile Range Facility
COMPACFLT N01CE
COMPACFLT, N7 (Mr. Long)

3

DEPARTMENT OF THE NAVY
PACIFIC MISSILE RANGE FACILITY
P.O. BOX 128
KEKAHA, HI 96752-0128

IN REPLY REFER TO

5090
Ser 00/ 0956
OCT 13 2006

Ms. Susan Lacy
US Department of Energy
National Nuclear Security Administration
Sandia Site Office
Albuquerque, NM 87185

Dear Ms. Lacy:

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT (EIS)/OVERSEAS EIS (OEIS)

In accordance with the National Environmental Policy Act (NEPA), the Department of the Navy (Navy) is initiating the preparation of an Environmental Impact Statement (EIS)/Overseas EIS (OEIS) to support decisions by the U.S. Navy concerning potential range enhancements at the Hawaii Range Complex. Your agency's assistance in adequately evaluating the potential environmental effects from potential enhancements to the Department of Energy (DOE) Kauai Test Facility at PMRF is needed to complete the EIS/OEIS. Therefore, in accordance with 40 CFR Part 1501 and the Council on Environmental Quality Cooperating Agency guidance issued on January 30, 2002, the Navy requests the DOE serve as a cooperating agency for the development of the EIS/OEIS.

The No-Action Alternative is the continuation of training operations, Research, Development, Test and Evaluation (RDT&E) activities, the ongoing base operations and maintenance of the technical and logistical facilities that support these operations and activities, and the monitoring of marine mammals in the Hawaii Range Complex.

The Proposed Action includes two action Alternatives. Alternative 1 includes the activities described in the No-Action Alternative with the addition of increased training necessary to support the Fleet Response Training Plan, Hawaii Range Complex improvements and modernization, planned RDT&E activities, and necessary force structure changes. Alternative 2 includes all of the activities described in Alternative 1 with the addition of major events, such as supporting three transient carrier strike group training exercises at the same time, increasing the tempo of training exercises, and additional RDT&E programs at Pacific Missile Range Facility (PMRF).

The purpose of the Proposed Action is to provide the Hawaii Range Complex with sufficient capabilities to support Fleet and DoD training, major exercises based on current and evolving world situations, and the development, testing, and evaluation of existing, upgraded and newly developed DoD and other federal agency systems. The Proposed Action will also provide additional range capabilities and support facilities at the Hawaii Range Complex, to include

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT (EIS)/OVERSEAS EIS (OEIS)

PMRF, to fully integrate range services in a modern, multi-threat, multi-dimensional environment, ensuring safe conduct and evaluation of training and RDT&E missions. The purpose of the Proposed Action is also to fulfill Navy commitment to update analyses on marine mammal impacts caused by noise in the water.

The EIS/OEIS will address measurably foreseeable activities in the particular geographical areas affected by the No-Action Alternative and action alternatives. Impacts could result from construction at launch and other support locations, sensor test preparations, launch preparation, missile flight tests, and intercept tests. The EIS/OEIS will also analyze the potential impacts of additional training missions and additional testing facilities. This EIS/OEIS will analyze the effects of sound in the water on marine mammals in the areas where Hawaii Range Complex activities occur. This analysis will be based on the initial results of Navy long-term research plans, which have studied the quantification of exposure of marine mammal species to acoustic emissions with differing experimental approaches and detailed observations of effects. In addition, other environmental resource areas that will be addressed as applicable in the EIS/OEIS include air quality; airspace; biological resources, including threatened and endangered species; cultural resources; geology and soils; hazardous materials and waste; health and safety; land use; noise; socioeconomics; transportation; utilities; visual and aesthetic resources; and water resources.

As the lead agency, the Navy will be responsible for overseeing preparation of the EIS/OEIS that includes but is not limited to the following:

• Gathering all necessary background information and preparing the EIS/OEIS.
• Working with DOE personnel to evaluate potential impacts of changes and enhancements to the DOE's Kauai Test Facility at PMRF.
• Determining the scope of the EIS/OEIS, including the alternatives evaluated.
• Circulating the appropriate NEPA documentation to the general public and any other interested parties.
• Scheduling and supervising meetings held in support of the NEPA process, and compiling any comments received.
• Maintaining an administrative record and responding to any Freedom of Information Act requests relating to the EIS/OEIS.

As the cooperating agency, the Navy requests DOE support the Navy in the following manner:

• Providing timely comments throughout the EIS process, to include, on working drafts of the EIS/OEIS documents. The Navy requests that comments on draft EIS/OEIS documents be provided within 21 calendar days.
• Responding to Navy requests for information. Timely DOE input will be critical to ensure a successful NEPA process.
• Participating, as necessary, in meetings hosted by the Navy for discussion of EIS/OEIS related issues.

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT (EIS)/OVERSEAS EIS (OEIS)

• Adhering to the overall schedule as set forth by the Navy.
• Providing a formal, written response to this request.

My point of contact for this is Neil Sheehan, (808) 471-7836, email: neil.a.sheehan.ctr@navy.mil.

Sincerely,

M. W. DARRAH
CAPT, U.S. NAVY
Commander, Hawaii Range Complex

Copy to:
Chief of Naval Operations (N45)
Commander, Naval Installations Command
Commander, Navy Region Hawaii
COMPACFLT, N01CE
COMPACFLT, N7 (Mr. Long)

DEPARTMENT OF THE NAVY
PACIFIC MISSILE RANGE FACILITY
P.O. BOX 128
KEKAHA, HI 96752-0128

IN REPLY REFER TO

5090
Ser 00/ 0957

OCT 13 2006

Mr. Patrick Leonard
Field Supervisor
US Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122
Honolulu, HI 96850

Dear Mr. Leonard:

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT (EIS)/OVERSEAS EIS (OEIS)

In accordance with the National Environmental Policy Act (NEPA), the Department of the Navy (Navy) is initiating the preparation of an Environmental Impact Statement (EIS)/Overseas EIS (OEIS) to support decisions by the U.S. Navy concerning potential range enhancements at the Hawaii Range Complex. To assist in this effort, and in accordance with 40 CFR Part 1501 and the Council on Environmental Quality Cooperating Agency guidance issued on January 30, 2002, the Navy requests US Fish and Wildlife Service serve as a cooperating agency for the development of the EIS/OEIS.

The No-Action Alternative is the continuation of training operations, Research, Development, Test and Evaluation (RDT&E) activities, the ongoing base operations and maintenance of the technical and logistical facilities that support these operations and activities, and the monitoring of marine mammals in the Hawaii Range Complex.

The Proposed Action includes two action Alternatives. Alternative 1 includes the activities described in the No-Action Alternative with the addition of increased training necessary to support the Fleet Response Training Plan, Hawaii Range Complex improvements and modernization, planned RDT&E activities, and necessary force structure changes. Alternative 2 includes all of the activities described in Alternative 1 with the addition of major events, such as supporting three transient carrier strike group training exercises at the same time, increasing the tempo of training exercises, and additional RDT&E programs at Pacific Missile Range Facility (PMRF).

The purpose of the Proposed Action is to provide the Hawaii Range Complex with sufficient capabilities to support Fleet and DoD training, major exercises based on current and evolving world situations, and the development, testing, and evaluation of existing, upgraded and newly developed DoD and other federal agency systems. The Proposed Action will also provide additional range capabilities and support facilities at the Hawaii Range Complex, to include PMRF, to fully integrate range services in a modern, multi-threat, multi-dimensional environment, ensuring safe conduct and evaluation of training and RDT&E missions. The

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT (EIS)/OVERSEAS EIS (OEIS)

purpose of the Proposed Action is also to fulfill Navy commitment to update analyses on marine mammal impacts caused by noise in the water.

The EIS/OEIS will address measurably foreseeable activities in the particular geographical areas affected by the No-Action Alternative and action alternatives. Impacts could result from construction at launch and other support locations, sensor test preparations, launch preparation, missile flight tests, and intercept tests. The EIS/OEIS will also analyze the potential impacts of additional training missions and additional testing facilities. This EIS/OEIS will analyze the effects of sound in the water on marine mammals in the areas where Hawaii Range Complex activities occur. This analysis will be based on the initial results of Navy long-term research plans, which have studied the quantification of exposure of marine mammal species to acoustic emissions with differing experimental approaches and detailed observations of effects. In addition, other environmental resource areas that will be addressed as applicable in the EIS/OEIS include air quality; airspace; biological resources, including threatened and endangered species; cultural resources; geology and soils; hazardous materials and waste; health and safety; land use; noise; socioeconomics; transportation; utilities; visual and aesthetic resources; and water resources.

As the lead agency, the Navy will be responsible for overseeing preparation of the EIS/OEIS that includes but is not limited to the following:

- Gathering all necessary background information and preparing the EIS/OEIS.
- Working with USF&WS personnel to evaluate potential impacts on wildlife refuges, critical habitat, and wildlife resources including threatened and endangered species.
- Determining the scope of the EIS/OEIS, including the alternatives evaluated.
- Circulating the appropriate NEPA documentation to the general public and any other interested parties.
- Scheduling and supervising meetings held in support of the NEPA process, and compiling any comments received.
- Maintaining an administrative record and responding to any Freedom of Information Act requests relating to the EIS/OEIS.

As the cooperating agency, the Navy requests USF&WS support the Navy in the following manner:

- Providing timely comments throughout the EIS process, to include, on working drafts of the EIS/OEIS documents. The Navy requests that comments on draft EIS/OEIS documents be provided within 21 calendar days.
- Responding to Navy requests for information. Timely USF&WS input will be critical to ensure a successful NEPA process.
- Participating, as necessary, in meetings hosted by the Navy for discussion of EIS/OEIS related issues.
- Adhering to the overall schedule as set forth by the Navy.
- Providing a formal, written response to this request.

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT (EIS)/OVERSEAS EIS (OEIS)

My point of contact for this is Neil Sheehan, (808) 471-7836, email: neil.a.sheehan.ctr@navy.mil.

Sincerely,

M. W. DARRAH
CAPT, U. S. Navy
Commander, Hawaii Range Complex

Copy to:
Chief of Naval Operations (N45)
Commander, Naval Installations Command
Commander, Navy Region Hawaii
COMPACFLT, N01CE
COMPACFLT, N7 (Mr. Long)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1315 East-West Highway
Silver Spring, Maryland 20910
THE DIRECTOR

NOV 16 2006

Admiral J.A. Symonds
Director, Environmental Readiness Division
Department of the Navy
2000 Navy Pentagon
Washington, DC 20350-2000

Dear Admiral Symonds:

Thank you for your letter requesting that NOAA's National Marine Fisheries Service (NMFS) be a cooperating agency in the preparation of an Environmental Impact Statement (EIS) on the Department of the Navy's plan to increase usage and enhance capability of the Hawaii Range Complex.

NMFS supports the Navy's decision to prepare an EIS on this activity and agrees to be a cooperating agency, due, in part, to our responsibilities under section 101(a)(5)(A) of the Marine Mammal Protection Act (MMPA) and section 7 of the Endangered Species Act. We will make every effort to support the Navy in the specific ways described in your October 3, 2006, letter. However, due to staffing constraints in Headquarters and the fact that comments will need to be compiled from multiple Offices (including NMFS' Pacific Islands Regional Office and the Hawaiian Islands Humpback Whale National Marine Sanctuary), we cannot guarantee that we will be able to provide comments on draft EIS documents within 21 calendar days. We ask that the Navy work with us to allow reasonable extensions to our comment periods when necessary. Additionally, to ensure that NMFS will be able to adopt the Navy's EIS to cover, pursuant to NEPA, our subsequent issuance of MMPA authorizations to the Navy for these activities, we request that the Navy include us as early as possible in the development of the EIS (specifically, the range of alternatives and the identification and analysis of potential mitigation measures).

If you need any additional information, please contact Ms. Jolie Harrison, at (301) 713-2289, ext. 166.

Sincerely,

William T. Hogarth, Ph.D.

THE ASSISTANT ADMINISTRATOR
FOR FISHERIES

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DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
INSTALLATIONS AND ENVIRONMENT
110 ARMY PENTAGON
WASHINGTON, DC 20310-0110

DEC 1 2 2006

SAIE-ESOH

MEMORANDUM FOR DIRECTOR, ENVIRONMENTAL READINESS DIVISION (OPNAV N45), OFFICE OF THE CHIEF OF NAVAL OPERATIONS

SUBJECT: Environmental Impact Statement (EIS)--Hawaii Range Complex

1. In response to your letter dated, 3 October 2006, to Assistant Secretary Eastin regarding the Navy's proposal to prepare an EIS to study environmental effects of increased usage and enhancement of the capability of the Hawaii Range Complex.

2. The Army agrees to become a cooperating agency and will provide information and comments on EIS documents, participate in public meetings, and provide additional assistance as appropriate.

3. The points of contact for this action are Mr. Mike Harada, U.S. Army Installation Management Command, Pacific Region, and Mr. Randy Gallien, U.S. Army Space and Missile Defense Command. Mr. Harada can be reached at (808) 438-9333 or email at michael.a.harada@us.army.mil, and Mr. Gallien can be reached at (256) 955-5027 or email at randy.gallien@us.army.mil.

Tad Davis

Addison D. Davis, IV
Deputy Assistant Secretary of the Army
(Environment, Safety and Occupational Health)

CF:
COMMANDING GENERAL, IMCOM
COMMANDING GENERAL, SMDC/ARSTRAT
DIRECTOR, ENVIRONMENTAL PROGRAMS, OACSIM

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DEPARTMENT OF DEFENSE
MISSILE DEFENSE AGENCY
7100 DEFENSE PENTAGON
WASHINGTON, DC 20301-7100

DT

JAN 0 9 2007

MEMORANDUM FOR DIRECTOR, ENVIRONMENTAL READINESS DIVISION, (OPNAV N45), U.S. NAVY
ATTN: MS. KAREN FOSKEY

SUBJECT: Hawaii Range Complex Environmental Impact Statement (EIS)

In response to your request (Ser N456C/6U838238) dated October 3, 2006, the Missile Defense Agency (MDA) hereby agrees to participate as a cooperating agency in the Hawaii Range Complex EIS process. As defined in 40 CFR 1501.6, MDA agrees to support the Navy by reviewing and submitting comments on working drafts of EIS documents, by responding to Navy requests for information about MDA test activities, and by participating, as appropriate, in public meetings hosted by the Navy. My points of contact for this issue are Mr. Steven Lopes, (703) 697-4747, email: steven.lopes@mda.mil, and Mr. Howard Finkel (SETAC), (703) 697-4403, email: howard.finkel.ctr@mda.mil.

CHRIS T. ANZALONE
Major General, USAF
Deputy for Test, Integration, and Fielding

Appendix B
Notice of Intent and Notice of Availability

APPENDIX B NOTICE OF INTENT AND NOTICE OF AVAILABILITY

51188 **Federal Register** / Vol. 71, No. 167 / Tuesday, August 29, 2006 / Notices

Background

Title V of the Trade and Development Act of 2000 (the Act) created two tariff rate quotas (TRQs), providing for temporary reductions in the import duties on limited quantities of two categories of worsted wool fabrics suitable for use in making suits, suit-type jackets, or trousers: (1) for worsted wool fabric with average fiber diameters greater than 18.5 microns (Harmonized Tariff Schedule of the United States (HTS) heading 9902.51.11); and (2) for worsted wool fabric with average fiber diameters of 18.5 microns or less (HTS heading 9902.51.12). On August 6, 2002, President Bush signed into law the Trade Act of 2002, which includes several amendments to Title V of the Act. On December 3, 2004, the Act was further amended pursuant to the Miscellaneous Trade Act of 2004, Public Law 108-429. The 2004 amendment included authority for the Department to allocate a TRQ for new HTS category, HTS 9902.51.16. This HTS category refers to worsted wool fabric with average fiber diameter of 18.5 microns or less. The amendment provided that HTS 9902.51.16 is for the benefit of persons (including firms, corporations, or other legal entities) who weave such worsted wool fabric in the United States that is suitable for making men's and boys' suits. The TRQ for HTS 9902.51.16 provided for temporary reductions in the import duties on 2,000,000 square meters annually for 2005 and 2006. The amendment requires that the TRQ be allocated to persons who weave worsted wool fabric with average fiber diameter of 18.5 microns or less, which is suitable for use in making men's and boys' suits, in the United States. On August 17, 2006, the Act was further amended pursuant to the Pension Protection Act of 2006, Public Law 109-280, which extended the TRQ for HTS 9902.51.16 through 2009.

On May 16, 2005, the Department published regulations establishing procedures for allocating the TRQ. 70 FR 25774, 15 CFR 335. In order to be eligible for an allocation, an applicant must submit an application on the form provided at *http://web.ita.doc.gov/tacgi/wooltrq.nsf/TRQApp/fabric* to the address listed above by 5 p.m. on September 28, 2006 in compliance with the requirements of 15 CFR 335. Any business confidential information that is marked business confidential will be kept confidential and protected from disclosure to the full extent permitted by law.

Dated: August 23, 2006.

Philip J. Martello,

Acting Deputy Assistant Secretary for Textiles and Apparel.

[FR Doc. E6–14333 Filed 8–28–06; 8:45 am]

BILLING CODE 3510–DS–S

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[I.D. 082306E]

North Pacific Fishery Management Council; Public Meeting

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice of a public committee meeting.

SUMMARY: The North Pacific Fishery Management Council's (Council) Steller Sea Lion Mitigation Committee (SSLMC) will meet in Seattle, WA.

DATES: The meeting will be held on September 12–14, 2006, from 8:30 a.m. to 5 p.m.

ADDRESSES: The meeting will be held at the Alaska Fishery Science Center, 7600 Sand Point Way NE, Building 4, Seattle, WA.

Council address: North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501–2252.

FOR FURTHER INFORMATION CONTACT: Bill Wilson, North Pacific Fishery Management Council; telephone: (907) 271–2809.

SUPPLEMENTARY INFORMATION: The main issues to be discussed by the SSLMC are the proposal ranking tool and the first chapters of the draft Biological Opinion. The Committee will complete work on development of the ranking tool and prepare a report for the Scientific and Statistical Committee (SSC).

Although non-emergency issues not contained in this agenda may come before this group for discussion, those issues may not be the subject of formal action during this meeting. Action will be restricted to those issues specifically identified in this notice and any issues arising after publication of this notice that require emergency action under section 305(c) of the Magnuson-Stevens Fishery Conservation and Management Act, provided the public has been notified of the Council's intent to take final action to address the emergency.

Special Accommodations

These meetings are physically accessible to people with disabilities. Requests for sign language interpretation or other auxiliary aids should be directed to Gail Bendixen, (907) 271–2809, at least 5 working days prior to the meeting date.

Dated: August 24, 2006.

James P. Burgess,

Acting Director, Office of Sustainable Fisheries, National Marine Fisheries Service.

[FR Doc. E6–14311 Filed 8–28–06; 8:45 am]

BILLING CODE 3510–22–S

DEPARTMENT OF DEFENSE

Department of the Navy

Notice of Intent To Prepare an Environmental Impact Statement (EIS)/ Overseas Environmental Impact Statement (OEIS) for a Proposal To Enhance Training, Testing, and Operational Capability Within the Hawaii Range Complex and To Announce Public Scoping Meetings

AGENCY: Department of the Navy, DoD.

ACTION: Notice.

SUMMARY: Pursuant to Section 102(2)(C) of the National Environmental Policy Act of 1969, as implemented by the Council on Environmental Quality regulations (40 CFR parts 1500–1508), and Executive Order 12114 (Environmental Effects Abroad of Major Federal Actions), the Department of the Navy (DoN) announces its intent to prepare an EIS/OEIS. This EIS/OEIS will evaluate the potential environmental effects of increasing usage and enhancing the capability of the Hawaii Range Complex to achieve and maintain Fleet readiness and to conduct current, emerging, and future training and research, development, test, and evaluation (RDT&E) operations. The EIS/OEIS will consider two action Alternatives to accomplish these objectives, in addition to the No Action Alternative.

The following will be invited to be cooperating agencies: Department of Energy, Missile Defense Agency, U.S. Army, U.S. Fish and Wildlife Service, and National Marine Fisheries Service.

DATES: Public scoping meetings will be held in Hawaii to receive oral and/or written comments on environmental concerns that should be addressed in the EIS/OEIS. The public scoping meetings will be held on:

1. Wednesday, September 13, 2006, 4 p.m.–8 p.m., Maui Arts and Cultural Center, One Cameron Way, Kahului, Maui, Hawaii.

2. Thursday, September 14, 2006, 4 p.m.–8 p.m., Disabled American

Federal Register / Vol. 71, No. 167 / Tuesday, August 29, 2006 / Notices **51189**

Veterans Hall, 2685 North Nimitz Highway, Honolulu, Oahu, Hawaii.

3. Saturday, September 16, 2006, 4 p.m.–8 p.m., Hilo Hawaiian Hotel, 71 Banyan Drive, Hilo, Hawaii, Hawaii.

4. Monday, September 18, 2006, 4 p.m.–8 p.m., Kauai Civil Defense Agency, Suite 100, 3990 Kaana Street, Kauai, Lihue, Hawaii.

Each of the four scoping meetings will consist of an informal, open house session with information stations staffed by DoN representatives. Additional information concerning the meetings will be available on the EIS/OEIS Web page located at: *http://www.govsupport.us/navynepahawaii.*

FOR FURTHER INFORMATION CONTACT: Mr. Tom Clements, Pacific Missile Range Facility, P.O. Box 128, Kekaha, Kauai, Hawaii 96752–0128, telephone 1–866–767–3347.

SUPPLEMENTARY INFORMATION: The Hawaii Range Complex geographically encompasses offshore, nearshore, and onshore areas located on or around the major islands of the Hawaiian Island chain. The geographic scope of this EIS/OEIS (Study Area) includes the Hawaii Offshore Operation Areas, consisting of 170,000 square nautical miles of ocean, generally from 17 to 26 degrees north latitude and from 154 to 162 degrees west longitude, land areas used by the DoN within these Operation Areas, and the Pacific Missile Range Facility (PMRF) Temporary Operating Area, consisting of 2.1 million square nautical miles to the north and west of Kauai. These ranges and Operation Areas are used to conduct operations and training involving military hardware, personnel, tactics, munitions, explosives, and electronic combat systems. Several of the areas are also used for RDT&E, including missile defense testing.

The purpose of the Proposed Action is to: (1) Provide the Hawaii Range Complex with sufficient capabilities to support Fleet and DoD training, major exercises based on training requirements identified to support the U.S. Unified Commanders, and the development, testing, and evaluation of existing, upgraded, and newly developed DoD and other federal agency systems; (2) provide additional range capabilities and support facilities at the Hawaii Range Complex, to include the PMRF, to fully integrate range services in a modern, multi-threat, multi-dimensional environment, ensuring safe conduct and evaluation of training and RDT&E missions; and (3) fulfill DoN commitment to update analyses on marine mammal exposures to noise in the water.

The need for the Proposed Action is to: (1) Ensure a robust training, testing, and operational capability within the Hawaii Range Complex operating areas and to take advantage of Hawaii's location to not only provide training for local assets, but also provide capability for short notice and surge deployments from the West Coast; (2) support the acquisition and integration into the Fleet of advanced military technology and accommodate future increases in operational training tempo; and (3) maintain the long-term viability of the range complex while protecting human health and the environment.

The No Action Alternative is the continuation of training operations, RDT&E activities, ongoing base operations, and maintenance of the technical and logistical facilities that support these operations and activities, and the monitoring of marine mammals. The No Action Alternative includes the current level of training and test activities, including the biennial Rim of the Pacific exercises. Alternative 1 includes the activities described in the No Action Alternative with the addition of increased training necessary to support the Fleet Response Training Plan, Hawaii Range Complex improvements and modernizations, planned RDT&E activities, and necessary force structure changes. Alternative 2 would include all of the activities described in Alternative 1 with the addition of major events, such as supporting three carrier strike groups training at the same time, increasing the tempo of training exercises, and additional RDT&E programs at PMRF. Future RDT&E programs proposed as part of Alternative 2 would include directed energy programs involving lasers.

Key environmental issues that will be addressed in the EIS/OEIS, as applicable, include: biological resources (marine mammals and threatened and endangered species), cultural resources, environmental justice, health and safety, and noise. The DoN has been involved in long-term research plans studying the quantification of exposure of marine mammal species to acoustic emissions with differing experimental approaches and detailed observations of effects. Now that initial findings are available, this EIS/OEIS will include acoustic exposure modeling and effects-analysis for marine mammals within the defined study area.

The DoN is initiating the scoping process to identify community concerns and local issues that will be addressed in the EIS/OEIS. Federal, state, and local agencies, the public, and interested persons are encouraged to provide oral and/or written comments to the DoN to identify specific environmental issues or topics of environmental concern that the commenter believes the DoN should consider. All comments, written or provided orally at the scoping meetings, will receive the same consideration during EIS/OEIS preparation.

Written comments on the scope of the EIS/OEIS should be postmarked no later than October 13, 2006. Comments may be mailed to Mr. Tom Clements, Pacific Missile Range Facility, P.O. Box 128, Kekaha, Kauai, Hawaii 96752–0128.

Dated: August 24, 2006.

Saundra K. Melancon,

Paralegal Specialist, Alternate Federal Register Liaison Officer.

[FR Doc. E6–14324 Filed 8–28–06; 8:45 am]

BILLING CODE 3810–FF–P

DEPARTMENT OF EDUCATION

Notice of Proposed Information Collection Requests

AGENCY: Department of Education.

SUMMARY: The IC Clearance Official, Regulatory Information Management Services, Office of Management, invites comments on the proposed information collection requests as required by the Paperwork Reduction Act of 1995.

DATES: Interested persons are invited to submit comments on or before October 30, 2006.

SUPPLEMENTARY INFORMATION: Section 3506 of the Paperwork Reduction Act of 1995 (44 U.S.C. Chapter 35) requires that the Office of Management and Budget (OMB) provide interested Federal agencies and the public an early opportunity to comment on information collection requests. OMB may amend or waive the requirement for public consultation to the extent that public participation in the approval process would defeat the purpose of the information collection, violate State or Federal law, or substantially interfere with any agency's ability to perform its statutory obligations. The IC Clearance Official, Regulatory Information Management Services, Office of Management, publishes that notice containing proposed information collection requests prior to submission of these requests to OMB. Each proposed information collection, grouped by office, contains the following: (1) Type of review requested, e.g. new, revision, extension, existing or reinstatement; (2) Title; (3) Summary of the collection; (4) Description of the need for, and proposed use of, the information; (5) Respondents and frequency of collection; and (6)

NOTICE OF AVAILABILITY

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Appendix C
Resource Descriptions Including Laws and Regulations Considered

APPENDIX C RESOURCE DESCRIPTIONS INCLUDING LAWS AND REGULATIONS CONSIDERED

This appendix provides a general description of each resource and addresses the Federal, State, and local environmental review programs that do, or may, apply to the No-action Alternative, Alternative 1, and Alternative 2. Project facilities and activities will be implemented in accordance with applicable Federal laws and regulations and with State and local laws, regulations, programs, plans, and policies as applicable.

This Environmental Impact Statement (EIS)/Overseas EIS (OEIS) has been prepared and provided for public review in accordance with the Council on Environmental Quality regulations implementing the National Environmental Policy Act (NEPA) (40 Code of Federal Regulations [CFR] Part 1500-1508).

C.1 Air Quality

Air quality in a given location is defined by the concentration of various pollutants in the atmosphere, generally expressed in parts per million or micrograms per cubic meter, or as a pollution standard index. Air quality is determined by the type and amount of pollutants emitted into the atmosphere, the size and topography of the air basin, and the prevailing meteorological conditions. The significance of a pollutant concentration is determined by comparing it to Federal and state ambient air quality standards (AAQS).

The Federal Clean Air Act (CAA) (42 United States Code [U.S.C.] 7401) requires the adoption of national ambient air quality standards (NAAQS) to protect the public health, safety, and welfare from known or anticipated effects of air pollution. Seven air pollutants have been identified by the U.S. Environmental Protection Agency (USEPA) as being a nationwide concern: carbon monoxide, ozone, nitrogen dioxide, particulate matter equal to or less than 10 microns in size (PM-10) (also called respirable particulate and suspended particulate), fine particulate matter equal to or less than 2.5 microns in size (PM-2.5), sulfur dioxide, and lead. The USEPA has established NAAQS for these pollutants, which are collectively referred to as criteria pollutants, as shown in Table C-1. Amendments to the CAA require the USEPA to describe the health and welfare impacts of a pollutant as the “criteria” for inclusion in the regulatory regime.

Hawaii has established State AAQS. Ambient conditions in each state are limited to the more restrictive standard (Federal or State). Table C-1 compares the NAAQS and the Hawaii AAQS.

According to USEPA guidelines, an area with air quality equal to or better than the NAAQS is designated as being in attainment; areas with worse air quality are classified as nonattainment areas. A nonattainment designation for a particular pollutant is given to a region if the primary NAAQS for that criteria pollutant is exceeded at any point in the region for more than 3 days during a 3-year period. An air basin may be designated as unclassified when there is insufficient data for the USEPA to determine attainment status.

Table C-1. Federal and State Ambient Air Quality Standards

Pollutant	Averaging Time	Hawaii State Standard	National Primary Standard	National Secondary Standard
Carbon Monoxide	8-hour	5 mg/m^3 (4.5 ppm)	10 mg/m^3 (9 ppm)	None
	1-Hour	10 mg/m^3 (9 ppm)	40 mg/m^3 (35 ppm)	None
Nitrogen Dioxide	Annual (1)	70 mg/m^3 (0.037 ppm)	100 μg/m^3 (0.053 ppm)	Same as Primary
Ozone	8-hour (2)	None	157 μg/m^3 (0.08 ppm) (1)	Same as Primary
	1-Hour	100 μg/m^3	235 μg/m^3 (0.12 ppm) (7)	Same as Primary
Lead	Quarterly (1)	1.5 mg/m^3	1.5 μg/m^3	Same as Primary
PM-2.5	Annual (3)	None	15 μg/m^3	Same as Primary
	24-hour (4)	None	35 μg/m^3	Same as Primary
PM-10	Annual (arithmetic mean)	50 mg/m^3	revoked (8)	
	24-hour (5)	150 mg/m^3	150 μg/m^3	Same as Primary
Sulfur Dioxide (6)	Annual (1)	80 μg/m^3 (0.03 ppm)	80 μg/m^3 (0.03 ppm)	None
	24-hour	365 μg/m^3 (0.14 ppm)	365 μg/m^3 (0.14 ppm)	None
	3-hour	1,300 μg/m^3 (0.5 ppm)	None	1,300 μg/m^3 (0.5 ppm)
Hydrogen Sulfide	1-hour	35 μg/m^3 (0.025 ppm)	None	None

Source:
(1) Calculated as the arithmetic mean
(2) Calculated as the 3-year average of the fourth highest daily maximum 8-hour ozone concentration
(3) Calculated as the 3-year average of the arithmetic means
(4) Calculated as the 98th percentile of 24-hour PM-2.5 concentration in a year (averaged over 3 years) at the population oriented monitoring site with the highest measured values in the area (effective December 17, 2006).
(5) Calculated as the 99th percentile of 24-hour PM-10 concentrations in a year (averaged over 3 years).
(6) Measured as sulfur dioxide
(7) As of June 15, 2005 the USEPA revoked the 1-hour ozone standard in all areas except the fourteen 8-hour ozone nonattainment Early Action Compact Areas
(8) EPA revoked the annual PM_{10} standard in 2006 (effective December 17, 2006)
mg/m^3 = milligrams per cubic meter
μg/m^3 = micrograms per cubic meter
PM-2.5 = fine particulate matter equal to or less than 2.5 microns in size
PM-10 = particulate matter equal to or less than 10 microns in size (also called respirable particulate and suspended particulate)
ppm = parts per million

The Clean Air Act Amendments of 1990 (Public Law [PL] 101-549, 104 Statute 2399) required the USEPA to promulgate rules to ensure that Federal actions in areas classified as nonattainment or maintenance areas (geographic areas that had a history of nonattainment, but are now consistently meeting NAAQS) conform to the appropriate state implementation plan. These rules, known together as the General Conformity Rule (40 CFR 51.850-860 and 40 CFR 93.150-160), require any Federal agency responsible for an action to determine if its action conforms to pertinent guidelines and regulations. Certain actions are exempt from conformity determinations if the projected emission rates would be less than specified emission rate thresholds, known as *de minimis* limits.

C.2 Airspace

Airspace, or that space which lies above a nation and comes under its jurisdiction, is generally viewed as being unlimited. However, it is a finite resource that can be defined vertically and horizontally, as well as temporally, when describing its use for aviation purposes.

Under Public Law 85-725, *Federal Aviation Act of 1958*, the Federal Aviation Administration (FAA) is charged with the safe and efficient use of our nation's airspace, and has established certain criteria for and limits to its use. The method used to provide this service is the National Airspace System. This system is "…a common network of U.S. airspace; air navigation facilities, equipment and services, airports or landing areas; aeronautical charts, information and services; rules, regulations and procedures, technical information and manpower and material."

Areas beyond the territorial limit are defined as international airspace. Therefore, the procedures of the International Civil Aviation Organization (ICAO) outlined in ICAO Document 4444, *Rules of the Air and Air Traffic Services*, are followed (International Civil Aviation Organization, 1996; 1997). ICAO Document 4444 is the equivalent air traffic control manual to FAA Handbook 7110.65, *Air Traffic Control*. The ICAO is a specialized agency of the United Nations whose objective is to develop the principles and techniques of international air navigation and to foster planning and development of international civil air transport.

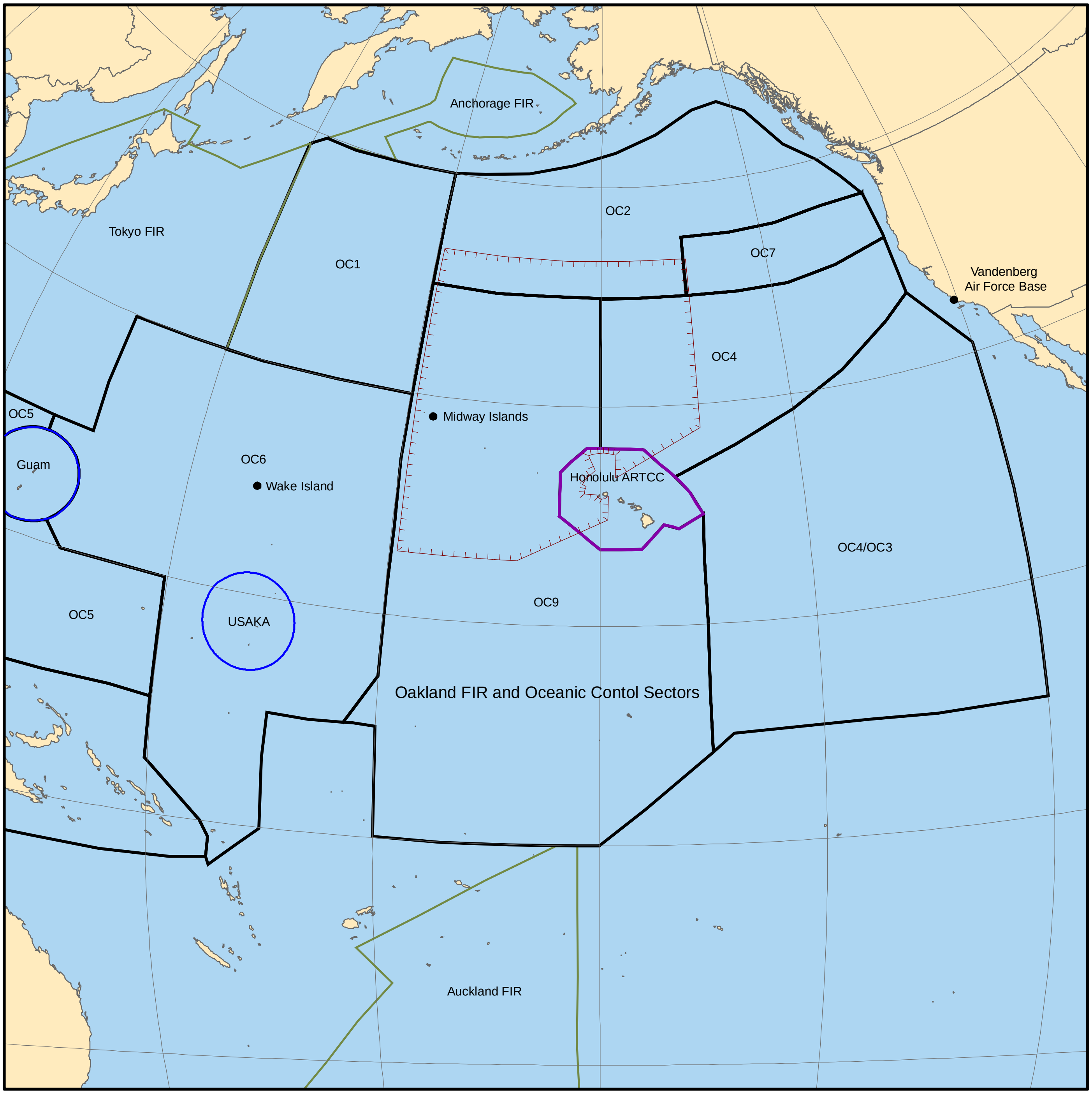
The FAA acts as the U.S. agent for aeronautical information to the ICAO, and air traffic in the Central Pacific is managed by the Oakland Air Route Traffic Control Center (ARTCC) within several Oceanic Control Sectors, the boundaries of which are shown in Figure C-1. The Honolulu Combined Radar Approach Control manages the Radar Control Area that surrounds the Hawaiian Islands.

Types of Airspace

Controlled and Uncontrolled Airspace

As part of the National Airspace System, controlled and uncontrolled airspace is divided into six classes, depending upon location, use, and degree of control. Pilots are also subject to certain qualification requirements, operating rules, and equipment requirements. Figure C-2 depicts the six classes of non-military airspace. A brief description of each class follows:

- The Open Ocean Area does not include Class A airspace, which includes airspace overlying the waters within 12 nautical miles (nm) of the coast.
- Class B airspace is generally that airspace surrounding the nation's busiest airports in terms of Instrument Flight Rules (IFR) operations or passengers boarding an aircraft. An air traffic control clearance is required for all aircraft to operate in the area, and all aircraft that are so cleared receive separation services within the airspace.
- Class C airspace is generally that airspace surrounding those airports that have an operational control tower, are serviced by a radar approach control, and that have a certain number of IFR operations or passenger boardings.



EXPLANATION

- Temporary Operating Area
- Radar Control Area
- Flight Information Region (FIR)
- Oakland FIR and Oceanic Control (OC) Sector
- Honolulu Air Route Traffic Control Center Area
- Land

Note:
USAKA = U.S. Army Kwajalein Atoll
ARTCC = Air Route Traffic Control Center

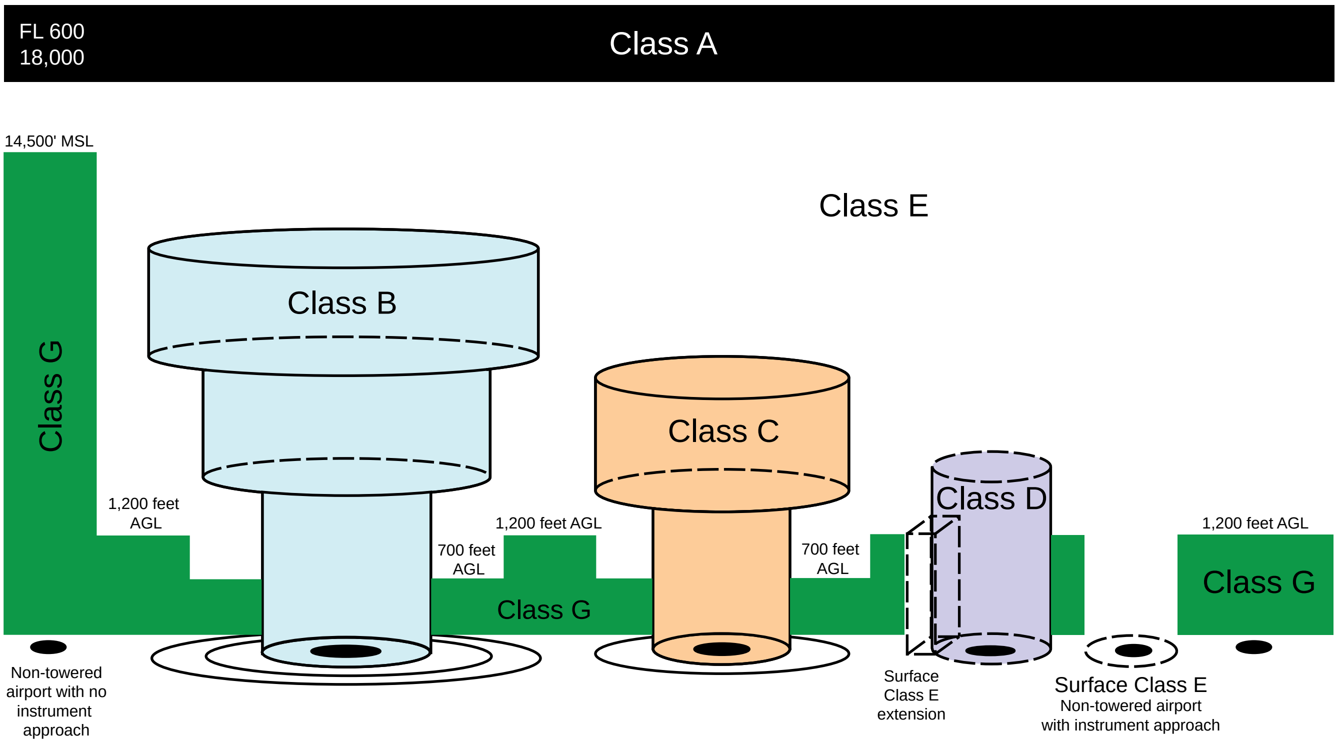
NORTH

0 300 600 1,200 Nautical Miles

Airspace Managed by Oakland and Honolulu Air Route Traffic Control Centers

Pacific Ocean

Figure C-1



Source: U.S. Department of Transportation, 2002a

EXPLANATION

AGL = Above Ground Level
FL = Flight Level
MSL = Above Mean Sea Level

The Six Classes of Non-Military Airspace

Figure C-2

- Class D airspace is generally that airspace surrounding those airports that have an operational control tower.
- Class E airspace is controlled airspace that is not Class A, Class B, Class C, or Class D airspace. Uncontrolled airspace, or Class G airspace, has no specific definition but generally refers to airspace not otherwise designated and operations below 1,200 ft above ground level. No air traffic control service to either IFR or Visual Flight Rules (VFR) aircraft is provided other than possible traffic advisories when the air traffic control workload permits and radio communications can be established.

Special Use Airspace

Complementing the classes of controlled and uncontrolled airspace are several types of special use airspace used by the military to meet its particular needs. Special use airspace consists of that airspace where activities must be confined because of their nature, or where limitations are imposed on aircraft operations that are not a part of these activities, or both. Except for controlled firing areas, special use airspace areas are depicted on aeronautical charts, IFR or visual charts, and include hours of operation, altitudes, and the controlling agency. Only the special use airspace found in the region of influence is described. For the open ocean area this includes Warning Areas, which are airspace that may contain hazards to non-participating aircraft in international airspace. Warning Areas are established beyond the 3-nm limit. Although the activities conducted within Warning Areas may be as hazardous as those in Restricted Areas, Warning Areas cannot be legally designated as Restricted Areas because they are over international waters (Aviation Supplies and Academics, Inc., 1996). For areas over and surrounding land and offshore areas this includes:

- Restricted Areas contain airspace identified by an area on the surface of the earth within which the flight of aircraft, while not wholly prohibited, is subject to restriction. Activities within these areas must be confined, because of their nature, or limitations imposed upon aircraft operations that are not a part of these activities, or both. Restricted Areas denote the existence of unusual, often invisible, hazards to aircraft such as artillery firing, aerial gunnery, or guided missiles. Restricted Areas are published in the Federal Register and constitute Federal Aviation Regulation (FAR) Part 73.

- Warning Areas are airspace that may contain hazards to non-participating aircraft in international airspace. Warning Areas are established beyond the 3-nautical-mile (nm) limit. Although the activities conducted within Warning Areas may be as hazardous as those in Restricted Areas, Warning Areas cannot be legally designated as Restricted Areas because they are over international waters (Aviation Supplies and Academics, Inc., 1996). By Presidential Proclamation No. 5928, dated 27 December 1988, the U.S. territorial limit was extended from 3 to 12 nm. Special FAR 53 establishes certain regulatory warning areas within the new (3- to 12-nm) territorial airspace to allow continuation of military activities.

Other Airspace Areas

Other types of airspace include airport advisory areas, temporary flight restrictions areas, flight limitations and prohibitions areas, published VFR routes, and terminal radar service areas (Federal Aviation Administration, 2006).

Special Airspace Use Procedures

Other types of airspace, and special airspace use procedures used by the military to meet its particular needs, include air traffic control assigned airspace and altitude reservation (ALTRV) procedures. Both of these types of airspace are described below:

- Air Traffic Control Assigned Airspace (ATCAA), or airspace of defined vertical and lateral limits, is assigned by air traffic control to provide air traffic segregation between specified activities being conducted within the assigned airspace and other IFR air traffic. ATCAAs are usually established in conjunction with Military Operations Areas, and serve as an extension of Military Operations Area airspace to the higher altitudes required. These airspace areas support high altitude operations such as intercepts, certain flight test operations, and air refueling operations.
- ALTRV procedures are used as authorized by the Central Altitude Reservation Function, an air traffic service facility, or appropriate ARTCC, under certain circumstances, for airspace utilization under prescribed conditions. An ALTRV receives special handling from FAA facilities. According to FAA Handbook 7610.4H, Chapter 3, ALTRVs are classified as either moving or stationary, with the latter normally defining the fixed airspace area to be occupied as well as the specific altitude(s) and time period(s) the area will be in use. ALTRVs may encompass certain rocket and missile activities and other special operations as may be authorized by FAA approval procedures.

C.3 Biological Resources

Native or naturalized vegetation, wildlife, and the habitats in which they occur are collectively referred to as biological resources. Existing information on plant and animal species and habitat types in the vicinity of the proposed sites was reviewed, with special emphasis on the presence of any species listed as threatened or endangered by Federal or State agencies, to assess their sensitivity to the effects of the No-action Alternative, Alternative 1, or Alternative 2.

The Endangered Species Act of 1973 (ESA) requires the U.S. Fish and Wildlife Service (USFWS) to identify plant and animal species that are threatened or endangered. Federal agencies are required to assess the effect of any project on threatened and endangered species under Section 7 of the ESA.

The Migratory Bird Treaty Act (16 U.S.C. 703-712) protects many species of migratory birds. Specifically, the act prohibits the pursuit, hunting, taking, capture, possession, or killing of such species or their nests and eggs.

The Marine Mammal Protection Act (16 U.S.C. 1361, et seq.) gives the USFWS and National Marine Fisheries Service (NMFS) co-authority and outlines prohibitions for the taking of marine mammals. A take means to attempt as well as to actually harass, hunt, capture, or kill any marine mammal. Subject to certain exceptions, the Act establishes a moratorium on the taking and importation of marine mammals. Exceptions to the taking prohibition allow USFWS and NMFS to authorize the incidental taking of small numbers of marine mammals in certain instances.

The Magnuson-Stevens Fishery Conservation and Management Act (Public Law 94-265) requires that Federal agencies consult with NMFS on activities that could harm Essential Fish

Habitat (EFH) areas. EFH refers to "those waters and substrate (sediment, hard bottom) necessary to fish for spawning, breeding, feeding or growth to maturity."

Executive Order (EO) 13089 Coral Reef Protection (63 FR 32701) and subsequent guidance documents from the Department of Defense (DoD) and the Navy were issued in 1998 "to preserve and protect the biodiversity, health, heritage, and social and economic value of U.S. coral reef ecosystems and the marine environment." It is DoD policy to protect the U.S. and International coral reefs and to avoid impacting coral reefs to the maximum extent possible. No concise definition of coral reefs has been promulgated, with regard to regulatory compliance of EO 13089. In general, coral reefs consist of tropical reef building Scleractinian and Hydrozoan corals, as well as calcified Octocorals in the families Tubiporidae and Helioporidae, non-calcified Octocorals (soft corals) and Gorgonian corals, all growing in the 0 to 300 feet (ft) depth range. Deep water (300 to 3,000 ft depth range) precious corals and other deep water coral communities will only be considered in the case of a Sinking Exercise, where a vessel might ultimately land on a deep water coral community.

C.4 Cultural Resources

Cultural resources include prehistoric and historic artifacts, archaeological sites (including underwater sites), historic buildings and structures, and traditional resources (such as Native American and Native Hawaiian religious sites). Cultural resources of particular concern include properties listed in or eligible for inclusion in the National Register of Historic Places (National Register). Section 106 of the National Historic Preservation Act (16 U.S.C. 470 *et seq.*) requires Federal agencies to take into consideration the effects of their actions on significant cultural properties. Implementing regulations (36 CFR 800) specify a process of consultation to assist in satisfying this requirement. To be considered significant, cultural resources must meet one or more of the criteria established by the National Park Service that would make that resource eligible for inclusion in the National Register. The term "eligible for inclusion in the National Register" includes all properties that meet the National Register listing criteria specified in Department of Interior regulations at 36 CFR 60.4. Resources not formally evaluated may also be considered potentially eligible and, as such, are afforded the same regulatory consideration as listed properties. Whether prehistoric, historic, or traditional, significant cultural resources are referred to as historic properties.

Numerous laws and regulations require that possible effects on important cultural resources be considered during the planning and execution of Federal undertakings. These laws and regulations stipulate a process of compliance, define the responsibilities of the Federal agency proposing the action, and prescribe the relationship among other involved agencies (e.g., State Historic Preservation Officer, the Advisory Council on Historic Preservation). In addition to the NEPA, the primary laws that pertain to the treatment of cultural resources during environmental analysis are the National Historic Preservation Act, especially Sections 106 and 110; the Archaeological Resources Protection Act of 1979 (16 U.S.C. 470aa-470mm), which prohibits the excavation or removal of items of archaeological interest from Federal lands without a permit; the Antiquities Act of 1906 (16 U.S.C. 431); and the Native American Graves Protection and Repatriation Act (25 U.S.C. 3001 et seq.), which requires that Federal agencies return "Native American cultural items" to the Federally recognized native groups with which they are associated, and specifies procedures to be followed if such items are discovered on Federal land.

C.5 Hazardous Materials and Waste

Hazardous Materials

The U.S. Department of Transportation defines a hazardous material as a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and that has been designated as hazardous under Section 5103 of the Federal hazardous materials transportation law (49 U.S.C. 5103). The term includes hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the Hazardous Materials Table (see 49 CFR 172.101), and materials that meet the defining criteria for hazard classes and divisions (49 CFR 173).

Hazardous Wastes

Solid waste materials are defined in 40 CFR 261.2 as any discarded material (i.e., abandoned, recycled, or “inherently waste-like”) that is not specifically excluded from the regulatory definition. This waste can include materials that are solid, liquid, or gaseous (but contained). Hazardous waste is further defined as any solid waste not specifically excluded which contains specified concentrations of chemical constituents or has certain toxicity, ignitability, corrosivity, or reactivity characteristics.

Federal Regulations

Oil Pollution Act. The Oil Pollution Act of 1990 required oil storage facilities and vessels to submit to the Federal government plans detailing how they will respond to large discharges. In 2002, however, the USEPA amended the Oil Pollution Prevention regulation. The Oil Pollution Prevention and Response; Non-Transportation-Related Onshore and Offshore Facilities; Final Rule (40 CFR 112) requires Spill Prevention, Control, and Countermeasure Plans and Facility Response Plans. These plans outline the requirements to plan for and respond to oil and hazardous substance releases. Chapter 10 (2003) of Chief of Naval Operations Instruction (OPNAVINST) 5090.1B also describes the Navy’s requirements for oil and hazardous substance spills.

Clean Water Act. The Clean Water Act (CWA) prohibits discharges of harmful quantities of hazardous substances into or upon U.S. waters out to 200 nm. Environmental compliance policies and procedures applicable to shipboard operations afloat are defined in OPNAVINST 5090.1B (2002), Chapter 19. These instructions reinforce the CWA discharge prohibition. The Navy’s Consolidated Hazardous Materials Reutilization and Inventory Management Program (CHRIMP) Manual also contains information to provide to the chain of command, afloat and ashore, to assist in developing and implementing hazardous materials management. Hazardous materials on Navy vessels afloat are procured, stored, used, and disposed in accordance with CHRIMP and related guidance.

Uniform National Discharge Standards (UNDS). In 1999, USEPA adopted a final rule intended to establish UNDS for 25 discharge sources on U.S. military vessels. The rule exempted 14 additional sources (40 CFR Part 1700). Pursuant to this legislation, State and local governments are prohibited from regulating the 14 discharges exempted from control, but may establish no-discharge zones for them. The UNDS legislation amended the CWA to exclude from the definition of "pollutant" a discharge incidental to the normal operation of a vessel of the Armed Forces.

Environmental and Natural Resource Program Manual

The Environmental and Natural Resource Program Manual, OPNAVINST 5090.1B provides Navy policy, identifies key statutory and regulatory requirements, and assigns responsibility for Navy programs, including pollution prevention, clean up of waste disposal sites, and compliance with current laws and regulations for the protection of the environment and natural resources.

Nuclear Regulatory Commission

The Nuclear Regulatory Commission (PL 93-438, 42 U.S.C. 5801, et seq.) regulates radioactive materials, including depleted uranium; enforcement of this statute is conducted under 10 CFR 19, 20, 21, 30, and 40, Nuclear Regulatory Commission Standards for Protection Against Radiation. These health and safety standards were established as protection against ionizing radiation resulting from activities conducted under the licenses issued by the Nuclear Regulatory Commission. The handling, storage, transport, and disposal of radioactive materials; establishment of radiation protection programs; and record keeping are subject to Nuclear Regulatory Commission requirements.

Pollution Prevention Act

"Pollution prevention," as defined by the Pollution Prevention Act of 1990 (PL 101-508, 42 U.S.C. 13101, *et seq.*) and EO 12856 (Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements, August 3, 1993), is "any practice which reduces the amount of a hazardous substance, pollutant or contaminant entering any waste stream or otherwise released to the environment (including fugitive emissions) prior to recycling, treatment or disposal; and any practice that reduces the hazards to public health and the environment associated with the release of such substances, pollutants or contaminants." The Pollution Prevention Act of 1990 requires the USEPA to develop standards for measuring waste reduction, serve as an information clearinghouse, and provide matching grants to state agencies to promote pollution prevention. Facilities with more than 10 employees that manufacture, import, process, or otherwise use any chemical listed in and meeting threshold requirements of Emergency Planning and Community Right-to-Know Act must file a toxic chemical source reduction and recycling report.

Toxic Substances Control Act

The Toxic Substances Control Act of 1976 (PL 94-469, 15 U.S.C. 2601, *et seq.*) establishes that the USEPA has the authority to require the testing of new and existing chemical substances entering the environment, and, subsequently, has the authority to regulate these substances. The Toxic Substances Control Act also regulates polychlorinated biphenyls.

Emergency Planning and Community Right-to-Know Act

The Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) as part of the SARA Title III establishes the emergency planning efforts at State and local levels and provides the public with potential chemical hazards information. There are two key concepts to understanding EPCRA: (1) EPCRA's intent to inform the public, and (2) a facility has four reporting requirements, defined in part by hazardous substance lists and exemptions, for emergency planning, emergency notification, community right-to-know, and toxic chemical release inventory.

Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act of 1972 regulates the labeling requirement and disposal practices of pesticide usage.

Hazardous Materials Transportation Act

The Hazardous Materials Transportation Act of 1975 gives the U.S. Department of Transportation authority to regulate shipments of hazardous substances by air, highway, or rail. These regulations, found at 49 CFR 171–180, may govern any safety aspect of transporting hazardous materials, including packing, repacking, handling, labeling, marking, placarding, and routing (other than with respect to pipelines).

State Regulations

In 2001, Hawaii was authorized by the USEPA to administer Resource Conservation and Recovery Act under the Hawaii's Hazardous Waste Rules. These rules apply to hazardous waste generators; transporters; owners, and operators of treatment, storage, and disposal facilities; handlers of universal wastes; and handlers of used oil. Hawaii's Hazardous Waste Rules are modeled after the Federal hazardous waste rules. Hawaii's Department of Health is responsible for hazardous waste management. Title 11 of the Hawaii Administrative Rules (HAR) describes the requirements for hazardous waste management.

Hawaii's Hazardous Waste Law (Hawaii Revised Statutes [HRS] 342J) authorizes the Department of Health to regulate hazardous waste. Under the Hawaii Hazardous Waste Management Act (HRS Title 19, Health, Chapter 342J), the State hazardous waste management program provides technical assistance to generators of hazardous waste to ensure safe and proper handling. The hazardous waste management program promotes hazardous waste minimization, reduction, recycling, exchange, and treatment as the preferred methods of managing hazardous waste, with disposal used only as a last resort when all other hazardous waste management methods are ineffective or unavailable. The State program is coordinated with Hawaii's counties, taking into consideration the unique differences and needs of each county.

C.6 Health and Safety

Regulatory requirements related to the Occupational Safety and Health Act of 1970 have been codified in 29 CFR 1910, *General Industry Standards,* and 29 CFR 1926, *Construction Industry Standards.* The regulations contained in these sections specify equipment, performance, and administrative requirements necessary for compliance with Federal occupational safety and health standards, and apply to all occupational (workplace) situations in the United States. Requirements specified in these regulations are monitored and enforced by the Occupational Safety and Health Administration (OSHA), which is a part of the U.S. Department of Labor.

With respect to ongoing work activities, the primary driver is the requirements found in 29 CFR 1910, *Occupational Safety and Health Standards.* These regulations address such items as electrical and mechanical safety and work procedures, sanitation requirements, life safety requirements (fire and evacuation safety, emergency preparedness, etc.), design requirements for certain types of facility equipment (such as ladders and stairs lifting devices), mandated training programs (employee Hazard Communication training, use of powered industrial equipment, etc.), and recordkeeping and program documentation requirements. For any construction or construction-related activities, additional requirements specified in 29 CFR 1926, *Safety and Health Regulations for Construction,* also apply.

OPNAVINST 5100.23G, Navy Safety and Occupational Health Program Manual, contains policy statements and outlines responsibilities for the implementation of the total safety and occupational health program for the Navy. The Navy's policy is to provide a safe and healthful working place for all personnel.

All work activities undertaken or managed by the U.S. Army Corps of Engineers, which can include many types of Federal construction projects, must comply with the requirements of EM 385-1-1, U.S. Army Corps of Engineers Safety and Health Requirements Manual. In many respects the requirements in this manual reflect those in 29 CFR 1910 and 1926, but also include Army Corps of Engineers-specific reporting and documentation requirements.

The Range Commanders Council (RCC) Standard 321, *Common Risk Criteria for National Test Ranges,* sets requirements for minimally-acceptable risk criteria to occupational and non-occupational personnel, test facilities, and non-military assets during range operations. Methodologies for determining risk are also set forth.

RCC 319-92, *Flight Termination System Commonality Standards*, specifies performance requirements for flight termination systems used on various flying weapons systems.

Requirements pertaining to the safe shipping and transport handling of hazardous materials (which can include hazardous chemical materials, radioactive materials, and explosives) are found in the Department of Transportation Hazardous Materials Regulations and Motor Carrier Safety Regulations codified in 49 CFR 107, 171-180 and 390-397). These regulations specify all requirements that must be observed for shipment of hazardous materials over highways (truck shipment) or by air. Requirements include specific packaging requirements, material compatibility issues, requirements for permissible vehicle/shipment types, vehicle marking requirements, driver training and certification requirements, and notification requirements (as applicable).

Marine Terminals, 29 CFR 1917, applies to employment within a marine terminal (as defined in 29 CFR 1917.2) including the loading, unloading, movement or other handling of cargo, ship's stores, or gear within the terminal or into or out of any land carrier, holding or consolidation area, and any other activity within and associated with the overall operation and functions of the terminal, such as the use and routine maintenance of facilities and equipment. Cargo transfers accomplished with the use of shore-based material handling devices are also regulated.

Air Installation Compatible Use Zones and Aircraft Safety

The DoD established the Air Installation Compatible Use Zone (AICUZ) program in 1973 to plan for land use compatibility in areas surrounding military air installations. The purposes of the AICUZ program are to minimize public exposure to safety hazards associated with aircraft operations and to protect the operational capability of an air installation. In addition to noise, the AICUZ program includes analyses of airfield Accident Potential Zones (APZs) and height and obstruction criteria. An AICUZ study has not been prepared specifically for the HRC.

Guidelines for establishing aviation safety zones around helicopter landing zones include clear zones and APZs. Infrequent helicopter operations require designation of a clear zone, but not APZs. The clear zone for VFR aircraft is the same as the takeoff safety zone. The takeoff safety zone constitutes the area under the approach/departure surface until that surface is 50 to 100 ft above the landing zone elevation. This zone is required to be free of obstructions.

Fleet Area Control and Surveillance Facility (FACSFAC) Pearl Harbor is responsible for area containment to preclude conflicts with other air traffic under FAA control. FACSFAC is not responsible for safe separation of aircraft operating under VFR in the Warning Areas. Commanding Officers will ensure that firing exercises and other hazardous operations have been approved and scheduled by the Scheduling Authority. In all live-fire exercises and those involving hazards to other units, final responsibility for ensuring the range is clear rests with the Commanding Officer of the firing unit.

Electromagnetic Radiation

Communications and electronic devices such as radar, electronic jammers, and other radio transmitters produce EMR. Equipment that produces an electromagnetic field has the potential to generate hazardous levels of EMR. An EMR hazard exists when transmitting equipment generates electromagnetic fields that induce currents or voltages great enough to trigger electro-explosive devices in ordnance, cause harmful effects to people or wildlife, or create sparks that can ignite flammable substances in the area. EMR can pose a health hazard to people or pose an explosive hazard to ordnance or fuels. Hazards are reduced or eliminated by establishing minimum distances from EMR emitters for people, ordnance, and fuels.

Explosive Safety Quantity Distance Arcs and Explosives

The types and amounts of explosives materials that may be stored in an area are determined by the quantity-distance requirements established by the DoD Explosives Safety Board. Explosive Safety Quantity-Distance (ESQD) arcs are defined by the Naval Sea Systems Command, and are used to establish the minimum safe distance between munitions storage areas and habitable structures. To ensure safety, personnel movements are restricted in areas surrounding a magazine or group of magazines. ESQD arcs have been developed for the Navy's munitions storage facilities at Naval Magazine Pearl Harbor.

Procedures for notification of underwater detonations are provided by Commander, Naval Surface Force, U.S. Pacific Fleet (COMNAVSURFPAC). Upon receipt of a "Request for Detonation of Underwater Ordnance" Commander, Naval Base Pearl Harbor determines whether the proposed detonation would constitute any danger, and replies to COMNAVSURFPAC by message stating concurrence or objection. Upon receipt of concurrence by appropriate Submarine Operating Authority and Naval Oceanographic Processing Facility, COMNAVSURFPAC grants permission via message to the requesting command to conduct underwater detonations. COMNAVSURFPAC simultaneously requests issuance of a local Notice to Mariners from the appropriate U.S. Coast Guard District (U.S. Department of the Navy, 2003).

High-Velocity Air

High-velocity air is generated by hovercraft operations during amphibious training activities. The high-velocity air that exits the hovercraft creates potential hazards from foreign objects propelled due to the force of the air induction during hovercraft operation. Due to diffusion with existing air, as distance from the hovercraft increases, the velocity of the air decreases. While in operation, the hovercraft requires a 250-ft radius safety zone. Hovercraft such as the Landing Craft, Air Cushioned are most likely to generate high-velocity air near members of the public during Expeditionary Assault Exercises.

To a lesser extent than hovercraft operations, high-velocity air also is created near helicopters when they land or take off, or hover within about 50 ft of the water surface. Depending on the ground conditions, a 50- to 100-ft diameter safety zone is required when helicopters take off or land. Military personnel are trained in the correct procedures for approaching helicopters at landing zones, and these areas are generally restricted to military personnel, so the potential for high-velocity air from helicopters to affect public safety is very low.

Most of the naval training operations that take place in the HRC occur in international waters and airspace. Non-participating aircraft and surface vessels may be present. Notices-to-Airmen and Notice to Mariners are published to inform the public of training activities and exercises in the area that may pose a public safety hazard. In general, if non-participating aircraft or ships are present, hazardous operations are suspended until the range is clear.

C.7 Land Use

Land use is described as the human use of land resources for various purposes, including economic production, natural resources protection, or institutional uses. Land uses are frequently regulated by management plans, policies, ordinances, and regulations that determine the types of uses that are allowable or protect specially designated or environmentally sensitive uses. Potential issues typically stem from encroachment of one land use or activity on another or an incompatibility between adjacent land uses that leads to encroachment.

C.8 Noise

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 or by transient sources. Noise receptors can include humans as well as terrestrial and marine animals. Of specific concern are potential noise effects on humans, marine mammals, birds, and fish. Each receptor has higher or lower sensitivities to sounds of varying characteristics.

Sound levels can be easily measured, but the variability in subjective and physical response to sound complicates the analysis of its impact on people. People judge the relative magnitude of sound sensation in subjective terms such as “loudness” or “noisiness.” Physically, sound pressure magnitude is measured and quantified in terms of a level scale in units of decibels (dB).

The human hearing system is not equally sensitive to sound at all frequencies. Because of this variability, a frequency-dependent adjustment called A-weighting has been devised so that sound may be measured in a manner similar to the way the human hearing system responds. The abbreviation for A-weighted sound level, dBA, is often used for expressing the units of the sound level quantities. Table C-2 lists typical A-weighted noise levels measured for various sources. When sound levels are read and recorded at distinct intervals over a period of time, they indicate the statistical distribution of the overall sound level in a community during the measurement period. The most common parameter derived from such measurements is the energy equivalent sound level (L_{eq}). L_{eq} is a single-number noise descriptor that represents the average sound level in a real environment where the actual noise level varies with time.

Table C-2. Noise Levels of Common Sources

Source	Noise Level (in A-weighted decibels)	Comment
Air raid siren	120	At 50 feet (threshold of pain)
Rock concert	110	
Airplane, 747	102.5	At 1,000 feet
Jackhammer	96	At 10 feet
Power lawn mower	96	At 3 feet
Football game	88	Crowd size: 65,000
Freight train at full speed	88 to 85	At 30 feet
Portable hair dryer	86 to 77	At 1 feet
Vacuum cleaner	85 to 78	At 5 feet
Long range airplane	80 to 70	Inside
Conversation	60	
Typical suburban background	50	
Bird calls	44	
Quiet urban nighttime	42	
Quiet suburban nighttime	36	
Library	34	
Bedroom at night	30	

Source: Cowan, 1994

While the A-weighted scale is often used to quantify the sound level of an individual event, the degree of annoyance perceived by individuals depends on a number of factors. Some of the factors identified by noise researchers that affect our perception and cause us to categorize a sound as an annoyance or “noise” are magnitude of the event sound level in relation to the background (i.e., ambient) sound level, duration of the sound event, frequency of occurrence of events, and time of day at which events occur.

Several methods have been devised to relate noise exposure over time to community response. The USEPA has developed the Day-Night Average Sound Level (L_{dn}) as the rating method to describe long-term annoyance from environmental noise. L_{dn} is similar to a 24-hour L_{eq} A-weighted, but with a 10 dB penalty for nighttime (10:00 p.m. to 7:00 a.m.) sound levels to account for the increased annoyance that is generally felt during normal sleep hours. The Air Force also uses L_{dn} for evaluating community noise impact.

The Community Noise Equivalent Level (CNEL) has been adopted by the State of California for environmental noise monitoring purposes. CNEL is also similar to the A-weighted L_{eq}, but includes a penalty of 5 dB during evening hours (7:00 p.m. to 10:00 p.m.), while nighttime hours

(10:00 p.m. to 7:00 a.m.) are penalized by 10 dB. For outdoor noise, the L_{dn} noise descriptor is usually 0.5 to 1 dB less than CNEL in a given environment.

CNEL and L_{dn} values can be useful in comparing noise environments and indicating the potential degree of adverse noise impact. However, averaging the noise event levels over a 24-hour period tends to obscure the periodically high noise levels of individual events and their possible adverse effects. In recognition of this limitation of the CNEL and L_{dn} metrics, the USEPA uses single-event noise impact analyses for sources with a high noise level and short duration.

The maximum sound level (L_{max}) is a noise descriptor that can be used for high-noise sources of short duration, such as space vehicle launches. The L_{max} is the greatest sound level that occurs during a noise event. The term “peak” defines peak sound over an instantaneous time frame for a particular frequency.

Federal and State governments have established noise regulations and guidelines for the purpose of protecting citizens from potential hearing damage and various other adverse physiological, psychological, and social effects associated with noise. The Federal government preempts the State on control of noise emissions from aircraft, helicopters, railroads, and interstate highways.

The Noise Control Act (PL 92-574, 42 U.S.C. 4901, *et seq.*) directs all Federal agencies, to the fullest extent within their authority, to carry out programs within their control in a manner that promotes an environment free from noise that jeopardizes the health or welfare of any American. The act requires a Federal department or agency engaged in any activity resulting in the emission of noise to comply with Federal, State, interstate, and local requirements respecting control and abatement of environmental noise. OSHA has established noise limits for workers. For an 8-hour workday, people should not be exposed to a continuous noise level greater than 90 dBA. In addition, personnel should not be exposed to noise levels higher than 115 dBA for periods longer than 15 minutes. For the general public, the USEPA recommends a 24-hour average noise level not to exceed 70 dBA. Table C-3 shows permissible noise exposures. The DoD Noise–Land Use Compatibility Guidelines state that sensitive land use, such as residential areas, are incompatible with annual L_{dn} greater than 65 dBA. Table C-4 shows land use zones for noise and accompanying day-night noise levels.

Table C-3. Permissible Noise Exposures*

Duration (hours per day)	Sound level (dBA) Slow Response
8	90
6	92
4	95
3	97
2	100
1 to 1.5	102
1	105
0.5	110
0.25 or less	115

Source: 29 CFR 1910.95, Table G-16
*Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level

Table C-4. Definition of Land Use Zones for Noise

Noise Zone	Compatibility with Noise Sensitive Land Uses	Percent of Population Highly Annoyed	C-Weighted Annual Average Day-Night Sound Level (Ldn)
I	Acceptable	Less than 15%	Less than 62 dB
II	Normally Unacceptable	15-39%	62–70 dB
III	Unacceptable	More than 39%	More than 70 dB

Source: U.S. Department of the Army, Regulation 200-1

C.9 Socioeconomics

Socioeconomics describes the social and economic character of a community through the review of several metrics including population size, employment characteristics, income generated, and the type and cost of housing. This section presents a socioeconomic overview of the region.

C.10 Transportation

Ground Transportation

Traffic circulation refers to the movement of ground transportation vehicles from origins to destinations through a road and rail network. Roadway operating conditions and the adequacy of the existing and future roadway systems to accommodate these vehicular movements usually are described in terms of the volume-to-capacity ratio, which is a comparison of the average daily traffic volume on the roadway to the roadway capacity. The volume-to-capacity ratio corresponds to a Level of Service (LOS) rating, ranging from free-flowing traffic conditions (LOS A) for a volume-to-capacity of usually less than 30 percent of the roadway capacity to forced-flow, congested conditions (LOS F) for a volume-to-capacity of 100 percent of the roadway capacity (Department of Defense, 2004).

Waterways

Water traffic is the transportation of commercial, private, or military vessels at sea, including submarines. Sea 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 also are implemented to ensure that harbors and ports-of-entry do not become congested. There is less control on ocean traffic involving recreational boating, sport fishing, commercial fishing, and activity by naval vessels. However, Navy vessels follow military procedures and orders (e.g., Fleet Forces Command) as well as federal, State, and local marine regulations. In most cases, the factors that govern shipping or boating traffic include adequate depth of water, weather conditions (primarily affecting recreational vessels), the availability of fish of recreational or commercial value, and water temperature (higher water temperatures will increase recreational boat traffic and diving activities) (Department of Defense, 2004).

Airways

Air transportation is the movement of aircraft through airspace. The control of airspace used by air traffic varies from very highly controlled to uncontrolled areas. Examples of highly controlled air traffic situations are: flight in the vicinity of airports, where aircraft are in critical phases of flight (take-off and landing); flight under IFR; and flight on the high or low altitude route structure (airways). Less-controlled situations include flight VFR or flight outside of U.S. controlled airspace (e.g., flight over international waters off the coast of Hawaii) (Department of Defense, 2004).

C.11 Water Resources

Regulatory Context

Federal

The objective of the Clean Water Act (CWA) and its amendments is to "restore and maintain the chemical, physical and biological integrity of the nation's waters." The overall goal of the CWA is to produce waters of the United States that are "fishable and swimmable." Under the CWA, the Federal government delegated responsibility for establishing water quality criteria to each State, subject to approval by the USEPA.

A primary means of evaluating and protecting water quality is establishing and enforcing water quality standards. Water quality standards consist of:

- Designated beneficial uses of water (for example, drinking, recreation, aquatic life);
- Numeric criteria for physical and chemical characteristics for each type of designated use;
- An "antidegradation" provision to protect uses and water quality.

In accordance with the CWA, States define the uses of waters within their borders, and each water body must be managed in accordance with its designated uses. Water quality standards are established for each designated use. Standards must be at least as stringent as those established by the USEPA. Most States have adopted the USEPA standards.

Under Section 313 of the CWA, Federal agencies must comply with all Federal, State, interstate, and local requirements to control and abate water pollution. Compliance includes managing any activity that may result in the discharge or runoff of pollutants. The CWA does not apply, however, to Navy operations more than 3 nm from the shoreline of the United States.

Water bodies that do not meet designated minimum quality standards are listed as "impaired" waters. For impaired water bodies, States are expected to develop Total Maximum Daily Loads (TMDLs), which are the amounts of pollutants that can be delivered to a body of water without exceeding the water quality standards. Based on the TMDLs that are developed, the State can limit discharges of pollutants to achieve the minimum water quality standards. Hawaii has identified 70 streams and 174 coastal stations as impaired waters.

State

HRS Chapter 342D authorizes Hawaii's Department of Health to regulate water quality in Hawaii. Hawaii's water quality regulations are found in HAR Title 11, Chapters 54, 55 (Water Pollution Control), 62 (Wastewater Systems), and 64 (Water Quality Standards). The Department of Health Clean Water Branch protects coastal and inland water resources, its Safe Drinking Water Branch safeguards Hawaii's potable surface and ground waters, and its Wastewater Branch regulates water pollution control and wastewater treatment plants. The

Clean Water Branch administers the Federal National Pollutant Discharge Elimination System program and issues State water quality certifications under Section 404 of the CWA.

The Non-Point Source Pollution Management and Control law (HRS 342E) authorizes the Department of Health to regulate the runoff of polluted water into lakes, streams, and coastal waters. This program was established pursuant to portions of the Federal Water Pollution Control Act and Coastal Zone Act Reauthorization Amendments.

Water quality is evaluated relative to criteria established under State Water Quality Standards (HAR 11-54). A water body may be polluted by a point source (e.g., sewage or industrial plant outfall) or by non-point-source pollution, which is caused by precipitation moving over and through the ground, picking up and carrying pollutants and depositing them in water bodies. Examples of non-point-source pollution are runoff from agricultural fields and urban streets.

Water quality is an increasing concern in Hawaii. Hawaii's Department of Health is promulgating contaminant TMDLs for impaired surface waters, pursuant to Section 303(d) of the CWA that will further restrict the allowable amounts of pollutants in surface runoff.

Training activities that disturb vegetation or soils can increase sediment concentrations. Training may also result in releases of petroleum products and other pollutants to surface waters. On live-fire ranges, explosive and propellant residues, residues from munitions remnants (e.g., heavy metals), and residues from targets could be a particular concern. At some point, further increases in training operations may conflict with achieving and maintaining Federally mandated TMDLs.

The State's 1991 *Hawaii Ocean Resources Management Plan* (*ORMP*) identified strategies for conserving and enhancing ocean resources, and for coordinating the resource management efforts of State agencies. The ORMP was updated in 2006. The September 2006 Draft ORMP focuses on (a) reducing pollutant discharges into the ocean, (b) resolving conflicts between expanded urban development, increased tourism, and resource conservation, (c) addressing a trend toward decreased agricultural runoff and increased urban runoff, and (d) managing increased vessel traffic.

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Appendix D
Current Training Operations Within the Hawaii Range Complex

APPENDIX D
CURRENT TRAINING OPERATIONS WITHIN THE HAWAII RANGE COMPLEX

Table D-1 lists descriptions of areas in the Hawaii Range Complex.

Table D-1. Hawaii Range Complex Area Descriptions of Operation

Operation Area	Description
OPEN OCEAN & OFFSHORE	
Northern Warning Areas	
W-188 Rainbow, W-189, W-190	The Northern Warning Areas lie north of Oahu. These areas are available from the surface to an unlimited altitude and are used for surface and air operations.
Southern Warning Areas	
W-192, W-193, W-194	The Southern Warning Areas are located south of Oahu. Available from the surface to an unlimited altitude, they are used for air and surface operations.
W-191	W-191, located directly south of Oahu, is available from the surface to 3,000 feet (ft) for air and surface operations.
W-196	W-196 is used only for surface and helicopter operations. The airspace extends from the surface to 2,000 ft, and is not available to fixed-wing aircraft.
Kapu/Quickdraw, Wela Hot Areas	Kapu/Quickdraw and Wela Hot Areas are located completely within W-192. These Areas are used for surface-to-air and air-to-air gunnery, air-to-surface bombing and gunnery, and jettisoning of ordnance.
Air Traffic Control Assigned Airspace (ATCAA)	
Nene	Nene is the only ATCAA associated with the Northern Warning Areas. It is typically activated for use during Hawaii Air National Guard intercept training.
Pali	Pali is a roughly 40 nm circular area over Oahu, from 25,000 ft to an unlimited altitude, although it is normally not available below 28,000 ft. Pali is used by high-altitude aircraft transiting between the Northern and Southern Warning Areas.
Taro	Taro overlies W-191, sharing the same borders and, when available, extending its airspace from 3,000 ft to 16,000 ft. This airspace allows aircraft to remain in controlled airspace while testing above W-191's 3000-ft ceiling.
Quint	Quint is located 45 nm southwest of Honolulu, with available airspace from flight level (FL) 250 to an unlimited altitude, although it is usually not available below FL 280.
Mela North, Mela Central, Mela South	The Mela ATCAAs connect the western border of W-192 with the southern border of W-186 (Pacific Missile Range Facility [PMRF]). They are available from the floor of controlled airspace (1,200 ft) to an unlimited altitude, except for Mela North which has a ceiling of 15,000 ft.
Mako, Lono West, Lono Central, Lono East	The Mako and Lono ATCAAs are available to extend the Special Use Airspace of Mela South, W-192, W-193, and W-194 by an additional 104 nm. All are available from the floor of controlled airspace to an unlimited altitude, and are activated to provide more southern area airspace.
Pele	Pele provides a transit corridor from W-194 and Lono East into R-3103 airspace over Pohakuloa Training Area on Hawaii. When activated, Pele extends from 16,000 ft to FL 290.

Table D-1. Hawaii Range Complex Area Descriptions of Operation (Continued)

Operation Area	Description
Kaula Rock	
Kaula Rock, R-3107, W-187	Kaula Rock is a 0.5-nm by 0.7-nm island surrounded by a 3-nm radius restricted area (R-3107), and a 5-nm radius warning area (W-187). Both R-3107 and W-187 extend from surface to 18,000 ft. Kaula Rock is used exclusively for air-to-ground bombing and gunnery training.
Pacific Missile Range Facility	
W-186, W-188	W-186 extends from surface to 9,000 ft, and W-188 extends from surface to unlimited. These two warning areas support operations at PMRF.
R-3101, Majors Bay	R-3101 extends from surface to unlimited and provides necessary airspace to support training and research, development, test and evaluation operations at PMRF. Majors Bay lies beneath R-3101 and includes beach area on PMRF property.
Barking Sands Tactical Underwater Range (BARSTUR)	BARSTUR is an instrumented underwater range that provides approximately 120 nm^2 of underwater tracking of participants and targets
Barking Sands Underwater Range Expansion (BSURE)	BSURE extends BARSTUR to the north, providing an additional 900 nm^2 of underwater tracking capability.
Other Restricted Areas	
Ewa Training Minefield	The Ewa Training Minefield is an ocean area extending from Ewa Beach approximately 2 nm toward Barbers Point, and out to sea approximately 4 nm. This restricted area has been used in the past for surface ship mine avoidance training.
Submarine Operating Area	The Submarine Operating Area encompasses the entire ocean area of the Hawaii Range Complex. This area is bounded by 17N, 25N, 154W, and 162 W.
Naval Undersea Warfare Center, Detachment Pacific Ranges	
Fleet Technical Evaluation Center (FTEC)	The FTEC range operations building is located on the southern shore of Oahu, west of the former Barbers Point Naval Air Station. The FTEC supports SESEF operations, and will support FORACS operations in the future.
Shipboard Electronic Systems Evaluation Facility (SESEF)	The SESEF range is located south and west of FTEC. Ships operate and maneuver in this area as necessary to remain within electronic signal reception range of FTEC.
Fleet Operational Readiness Accuracy Check Site (FORACS)	The FORACS range includes an approximately 5-nm by 5-nm ocean area just offshore of the southwestern coast of Oahu, northwest of the SESEF range.
Explosive Ordnance Disposal (EOD) Ranges	
West Loch EOD Shore Area	The EOD shore area consists of a 2.75 acre facility at Naval Magazine Pearl Harbor West Loch.
Lima Landing Underwater Area	Lima Landing is a small underwater area just off an abandoned concrete pier at the approach to Pearl Harbor near the entrance of West Loch.
Puuloa Underwater Range	The Puuloa Underwater Range is a 1 nm^2 area in the open ocean outside and to the west of the entrance to Pearl Harbor.

Table D-1. Hawaii Range Complex Area Descriptions of Operation (Continued)

Operation Area	Description
ONSHORE	
Oahu	Activities occur at Naval Inactive Ship Maintenance Facility, Pearl Harbor, Marine Corps Training Area/Bellows, Pearl Harbor, Ford Island, Marine Corps Base Hawaii, Hickam Air Force Base, Wheeler Army Airfield, Schofield Barracks (R-3109), Coast Guard Station Barbers Point/Kalaeloa Airport, Makua Military Reservation (R-3110), Kahuku Training Area (A-311), Kaena Point, Mt. Kaala, Wheeler Network Communications Control, and Dillingham Military Reservation.
Kauai	Activities occur at the following PMRF locations: Main Base, Makaha Ridge, Kokee, Kamokala Magazine, Hawaii Air National Guard, Kauai Test Facility, Port Allen, Kikiaola Boat Harbor, and Mt. Kahili.
Hawaii	Activities occur at Pohakuloa Training Area (R-3103) and adjacent leased property, Bradshaw Army Airfield, and Kawaihae Pier.
Maui	Activities occur at Maui Space Surveillance System, Maui High Performance Computing Center, and Sandia Maui Haleakala Facility.
Niihau	Activities occur at Perch site, and other authorized areas.

Anti-Air Warfare Operations

Air Combat Maneuver

Air Combat Maneuver (ACM) includes basic flight maneuvers where aircraft engage in offensive and defensive maneuvering against each other. These maneuvers typically involve supersonic flight and use of chaff and flares. No Air-to-Air ordnance is released during this exercise. ACM operations within the range complex are primarily conducted within W-188, W-189, W-190, W-192, W-193, and W-194 under Fleet Area Control and Surveillance Facility (FACSFAC) Pearl Harbor's control. These operations typically involve from two to eight aircraft. However, based upon the training requirement, ACM exercises may involve over a dozen aircraft. Sorties can be as short as 30 minutes or as long as 2 hours, but the typical ACM mission has an average duration of 1.5 hours.

	Baseline Operations				
	NTA	Area	Metric	Duration (Hours)	Total Operations
ACM	3.2.3	W-188, 189, 190, 192, 193, 194	Ops	1.5	738

Air-to-Air Missile Exercise

In an Air-to-Air Missile Exercise (A-A MISSILEX), missiles are fired from aircraft against unmanned aerial target drones such as BXM-34s and BQM-74s. Additionally, weapons may be fired against flares or Tactical Air Launched Decoys (TALDs) dropped by supporting aircraft. Typically, about half of the missiles fired have live warheads and half have telemetry packages. The fired missiles and targets are not recovered, with the exception of the BQM drones, which have parachutes and will float to the surface where they are recovered by boat.

A-A MISSILEX exercises include 1 to 6 jet target drones, 2 to 20 aircraft, 2 to 20 missiles, and a weapons recovery boat for target recovery, and are conducted within PMRF Warning Area W-188. Jet target drones are launched from an existing ground-based target launch site at PMRF Launch Complex, from a Mobile Aerial Target Support System (MATSS) located in the open ocean within the PMRF Warning Areas, or from an aircraft controlled by PMRF. The targets are engaged by aircraft equipped with air-to-air missiles. The targets are tracked by the aircraft and then the air-to-air missiles are launched at the targets. Recoverable target drones and all recoverable elements are refurbished and reused.

Baseline Operations					
A-A MISSILEX	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.3	W-188	Ops	2-6	12

Surface-to-Air Gunnery Exercise

A Surface-to-Air GUNEX requires an aircraft or missile that will fly high or low altitude threat profiles. Commercial aircraft also tows a target drone unit (TDU) that ships track, target, and engage with their surface-to-air weapon systems. The exercise involves 1 to 10 surface vessels, towed aerial targets, and/or jet aerial targets. Ship-deployed and air-deployed weapons systems are used, ranging from 20-mm to 5-inch caliber guns. GUNEX activities are conducted within PMRF Warning Areas W-186 and W-188, Oahu Warning Areas W-187 (Kaula), W-194, and Restricted Airspace R-3107 (Kaula).

Baseline Operations					
S-A GUNEX	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.7	W-188, 192, Mela South	Ops	3.1	86

Surface-to-Air Missile Exercise

A Surface-to-Air MISSILEX involves surface combatants firing live missiles (RIM-7 Sea Sparrows, SM-1 or SM-2 Standard Missiles) at target drones. The surface ship must detect, track, and engage the target using its onboard weapon systems. The purpose of the exercise is to provide realistic training and evaluation of surface ships and their crews in defending against enemy aircraft and missiles.

Target drones representing enemy aircraft or missiles are flown or towed into the vicinity of the surface ship. The crew must identify the incoming object and respond with surface-to-air missiles as appropriate. There are two types of missiles. One type of missile is equipped with an instrumentation package, while the other type is equipped with a warhead. Recoverable target drones are refurbished and reused.

The exercise consists of one or more surface ships, one or more target drones, and a helicopter and weapons recovery boat for target recovery. The surface-to-air missiles are launched from ships located within PMRF Warning Area W-188. Targets are launched from an existing ground-based target launch site at PMRF Launch Complex; from a MATSS located in the open ocean within the PMRF Warning Areas; or released from an aircraft.

Baseline Operations					
S-A MISSILEX	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.7	W-188	Ops	5.1	17

Chaff Exercise (CHAFFEX)

A CHAFFEX trains aircraft and shipboard personnel in the use of chaff to counter antiship missile threats. During a CHAFFEX, the ship combines maneuvering with deployment of multiple rounds of MK-36 super rapid bloom offboard chaff (SRBOC) to confuse incoming missile threats, simulated by aircraft. In an integrated CHAFFEX scenario, helicopters deploy air-launched, rapid-bloom offboard chaff (AIRBOC) in pre-established patterns designed to enhance antiship missile defense. Chaff exercises average 3.8 hours in duration.

Baseline Operations					
CHAFFEX	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.9	Hawaii Offshore	Ops	3.8	34

<u>Amphibious Warfare</u>

Naval Surface Fire Support Exercise

Navy surface combatants conduct fire support exercise (FIREX) operations at PMRF on a virtual range against “Fake Island”, located on Barking Sands Tactical Underwater Range (BARSTUR). Fake Island is unique in that it is a virtual landmass simulated in three dimensions. Ships conducting FIREX training against targets on the island are given the coordinates and elevation of targets. PMRF is capable of tracking fired rounds to an accuracy of 30 feet.

Baseline Operations					
NSFS	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.8	W-188	Ops	8.1	22

Expeditionary Assault

An expeditionary assault exercise provides a realistic environment for amphibious training, reconnaissance training, hydrographic surveying, surf condition observance, and communication. Expeditionary assault (formerly known as amphibious exercise) consists of a seaborne force assaulting a beach with a combination of helicopters, vertical takeoff and landing

(VTOL) aircraft, landing craft air cushion (LCAC), amphibious assault vehicles (AAVs), expeditionary fighting vehicle (EFV) and landing craft. More robust expeditionary assault operations include support by naval surface fire support (NSFS), close air support (CAS), and Marine artillery.

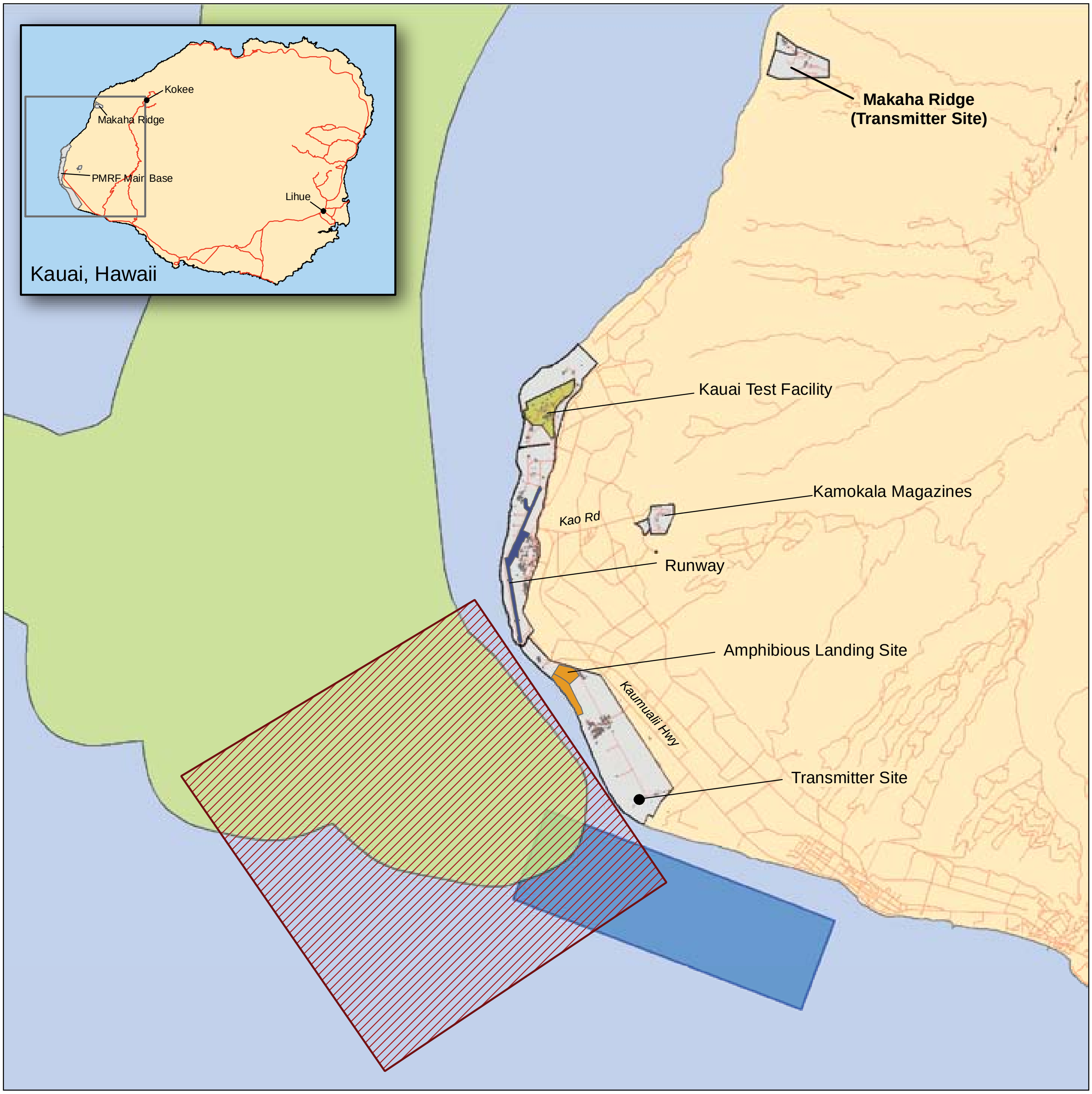
Types of amphibious landing craft and vehicles include:

- LCAC, an air-cushioned vessel equipped with an open-bay craft with roll-on, roll-off ramps capable of carrying tank-sized vehicles or up to 185 troops. Approximately 88 feet by 47 feet
- Landing Craft, Utility (LCU), a displacement hull craft designed to land very heavy vehicles, equipment, and cargo or up to 400 troops on the beach. Approximately 135 feet by 29 feet
- AAV, a tracked, armored personnel carrier with a capacity of 21 troops. Approximately 24 feet by 13 feet
- CRRC, a lightweight, inflatable boat carrying up to 8 people used for raid and reconnaissance missions. Approximately 16 feet by 6 feet
- Rigid Hull, Inflatable Boat (RHIB), similar to the CRRC, but larger, carrying up to 15 people. Approximately 24 feet by 9 feet

An Expeditionary Strike Group (ESG) is normally a mix of three to five amphibious ships equipped with aircraft landing platforms for helicopter and fixed wing operations and well decks for carrying landing craft and AAVs. The ESG typically launches its aircraft, and landing craft up to 25 miles from a training beachhead. AAVs are typically launched approximately 2,000 yards from the beach. The aircraft provide support while the landing craft approach and move onto the beach. The troops disperse from the landing craft and use existing vegetation for cover and concealment while attacking enemy positions. The landing craft and troops proceed to a designated area where they stay 1 to 4 days. When the expeditionary assault exercise is complete, the backload operation takes place. The backload is normally accomplished over a 2- to 3-day period.

Amphibious landings are restricted to specific areas of designated beaches. Before each major amphibious landing exercise is conducted, a hydrographic survey is performed to map out the precise transit routes through sandy bottom areas. During the landing, the crews follow established procedures, such as having a designated lookout watching for other vessels, obstructions to navigation, marine mammals (whales or monk seals), or sea turtles. The primary location for the amphibious landings is Majors Bay, PMRF, Kauai (Figure D-1). Amphibious landings could also occur at the K-Pier boat ramp, Kawaihae, Hawaii, Marine Corps Base Hawaii (three beaches), and Marine Corps Training Area–Bellows (MCTAB), Oahu (Figure D-2).

Baseline Operations					
Expeditionary Assault	NTA	Area	Metric	Duration (Hours)	Total Operations
	1.5.4	PMRF, MCTAB	Ops	48	11



EXPLANATION

- Roads
- Existing Kingfisher Area
- Kauai Test Facility
- PMRF Shallow Water Training Range (SWTR)
- Amphibex / Demolition Area
- RIMPAC Amphibious Landing Site
- Airfield
- Existing Structures
- PMRF Installation Areas
- Land

NORTH

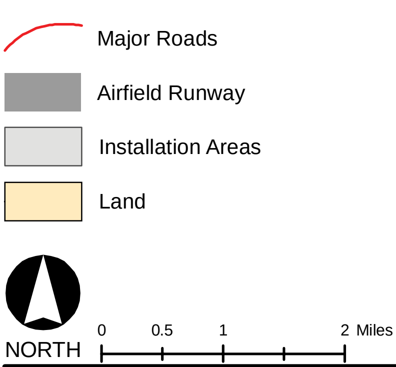
0 1 2 4 Miles

Location of Pacific Missile Range Facility and Related Sites

Kauai, Hawaii

Figure D-1

EXPLANATION



Marine Corps Base - Hawaii and Marine Corps Training Area Bellows

Oahu, Hawaii

Figure D-2

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Anti-Surface Warfare

Visit, Board, Search, and Seizure

Visit, Board, Search, and Seizure (VBSS) is conducted to train helicopter crews to insert personnel onto a vessel for the purpose of inspecting the ship's personnel and cargo for compliance with applicable laws and sanctions. VBSS training requires a cooperative surface ship. Typical duration of a VBSS operation is approximately 1.5 hours.

Baseline Operations					
	NTA	Area	Metric	Duration (Hours)	Total Operations
VBSS	1.4.6	Hawaii Offshore	Ops	1.5	60

Surface-to-Surface Gunnery Exercise

Surface gunnery exercises (GUNEX) take place in the open ocean to provide gunnery practice for Navy and Coast Guard ship crews. GUNEX training operations conducted in the Offshore Operating Area (OPAREA) involve stationary targets such as a MK-42 Floating At Sea Target (FAST) or a MK-58 marker (smoke) buoy. A GUNEX lasts approximately 1 to 2 hours, depending on target services and weather conditions.

The gun systems employed against surface targets include the 5-inch, 76-millimeter (mm), 25-mm chain gun, 20-mm Close In Weapon System (CIWS), and .50-caliber machine gun. Typical ordnance expenditure for a single GUNEX is a minimum of 21 rounds of 5-inch or 76-mm ammunition, and approximately 150 rounds of 25-mm or .50-caliber ammunition. Both live and inert training rounds are used. After impacting the water, the rounds and fragments sink to the bottom of the ocean.

There are three new rounds of 5-inch gun ordnance nearing introduction to the Fleet. The High Explosive Electronically Timed Projectile (HE-ET) is a standard High Explosive (HE) round with an improved electronically timed (ET) fuse. The Kinetic Energy Projectile (KE-ET), commonly called the "BB" round, contains 9,000 tungsten pellets and is designed to be fired down a bearing at incoming boats. The EX-171 Extended Range Guided Munition (ERGM) projectile is a major component of the Navy's littoral warfare concept. The 5-inch, rocket-assisted projectile is capable of carrying a 4-caliber submunition, and will be fired from the new 5-inch, 62-caliber gun being installed on Arleigh Burke (DDG-51) class destroyers.

Baseline Operations					
	NTA	Area	Metric	Duration (Hours)	Total Operations
S-S GUNEX	3.2.1.1	W-191, 192, 193, 194, 196, Mela South, PMRF	Ops	3.5	69

Surface-to-Surface Missile Exercise

A surface-to-surface missile exercise (MISSILEX [S-S]) involves the attack of surface targets at sea by use of cruise missiles or other missile systems, usually by a single ship conducting training in the detection, classification, tracking and engagement of a surface target. Engagement is usually with surface-to-surface Harpoon missiles or Standard missiles. Targets include virtual targets or the seaborne powered target (SEPTAR) or ship deployed surface target.

A MISSILEX (S-S) includes 4 to 20 surface-to-surface missiles, SEPTARs, a weapons recovery boat, and a helicopter for environmental and photo evaluation. All missiles are equipped with instrumentation packages or a warhead. Surface-to-air missiles can also be used in a surface-to-surface mode.

MISSILEX (S-S) activities are conducted within PMRF Warning Area W-188. Each exercise typically lasts 5 hours. Future (MISSILEX [S-S]) could range from 4 to 35 hours.

Baseline Operations					
S-S MISSILEX	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.1.1	PMRF (W-188)	Ops	5.0	7

Air-to-Surface Gunnery Exercise

Air-to-Surface GUNEX operations are conducted by rotary-wing aircraft against stationary targets (FAST and smoke buoy). Rotary-wing aircraft involved in this operation include a single SH-60 using either 7.62-mm or .50-caliber door-mounted machine guns. A typical GUNEX lasts approximately 1 hour and involves the expenditure of approximately 400 rounds of .50-caliber or 7.62-mm ammunition.

Baseline Operations					
A-S GUNEX	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.1.1	Hawaii Offshore, PMRF	Ops	1.1	128

Air-to-Surface Missile Exercise

The air-to-surface missile exercise (MISSILEX [A-S]) consists of releasing a forward-fired, guided weapon at the designated towed target. The exercise involves locating the target, usually with a laser.

MISSILEX (A-S) training that does not involve the release of a live weapon can take place if a captive air training missile (CATM), simulating the weapon involved in the training, is carried. The CATM MISSILEX is identical to a live-fire exercise in every aspect except that a weapon is not released. The operation requires a laser-safe range as the target is located just as in a live-fire exercise.

From one to 16 fixed wing aircraft and/or helicopters, carrying air training missiles or flying without ordnance (dry runs), are used during the exercise. Missiles include air-to-surface missiles and anti-radiation missiles (electromagnetic radiation source seeking missiles). When a high-speed anti-radiation missile (HARM) is used, the exercise is called a HARMEX. At sea, SEPTARs, Improved Surface Towed Targets (ISTTs), and excess ship hulks are used as targets.

Baseline Operations					
A-S MISSILEX	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.1.1	PMRF	Ops	5.5	36

Bombing Exercise (BOMBEX [Sea])

Fixed-wing aircraft conduct BOMBEX (Sea) operations against stationary targets (MK-42 FAST or MK-58 smoke buoy) at sea. An aircraft clears the area, deploys a smoke buoy or other floating target, and then sets up a racetrack pattern, dropping on the target with each pass. At PMRF, a range boat might be used to deploy the target for an aircraft to attack.

Baseline Operations					
BOMBEX (Sea)	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.1.1	Hawaii Offshore, PMRF	Ops	6.0	35

Sink Exercise

A Sink Exercise (SINKEX) provides training to ship and aircraft crews in delivering live ordnance on a real target. Each 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 ship hull that is towed to a designated location where multiple types of weapons fire shots at the hulk. SINKEX vessels can number from one to as many as six during a major range exercise. The duration of a SINKEX is unpredictable since it ends when the target sinks, sometimes immediately after the first weapon impact and sometimes only after multiple impacts by a variety of weapons.

Weapons can include missiles, precision and non-precision bombs, gunfire, and torpedoes. Examples of missiles that could be fired at the targets include AGM-142 from a B-52 bomber, Walleye AGM-62 from FA-18 aircraft, and a Harpoon from a P-3C aircraft. Surface ships and submarines may use either torpedoes or Harpoons, surface-to-air missiles in the surface-to-surface mode, and guns. Other weapons and ordnance could include, but are not limited to, bombs, Mavericks, and Hellfire.

If none of the shots result in the hulk sinking, either a submarine shot or placed explosive charges are used to sink the ship. Charges ranging from 100 to 200 pounds, depending on the size of the ship, are placed on or in the hulk.

The vessels used as targets are selected from a list of U.S. Environmental Protection Agency (EPA) approved destroyers, tenders, cutters, frigates, cruisers, tugs, and transports (Department of the Navy and U.S. Environmental Protection Agency, 1996). The EPA granted the Department of the Navy a general permit through the Marine Protection, Research, and Sanctuaries Act to transport vessels "for the purpose of sinking such vessels in ocean waters…" (40 CFR Part 229.2) Subparagraph (a)(3) of this regulation states "All such vessel sinkings shall be conducted in water at least 1,000 fathoms (6,000 feet) deep and at least 50 nautical miles from land." In Hawaii, SINKEX events take place within PMRF Warning Area W-188.

	Baseline Operations				
SINKEX	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.1.1	Hawaii Offshore, PMRF	Ops	14.5	6

Antisurface Warfare Torpedo Exercise (Submarine-Surface)

Submarines conduct most of their torpedo firings at PMRF, and many of those are against surface targets. Surface targets will typically be PMRF range boats or targets, or U.S. Navy combatants. The Antisurface Warfare (ASUW) Torpedo Exercise (TORPEX) culminates with the submarine firing a MK-48 torpedo against the surface target.

Twice a year, "Hollywood" operations are conducted on PMRF as part of the Submarine Commander's Course, which trains prospective submarine Commanding Officers (COs) and Executive Officers (XOs). These are integrated operations involving complex scenarios that will include a coordinated surface, air, and submarine force challenging the submarine CO and crew. During these events, submarines will be engaged in ASUW torpedo firings, as well as Antisubmarine Warfare (ASW) tracking exercises (TRACKEX) and ASW TORPEX operations.

	Baseline Operations				
ASUW TORPEX (Submarine-Surface)	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.1.1	Hawaii Offshore, PMRF	Ops	12.3	35

Flare Exercise

A flare exercise is an aircraft defensive operation in which the aircrew uses an infrared (IR) or radar energy source to disrupt attempts to lock onto the aircraft. During IR break-lock (flare) training, a shoulder-mounted IR surface-to-air missile simulator is trained on the aircraft by an operator attempting to lock onto the aircraft's IR signature. The aircraft maneuvers while expending flares. The scenario is captured on videotape for replay and debrief. No actual missiles are fired during this training operation. Radar break-lock training is similar except that the energy source is an electronic warfare (EW) simulator, and the aircraft expels chaff during its defensive maneuvering. Chaff is a radar confusion reflector, consisting of thin, narrow metallic strips of various lengths and frequency responses, used to deceive radars.

Baseline Operations					
Flare Exercise	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.9	W-188	Ops	5.7	6

Antisubmarine Warfare

Antisubmarine Warfare Tracking Exercise (ASW TRACKEX)

ASW TRACKEX trains aircraft, ship, and submarine crews in tactics, techniques, and procedures for search, detection, and tracking of submarines. No torpedoes are fired during a TRACKEX. ASW TRACKEX includes ships, fixed wing aircraft, helicopters, torpedo targets, 1 to 10 submarines, and weapons recovery boats and/or helicopters. As a unit-level exercise, an aircraft, ship, or submarine is typically used versus one target submarine or simulated target.

The target may be non-evading while operating on a specified track or it may be fully evasive, depending on the state of training of the ASW unit. Duration of a TRACKEX is highly dependent on the tracking platform and its available on-station time. A maritime patrol aircraft can remain on station for 8 hours, and typically conducts tracking exercises that last 3 to 6 hours. An ASW helicopter has a much shorter on-station time, and conducts a typical TRACKEX in 1 to 2 hours. Surface ships and submarines, which measure their on-station time in days, conduct tracking exercises exceeding 8 hours and averaging up to 18 hours.

ASW TRACKEX operations are conducted on ranges within PMRF Warning Area W-188, the Hawaii Offshore Areas and/or the open ocean. Whenever aircraft use the ranges for ASW training, range clearance procedures include a detailed visual range search for marine mammals and unauthorized boats and planes by the aircraft releasing the inert torpedoes, range safety boats/aircraft, and range controllers.

Sensors used during exercises include sonars, non-acoustic sensors (sonobuoys), and airborne early warning radars. The use of sonobuoys is generally limited to areas greater than 100 fathoms, or 600 feet, in depth. Before dropping sonobuoys, the crew visually determines that the area is clear. When the sonobuoy is released, a small parachute (about 4 feet in diameter) retards its entry into the ocean. The sonobuoy is designed to float on the surface and, after a controlled period of time (no longer than 8 hours), the complete package (with the parachute) sinks to the bottom.

Baseline Operations					
ASW TRACKEX	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.1.2	Hawaii Offshore, PMRF	Ops	10.9	372

Antisubmarine Warfare Torpedo Exercises

Antisubmarine Warfare Torpedo Exercises (ASW TORPEX) operations train crews in tracking and attack of submerged targets, firing one or two Exercise Torpedoes (EXTORPs) or Recoverable Exercise Torpedoes (REXTORPs). TORPEX targets used in the Offshore Areas include live submarines, MK-30 ASW training targets, and MK-39 Expendable Mobile ASW Training Targets (EMATT). The target may be non-evading while operating on a specified track, or it may be fully evasive, depending on the training requirements of the operation.

Submarines periodically conduct torpedo firing training exercises within the Hawaii Offshore OPAREA. Typical duration of a submarine TORPEX operation is 22.7 hours, while air and surface ASW platform TORPEX operations are considerably shorter.

Baseline Operations					
ASW TORPEX	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.1.2	Hawaii Offshore, PMRF	Ops	14.3	500

Major Integrated Antisubmarine Warfare Training Exercise

ASW training conducted during a major integrated ASW training exercise uses ships, submarines, aircraft, non-explosive exercise weapons, and other training systems and devices. These large scale ASW exercises occur as part of RIMPAC, Undersea Warfare Exercise (USWEX), or other exercises where one or more CSGs converge to train in the range complex. No new or unique operations take place during an integrated event; it is merely the compilation of numerous ASW operations as conducted by multiple units over a period of time ranging from 3 to 30 days.

Baseline Operations					
Major Integrated ASW	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.1.2	Hawaii Offshore, PMRF	Ops	Various	5

Electronic Combat

Electronic Combat Operations

Electronic Combat (EC) operations consist of air-, land-, and sea-based emitters simulating enemy systems and activating air, surface and submarine electronic support measures (ESM) and electronic countermeasures (ECM) systems. Appropriately configured aircraft fly threat profiles against the ships so that crews can be trained to detect electronic signatures of various threat aircraft, or so that ship crews can be trained to detect counter jamming of their own electronic equipment by the simulated threat.

Baseline Operations					
EC Operations	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.5	Hawaii Offshore, PMRF	Ops	6.1	50

Mine Warfare

Mine Countermeasures Exercise

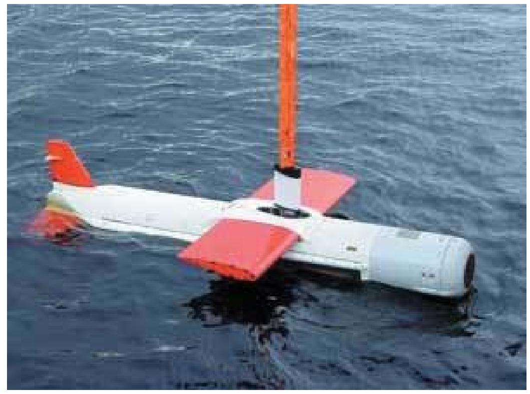
Mine Countermeasures (MCM) exercises train forces to detect, identify, mark, and/or disable mines using a variety of methods.

Organic Mine Countermeasures

Organic Mine Countermeasures (OMCM) include systems deployed by air, ship, and submarine. Five Organic Airborne Mine Countermeasures (OAMCM) systems (Figure D-3) are deployed by the MH-60S Seahawk Multi-Mission, including:

- **Advanced Mine Hunting Sonar:** The AN/AQS-20A Advanced Mine Hunting Sonar is a single-pass multi-sonar system designed to detect, locate, and identify mines on the sea floor and in the water.
- **AN/AES-1 Airborne Laser Mine Detection System (ALMDS):** The AN/AES-1 ALMDS is a sensor designed to detect moored, near surface mines using light detection and ranging technology.
- **AN/ALQ-220 Organic Airborne and Surface Influence Sweep (OASIS):** The AN/ALQ-220 OASIS System is a lightweight magnetic/acoustic system employed by the MH-60S.
- **AN/AWS-2 Rapid Airborne Mine Clearance System (RAMICS):** The AN/AWS-2 RAMICS is being developed to destroy near-surface and floating mines using a 30-mm cannon hydro-ballistic projectile, and includes a target reacquisition pod on the MH-60S.
- **AN/ASQ-235 Airborne Mine Neutralization System (AMNS):** The AN/ASQ-235 AMNS is a lightweight expendable system designed to rapidly neutralize bottom and moored mines.

AN/AES-1



AN/ASQ-20A

AN/AWS-2

AN/ALQ-220 OASIS

EXPLANATION

Organic Mine Countermeasures

Not To Scale

Figure D-3

One OMCM System, the Remote Minehunting System (RMS), is deployed from a surface ship. Another OMCM system, the Long-term Mine Reconnaissance System (LMRS), is deployed from a submarine. The RMS and LMRS should be operational after FY 2007.

Baseline Operations					
Mine Countermeasures Exercise	NTA	Area	Metric	Duration (Hours)	Total Operations
	1.3.1	PMRF, Sub Op Area	Ops	6-12	32

Mine Neutralization

Mine Neutralization operations involve the detection, identification, evaluation, rendering safe, and disposal of mines and unexploded ordnance (UXO) that constitutes a threat to ships or personnel. Mine neutralization training is conducted by a variety of air, surface and sub-surface assets.

Tactics for neutralizing ground or bottom mines involve the diver placing a specific amount of explosives which, when detonated underwater at a specific distance from a mine, results in neutralization of the mine. Floating, or moored, mines involve the diver placing a specific amount of explosives directly on the mine. Floating mines encountered by fleet ships in open-ocean areas are detonated at the surface. In support of a military expeditionary assault, the U.S. Navy deploys in very shallow water depths (10 to 40 feet) to locate mines and obstructions.

Divers are transported to the mines by boat or helicopter. Inert dummy mines are used in exercises. The total net explosive weight used against each mine ranges from less than less than 1 pound to 20 pounds.

Various types of surveying equipment are used during Rim of the Pacific (RIMPAC) exercises. Examples include the Canadian Route Survey System that hydrographically maps the ocean floor using multi-beam side scan sonar, and the Bottom Object Inspection Vehicle used for object identification. These units help to support mine detection prior to Special Warfare Operations (SPECWAROPs) and amphibious exercises.

Occasionally, marine mammals are used in mine detection training operations. The U.S. Navy's Very Shallow Water Mine Countermeasures Detachment of Commander Mine Warfare Command deploys trained Atlantic bottlenose dolphins (*Tursiops truncatus*) of their marine mammal mine-hunting systems in several missions. Each mission includes up to four motorized small craft, several crew members and a trained dolphin. Exercises using dolphins are coordinated with other U.S. Navy units to avoid conflicts with other U.S. Navy activities, underwater acoustic emissions associated with those activities, or civilian craft. Any unplanned situation that has the potential for exposing a dolphin to dangerous or conflicting underwater acoustic emissions or other interference is mitigated by recalling it into a small craft and moving the dolphin out of the area. As such, these marine mammals are continuously protected. Transportation of these animals into the State of Hawaii and housing there is in accordance with the regulations of the Hawaii State Department of Agriculture.

Mine neutralization operations take place offshore in the Puuloa Underwater Range (called Keahi Point in earlier documents), Pearl Harbor; Lima Landing; Barbers Point Underwater Range off-shore of Coast Guard Air Station Barbers Point/Kalaeloa Airport (formerly Naval Air Station [NAS] Barbers Point); PMRF, Kauai (Majors Bay area); PMRF and Oahu Training Areas; and in open-ocean areas.

All demolition activities are 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 (Department of the Navy, 2003). Before any explosive is detonated, divers are transported a safe distance away from the explosive. Standard practices for tethered mines in Hawaiian waters require ground mine explosive charges to be suspended 10 feet below the surface of the water. For mines on the shallow water floor (less than 40 feet of water), only sandy areas that avoid/minimize potential impacts to coral are used for explosive charges.

Baseline Operations					
	NTA	Area	Metric	Duration (Hours)	Total Operations
Mine Neutralization	1.3.1	Puuloa Underwater Range	Ops	6	62

Mine Laying

Mine laying operations are designed to train forces to conduct offensive (deploy mines to tactical advantage of friendly forces) and defensive (deploy mines for protection of friendly forces and facilities) mining operations. Mines can be laid from the air (FA-18/P-3) or by submarine.

Airborne mine laying involves one or more aircraft and either computer-simulated or inert exercise mines. Mine warfare operations are limited to either the simulated laying of aircraft-deployed mines, where no actual mine ordnance is dropped, or the use of inert exercise mines or inert exercise submarine-deployed mines.

The use of inert exercise mines is generally limited to areas greater than 100 fathoms, or 600 feet in depth. Before dropping inert exercise mines, the crew visually determines that the area is clear. Although the altitude at which inert exercise mines are dropped varies, the potential for drift during descent generally favors release at lower altitudes, where visual searches for marine mammals are more effective. When the inert exercise mine is released, a small parachute retards its entry into the ocean. The mine can be designed to float on the surface or near surface or to sink on a tether. Ultimately the mine sinks carrying the parachute with it. Standard Navy procedures are followed for the deployment of inert mines from submarines.

Aerial mining lines are generally developed off the southwest coast of Kauai and the southeast coast of Niihau, within PMRF Warning Areas W-186 and W-188. Submarine mining exercises are conducted within PMRF Warning Area W-188. Aircraft operations are conducted within R3101. (See Figure 1.1-1)

Baseline Operations					
Mine Laying	NTA	Area	Metric	Duration (Hours)	Total Operations
	1.4.1	PMRF	Ops	6-12	22

Land Demolitions

Land demolitions are operations designed to train forces to cause the explosion and the resulting destruction of enemy personnel, vehicles, aircraft, obstacles, facilities, or terrain on land. These operations are also designed to develop and hone EOD mission proficiency in locating, identifying, excavating, and neutralizing land mines. Land demolitions take place at the West Loch EOD Training Facility. (See Figure 2.2.3.5.1-1) In addition to Navy personnel, Honolulu Police, Federal Bureau of Investigation, and several RDT&E companies conduct land demolitions at the EOD shore facility. The EOD facility is limited to 2.5 pounds of non-fragment producing explosives. EOD Range demolition operations take approximately 4.5 hours to complete and there are between 70 and 80 operations per year.

Baseline Operations					
Land Demolitions	NTA	Area	Metric	Duration (Hours)	Total Operations
	1.4.4	EOD Land Range	Ops	4	85

<u>Naval Special Warfare</u>

Swimmer Insertion/Extraction

Naval Special Warfare (NSW) personnel conduct underwater swimmer insertion and extraction training in the Hawaii Offshore Areas using either the Sea, Air, Land (SEAL) Delivery Vehicle (SDV), or the Advanced SEAL Delivery System (ASDS). Both submersibles are designed to deliver special operations forces for clandestine operations. The SDV is an older, open-design delivery vehicle. The ASDS is a new dry compartment vehicle that keeps the SEALs warmer during transit. The battery-powered ASDS is capable of operating independently or with submarines.

Two types of training occur with the ASDS—unit and integrated. Unit training with the ASDS consists of the SDV Team operating the ASDS independently. Integrated training operations involve the SDV Team working with a submarine and the ASDS.

Underwater swimmer insertion and extraction training is focused on undersea operation of the SDV or ASDS, and does not typically involve SEAL personnel landing ashore or conducting shore operations. Although undersea range areas are usually reserved for a 24-hour period, the insertion/extraction operation itself lasts approximately 8 hours. Swimmer insertion and extraction operations can also include the use of helicopters to insert or extract NSW personnel using a variety of techniques.

Baseline Operations					
	NTA	Area	Metric	Duration (Hours)	Total Operations
Swimmer Insertion/Extract ion (SDV Ops)	1.1.2.4	Hawaii Offshore, MCTAB, PMRF	Days	8	80

Special Warfare Operations

Special Warfare Operation (SPECWAR OPS) are performed by Navy SEALs and U.S. Marines. Activities include special reconnaissance (SR), reconnaissance and surveillance, combat search and rescue (CSAR), and direct action (DA). SR units consist of small special warfare unit and utilize helicopters, submarines, and combat rubber raiding craft to gain covert access to military assets, gather intelligence, stage raids, and return to their host units. Reconnaissance inserts and beach surveys are often conducted before large-scale amphibious landings and can involve several units gaining covert access using a boat. CSAR operations are similar to SR (R&S), but the mission is to locate and recover a downed aircrew. DA missions consist of an initial insertion, followed by the helicopters/boats inserting additional troops to take control of an area. The helicopters may land for refueling.

Baseline Operations					
	NTA	Area	Metric	Duration (Hours)	Total Operations
SPECWAR OPS	1.5.6	Bradshaw, MMR, KMTA, DMR, WAAF, Niihau, MCTAB, PTA	Days	8	30

<u>**Strike Warfare**</u>

Bombing Exercise (Land)

Kaula Rock also is used for bomb exercise (BOMBEX) training. BOMBEX operations consist of air-to-ground delivery of small, 25-pound (lb), inert MK-76 (a type of training ordnance); or the MK-82, a 500-lb bomb. Bombing exercises originate from an aircraft carrier or a land base. Carrier Strike Group (CSG) fixed-wing aircraft account for all of the Navy BOMBEX operations at Kaula Rock. Only inert ordnance 500 pounds or less is authorized for use on Kaula Rock.

Baseline Operations					
	NTA	Area	Metric	Duration (Hours)	Total Operations
BOMBEX (Land)	3.2.6	Kaula Rock, PTA	Ops	0.8	165

Air-to-Ground Gunnery Exercise

Kaula Rock, a small island southwest of Kauai (shown in Figure 1.1-1), is used for air-to-ground gunnery (GUNEX [A-G]) training. GUNEX (A-G) includes live-fire gunnery training from fixed- or rotary-wing aircraft. The use of 20mm and 30mm cannon fire is not allowed from November through May.

Baseline Operations					
GUNEX (A-G)	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.6	Kaula Rock	Ops	0.8	16

<u>Other Operations</u>

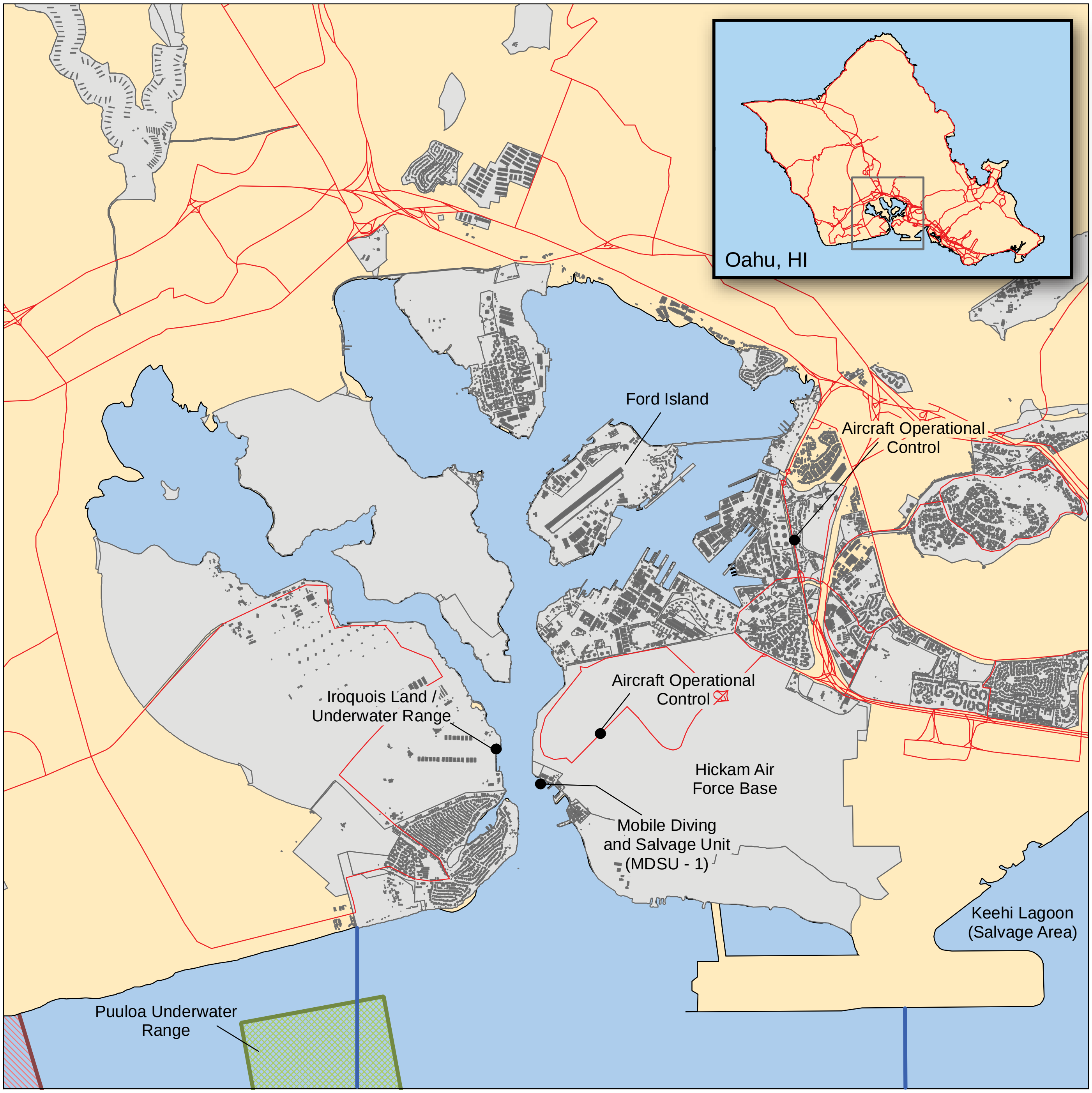
Salvage Operations

The purpose of Salvage Operations is to provide a realistic training environment for battling fires at sea, de-beaching of stranded ships, and harbor clearance operations training by U.S. Navy diving and salvage units.

The U.S. Navy's Mobile Diving and Salvage Unit One (MDSU-1) (Figure D-4) and divers from other countries practice swift and mobile ship and barge salvage, towing, battle damage repair, deep ocean recovery, harbor clearance, removal of objects from navigable waters, and underwater ship repair capabilities.

Diving and salvage forces exercise include the following activities:

- SCUBA and surface supplied air and mixed gas (HeO_2) diving operations to depths of 300 feet of sea water
- Hyperbaric recompression chamber operations
- Underwater ship inspection, husbandry, and repair of coalition Naval ships and submarines
- Underwater search and recovery operations
- Underwater cutting employing hydraulic, pneumatic, and oxy-arc powered tools
- Underwater welding
- Removal of petroleum, oil, and lubricants (POL) exercising various POL offload techniques
- Restoring Buoyancy (Survey, Patch, De-water) to a grounded or sunken vessel or object of value
- Harbor clearance for removal of derelict vessels or other obstructions from navigable waterways and berthing
- Off-Ship fire fighting to simulate rescue and assistance operations battling fires



EXPLANATION

- Major Roads
- Ewa Training Minefield
- Pu'uloa Underwater Range
- Pearl Harbor Naval Defense Sea Area
- Existing Facilities
- Installation Areas
- Land

NORTH

0 0.5 1 2 Miles

Pearl Harbor Area and Hickam Air Force Base

Oahu, Hawaii

Figure D-4

These activities take place at Puuloa Underwater Range, Pearl Harbor, and Keehi Lagoon. Staging for these activities is from the MDSU-1 Facility located on Bishop Point, an annex of Pearl Harbor, on the southwestern side of Hickam AFB, Oahu. To capitalize on real-world training opportunities and to provide mutual benefit for both the U.S. Naval and Coalition Salvage Force and for the State of Hawaii, salvage training and harbor clearance exercises take place in any of the shoal waters, harbors, ports, and in-land waterways throughout the Hawaiian OPAREA.

The ship fire exercise lasts no more than 1 day per event. De-beaching activities last no more than 1 to 2 days per event. Deep ocean recovery exercises last up to 2 weeks and could be longer depending on the availability of missions.

The duration of salvage exercises varies considerably. For a fire at sea or ship retraction of a grounded vessel, the exercise lasts up to 4 days. For underwater cutting, welding, pumping, restoring buoyancy, and exercises that practice a single skill in a controlled environment, the event usually does not exceed 1 day. However, multiple iterations could extend throughout the duration of the exercise.

All U.S. and Coalition Naval Salvage Force exercise scenarios will be conducted in accordance with the following references:

a. U.S. Navy Diving Manual Revision 4, with a change a dated March 2001
b. U.S. Navy Salvage Safety Manual
c. U.S. Navy Salvage Manual Vol 1—Strandings
d. U.S. Navy Salvage Manual Vol 2—Harbor Clearance
e. U.S. Navy Salvage Manual Vol 3—Firefighting and Damage Control
f. U.S. Navy Salvage Manual Vol 5—Petroleum Oil and Lubricant Offload
g. U.S. Navy Towing Manual
h. OPNAVINST 5100.19B (safety manual)
i. Fleet Exercise Publication—4 Chapter 12 Mobile Diving and Salvage Units and Chapter X ARSs

Baseline Operations					
	NTA	Area	Metric	Duration (Days)	Total Operations
Salvage Operations	4.13	Pearl Harbor, Puuloa Underwater Range	Ops	1	3

Live Fire Exercise (LFX)

LFX provides ground troops with live-fire training and combined arms live-fire exercises training, including aerial gunnery and artillery firing. These exercises include platoon troop movements through numerous target objectives with various weapons. Aerial gunnery exercises and artillery and mortar exercises are also conducted as part of combined and separate exercises. Live fire and blanks are used. Blanks are used outside of defined impact areas. LFX benefit ground personnel who receive semi-realistic training.

LFX typically consists of ground troops and special forces, including a sniper unit, of about 2 to 18 people, a helicopter, artillery, mortars, and miscellaneous small arms. In the future, up to a brigade of U.S. or foreign troops could receive LFX training during a major exercise. LFX operations are conducted at PTA (Figure D-5) and Makua Military Reservation (MMR) (Figure D-6).

Baseline Operations					
LFX	NTA	Area	Metric	Duration (Hours)	Total Operations
	3.2.2	Makua, PTA	Ops	1 - 24	3

Humanitarian Assistance Operation/Non-combatant Evacuation Operation

The purpose of Humanitarian Assistance Operation/Non-combatant Evacuation Operation (HAO/NEO) is to provide training in providing humanitarian assistance in an increasingly hostile setting, which could require the evacuation of personnel and troops. Marine Corps Base Hawaii is used for HAO/NEO and direct action training. MCTAB, Kahuku Training Area, Majors Bay at PMRF, and Niihau are also be used for HAO/NEO.

HAO/NEO training exercises, which last approximately 4 days, involve approximately 150 personnel, troops, and specialists who initially provide assistance to civilians and then evacuate them when necessary. This scenario is also used to simulate a prisoner-of-war camp or place where people are interned. A direct action exercise (lasting several hours) is another scenario included in the HAO/NEO. It is much quicker and involves approximately 50 personnel and 150 troops who gain access to an area by boat or helicopter, storm the location, recover the mission target, and return to their units.

HAO/NEO exercises use trucks; helicopters; landing craft air cushion; landing craft, utility and/or Combat Rubber Raiding Craft to shuttle supplies. Evacuations may be made using helicopters, and/or landing craft air cushion vehicles. Direct actions may use Combat Rubber Raiding Craft, Rigid Hull, Inflatable Boats, trucks, and/or helicopters. Existing building and facilities are used to the extent practicable, but in some instances tents and other temporary structures may be used.

Baseline Operations					
HAO/NEO	NTA	Area	Metric	Duration (Days)	Total Operations
	6.2.1	Niihau, MCBH, MCTAB, Kahuku, PMRF	Ops	4	1

EXPLANATION

- Roads
- Bradshaw Army Airfield
- Impact Area
- Land

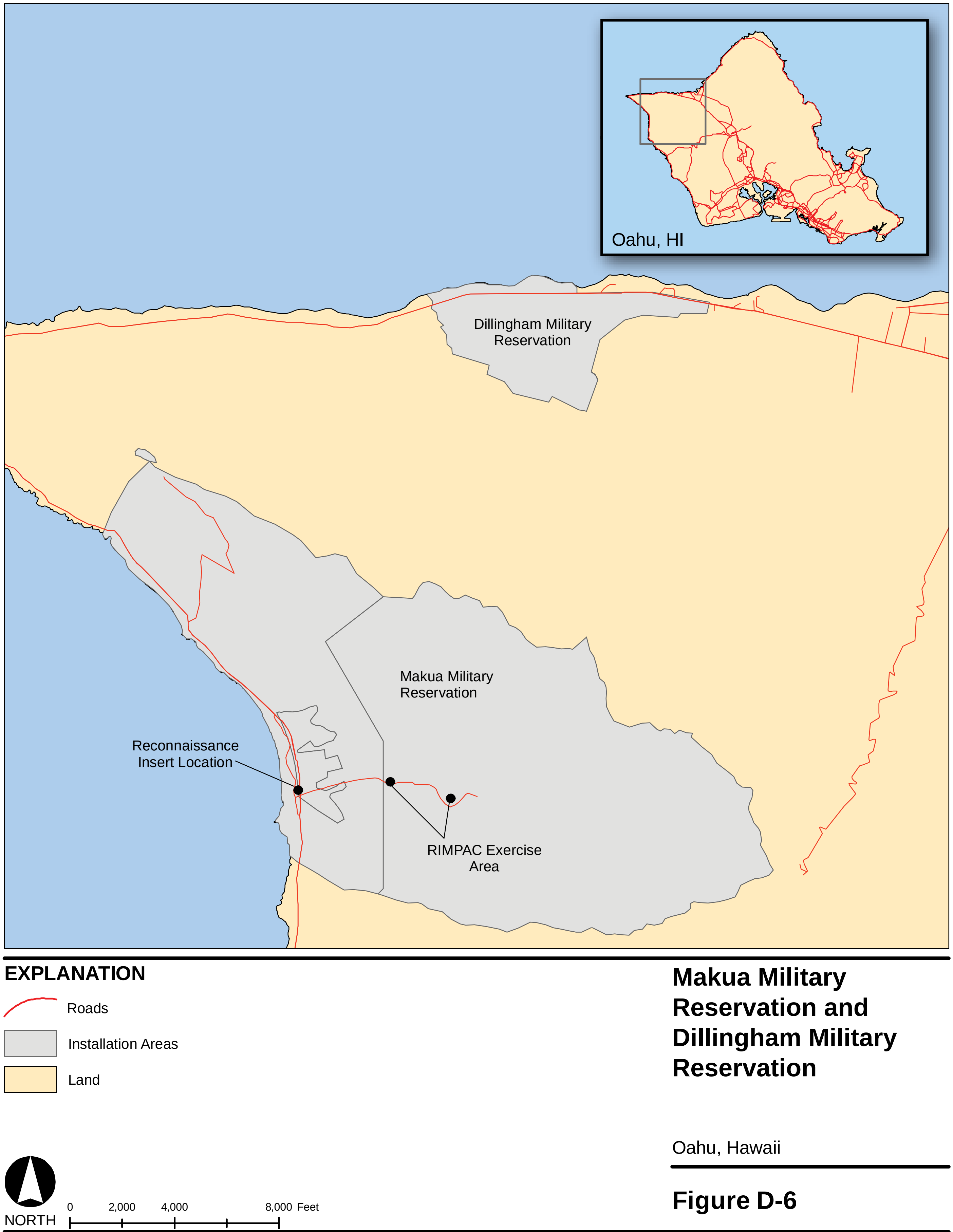
NORTH

0 1 2 4 Miles

Pohakuloa Training Area and Bradshaw Army Airfield

Island of Hawaii

Figure D-5



Makua Military Reservation and Dillingham Military Reservation

Oahu, Hawaii

Figure D-6

Humanitarian Assistance/Disaster Relief

The purpose of Humanitarian Assistance/Disaster Relief (HA/DR) is to provide training in responding to a United Nations request for complex emergency support. HA/DR training exercises involve approximately 125 to 250 troops and 125 to 200 refugee actors. An amphibious landing craft off-loads approximately 4 transport trucks, 3 support vehicles, 3 water supply vehicles, water and food supply, and 125 troops. They travel along authorized highways to the HA/DR site. A safe haven camp is established in existing facilities or temporary facilities (tents, etc.).

The HA/DR exercise lasts for approximately 10 days. Future HA/DR exercises could range from 2 to 18 days. The camp is established in 2 days. Personnel are provided water, shelter, food, sanitation, and communications for 5 days. Takedown takes about 2 days.

For each exercise, there are two sites: a refugee camp and a Civil–Military Operations Center area. There are roughly 30 five-person Red Cross tents within the refugee camp, with a few larger tents for various support functions including meals, showers, recreation, administration, and storage. The Civil–Military Operations Center section contains more storage, communication links, staff housing, experimentation (including information management and high-bandwidth informatics support, digital transcription facilities to interview refugees for war-crimes documentation, and solar powered computer systems), and various public relations areas for visitors. Approximately 18 portable latrines are at the sites. Buses and/or trucks, and military helicopters as needed, are used to transport refugees.

A safe haven refugee camp would be established within the Marine Corps Base Hawaii, MCTAB and/or Kahuku Training Area. An amphibious landing craft or trucks would offload equipment, vehicles, troops, and refugees. Airstrips at these locations would be used to transport personnel.

The HA/DR exercise takes place near an existing training trail. The access road to the site would be graded before the exercise, if required. Grading would be within the existing roadway in accordance with standard procedures. Equipment and personnel would be transferred to the camp location via transport trucks and buses, respectively. Training map overlays that identify the transit route, camp location, and any nearby restricted areas or sensitive biological and cultural resource areas would be used by participants.

Baseline Operations					
	NTA	Area	Metric	Duration (Days)	Total Operations
HA/DR	6.2.3	MCBH, MCTAB, Kuhuku	Ops	10	1

Rim of the Pacific and USWEX

The Commander, U.S. THIRD Fleet, conducts RIMPAC within the HRC every other year. The biennial RIMPAC is a multinational, sea control and power projection exercise that consists of various phases of activity by Army, Marine Corps, Navy, and Air Force forces, as well as the military forces of several Pacific Rim nations. During the month-long exercise, individual training operations occur in open ocean, offshore, and onshore areas. Table D-2 shows the matrix of operations used during previous RIMPAC exercises by location.

USWEX includes a single Strike Group, training in the HRC for up to 4 days, four times per year. Table D-3 shows the matrix of operations generally used during a USWEX exercise by location.

Under Alternative 1 the Navy proposes to continue RIMPAC and USWEX exercises described in the No-action Alternative. USWEX frequency would increase from four to six times per year. RIMPAC would include two Strike Groups, and FCLPs would occur in association with transiting Strike Groups participating in major exercises. The operations associated with major exercises would be chosen from the appropriate matrix of training operations, in Table D-4.

Under Alternative 2, up to three Strike Groups would conduct training exercises simultaneously in the HRC. The Strike Groups would not be home ported in Hawaii, but would stop in Hawaii en route to a final destination. The Strike Groups would be in Hawaii for up to 10 days per exercise. Proposed exercise operations would be similar to current operations for the RIMPAC and USWEX exercises. Also included in the training operations would be FCLP conducted at the following airfields: Marine Corps Base Hawaii and PMRF. The operations associated with multiple strike group training would be chosen from the appropriate matrix of training operations, in Table D-5.

Table D-2. Rim of the Pacific 06 Exercise Matrix

Training Events

Service	Location	Island	IN-PORT/ SUPPORTEX	C2	AAW: AIROPS	AAW: S-A MISSILEX	AAW: A-A MISSILEX/ ACM	AAW: A-S MISSILEX	ASUW / ASW: S-S MISSILEX	ASUW / ASW: ASW	MIW: MINEX	MIW – MCM: SMWEX	MIW – MCM: Air MIWEX	MIW – MCM: UMWEX	ASUW: STW, CASEX	ASUW: GUNEX	ASUW: SINKEX	LFX	HAO/NEO	HA/DR	SPECWAROPS	DEMO	SALVAGE OPS	Expeditionary Assault	SUBOPS	Seaglider
Navy	Pacific Missile Range Facility*	Kauai		Green	Green	Green	Green		Green			Green			Green				Blue		Green	Green		Green		
	Niihau	Niihau																	Blue		Gray					
	Kaula	Kaula													Gray	Gray										
	Pearl Harbor**	Oahu	Green	Green	Green																Gray	Yellow	Green			
	Iroquois Land/Underwater Range	Oahu																			Gray	Gray				
	Puuloa Underwater Range – Pearl Harbor	Oahu																			Gray	Green	Green			
	Barbers Point Underwater Range	Oahu																			Gray	Gray				
	Coast Guard AS Barbers Point/ Kalaeloa Airport	Oahu			Gray																Gray					
	PMRF Warning Areas#	Ocean Areas				Green	Green	Green	Green	Green	Green				Gray	Green	Green				Gray	Gray			Green	
	Oahu Warning Areas#	Ocean Areas				Gray	Gray			Gray						Green					Gray	Gray			Green	
	Open Ocean Areas#	Ocean Areas								Gray		Yellow	Yellow	Yellow							Gray	Gray			Green	Yellow
	U.S. Command Ship	Ocean Areas		Gray																						
Marines	Marine Corps Base Hawaii	Oahu		Green	Green									Yellow					Gray	Gray	Gray			Green		
	Marine Corps Training Area Bellows	Oahu																	Gray	Gray	Gray			Green		
Air Force	Hickam Air Force Base	Oahu		Gray	Green																Gray					
Army	Kahuku Training Area	Oahu																	Gray	Gray	Gray					
	Makua Military Reservation	Oahu																Gray			Gray					
	Dillingham Military Reservation	Oahu																			Gray					
	Wheeler Army Airfield	Oahu		Gray	Gray																Gray					
	K-Pier, Kawaihae	Hawaii																			Gray			Green		
	Bradshaw Army Airfield	Hawaii		Gray	Green																Gray					
	Pohakuloa Training Area	Hawaii		Green											Green			Gray			Gray					
State	Keehi Lagoon	Oahu																					Green			

* Includes Port Allen and Makaha Ridge ** Includes Ford Island and all other areas within the harbor.

These areas are included in the HRC. The HRC is now used to define the outer limits of the ocean areas used during Major Fleet Exercises.

Gray: Locations where events can occur; Green: RIMPAC 02 Programmatic; Yellow: Added RIMPAC 04 Supplement; Blue: Added RIMPAC 06 Supplement

Training Events:

A-A MISSILEX	Air-to-Air Missile Exercise (formerly AAMEX)	C2	Command and Control
AAW[1]	Anti-Air Warfare	DEMO	Demolition Exercise
AIROPS	Aircraft Operations	GUNEX	Gunnery Exercise
AMPHIBEX	Amphibious Landing Exercise (now Expeditionary Assault)	HA/DR	Humanitarian Assistance/Disaster Relief
Air MIWEX	Air Mine Warfare Exercise (formerly AMWEX)	HAO/NEO	Humanitarian Assistance Operation/ Non-Combatant Evacuation Operation
A-S MISSILEX	Air-to-Surface Missile Exercise (formerly ASMEX)	IN-PORT	In-port Briefings and Activities
ASUW[2]/ASW[3]	Anti-Surface Warfare/ Anti-Submarine Warfare Exercise	LFX	Live Fire Exercise
ASW	Anti-Submarine Warfare Exercise (formerly ASWEX)	MCM	Mine Countermeasures
CASEX	Close Air Support	MINEX	Mine Exercise
		MIW[4]	Mine Warfare
SALVAGE OPS	Salvage Operations		
S-A MISSILEX	Surface-to-Air Missile Exercise (formerly SAMEX)		
SINKEX	Sink Exercise		
SMWEX	Ship Mine Warfare Exercise		
SPECWAROPS	Special Warfare Operations (NSW Operations?)		
S-S MISSILEX	Surface-to-Surface Missile (formerly SSMEX)		
STW	Strike Warfare Exercise (formerly STWEX)		
SUBOPS	Submarine Operations		
SUPPORTEX	In-Port Support Exercise		
UMWEX	Underwater Mine Warfare Exercise		

Note: Since the publication of the RIMPAC PEA, new terminology and/or categories of exercises have come into use. They are as follows:

[1] AAW includes AIROPS, S-A MISSILEX, A-A MISSILEX, and A-S MISSILEX

[2] ASUW includes GUNEX, S-S MISSILEX, and ASW

[3] ASW includes S-S MISSILEX and ASW

[4] MIW encompasses two subsets, MINEX and MCM. MINEX is the act of laying mines. MCM is the act of locating and countering mining by others and includes SMWEX, AMWEX, and UMWEX.

1

Table D-3. Example Undersea Warfare Exercise Matrix

Training Events

					AAW/ACM				ASUW / ASW		MIW				ASUW											
												MCM														
Service	Location	Island	IN-PORT/ SUPPORTEX	C2	AIROPS	S-A MISSILEX	A-A MISSILEX/ ACM	A-S MISSILEX	S-S MISSILEX	ASW	MINEX	SMWEX	Air MIWEX	UMWEX	STW, CASEX	GUNEX	SINKEX	LFX	HAO/NEO	HA/DR	SPECWAROPS	DEMO	SALVAGE OPS	Expeditionary Assault	SUBOPS	Seaglider
Navy	Pacific Missile Range Facility*	Kauai		X	X	X	X		X			X			X				X		X	X		USWEX		
	Niihau	Niihau																	X		X					
	Kaula	Kaula													X	USWEX										
	Pearl Harbor**	Oahu	X	X	X																X	X	X			
	Iroquois Land/Underwater Range	Oahu																			X	X				
	Puuloa Underwater Range – Pearl Harbor	Oahu																			X	X	X			
	Barbers Point Underwater Range	Oahu																			X	X				
	Coast Guard AS Barbers Point/ Kalaeloa Airport	Oahu			X																X					
	PMRF Warning Areas#	Ocean Areas				X	USWEX	USWEX	X	USWEX	X				USWEX	USWEX	X				X	X			USWEX	
	Oahu Warning Areas#	Ocean Areas				X	USWEX			USWEX						USWEX					X	X			USWEX	
	Open Ocean Areas#	Ocean Areas								USWEX		X	X	X							X	X			USWEX	X
	U.S. Command Ship	Ocean Areas		X																						
Marines	Marine Corps Base Hawaii	Oahu		X	X									X					X	X	X			X		
	Marine Corps Training Area Bellows	Oahu																	X	X	X			USWEX		
Air Force	Hickam Air Force Base	Oahu		X	X																X					
Army	Kahuku Training Area	Oahu																	X	X	X					
	Makua Military Reservation	Oahu																X			X					
	Dillingham Military Reservation	Oahu																			X					
	Wheeler Army Airfield	Oahu		X	X																X					
	K-Pier, Kawaihae	Hawaii																			X			X		
	Bradshaw Army Airfield	Hawaii		X	X																X					
	Pohakuloa Training Area	Hawaii		X											USWEX			X			X					
State	Keehi Lagoon	Oahu																					X			

* Includes Port Allen and Makaha Ridge

** Includes Ford Island and all other areas within the harbor.

\# These areas are included in the HRC. The HRC is now used to define the outer limits of the ocean areas used during Major Fleet Exercises.

[grey box] Locations where events occur [yellow box] USWEX

Training Events:

A-A MISSILEX	Air-to-Air Missile Exercise (formerly AAMEX)	C2	Command and Control
AAW[1]	Anti-Air Warfare	DEMO	Demolition Exercise
AIROPS	Aircraft Operations	GUNEX	Gunnery Exercise
AMPHIBEX	Amphibious Landing Exercise (now Expeditionary Assault)	HA/DR	Humanitarian Assistance/Disaster Relief
Air MIWEX	Air Mine Warfare Exercise (formerly AMWEX)	HAO/NEO	Humanitarian Assistance Operation/ Non-Combatant Evacuation Operation
A-S MISSILEX	Air-to-Surface Missile Exercise (formerly ASMEX)	IN-PORT	In-port Briefings and Activities
ASUW[2]/ASW[3]	Anti-Surface Warfare/ Anti-Submarine Warfare Exercise	LFX	Live Fire Exercise
ASW	Anti-Submarine Warfare Exercise (formerly ASWEX)	MCM	Mine Countermeasures
CASEX	Close Air Support	MINEX	Mining Exercise
		MIW[4]	Mine Warfare
SALVAGE OPS	Salvage Operations		
S-A MISSILEX	Surface-to-Air Missile Exercise (formerly SAMEX)		
SINKEX	Sink Exercise		
SMWEX	Ship Mine Warfare Exercise		
SPECWAROPS	Special Warfare Operations (NSW Operations?)		
S-S MISSILEX	Surface-to-Surface Missile (formerly SSMEX)		
STW	Strike Warfare Exercise (formerly STWEX)		
SUBOPS	Submarine Operations		
SUPPORTEX	In-Port Support Exercise		
UMWEX	Underwater Mine Warfare Exercise		

Note: Since the publication of the RIMPAC PEA, new terminology and/or categories of exercises have come into use. They are as follows:

[1] AAW includes AIROPS, S-A MISSILEX, A-A MISSILEX, and A-S MISSILEX

[2] ASUW includes GUNEX, S-S MISSILEX, and ASW

[3] ASW includes S-S MISSILEX and ASW

[4] MIW encompasses two subsets, MINEX and MCM. MINEX is the act of laying mines. MCM is the act of locating and countering mining by others and includes SMWEX, AMWEX, and UMWEX.

Table D-4. Proposed Future RIMPAC Exercise Matrix

Training Events

Service	Location	Island	IN-PORT/ SUPPORTEX	C2	AAW: AIROPS	AAW: S-A MISSILEX	AAW: A-A MISSILEX/ ACM	AAW: A-S MISSILEX	ASUW / ASW: S-S MISSILEX	ASUW / ASW: ASW	MIW: MINEX	MIW / MCM: SMWEX	MIW / MCM: Air MIWEX	MIW / MCM: UMWEX	ASUW: STW, CASEX	ASUW: GUNEX	ASUW: SINKEX	LFX	HAO/NEO	HA/DR	SPECWAROPS	DEMO	SALVAGE OPS	Expeditionary Assault	SUBOPS	Seaglider	FCLP
Navy	Pacific Missile Range Facility*	Kauai																									
	Niihau	Niihau																									
	Kaula	Kaula																									
	Pearl Harbor**	Oahu																									
	Iroquois Land/Underwater Range	Oahu																									
	Puuloa Underwater Range – Pearl Harbor	Oahu																									
	Barbers Point Underwater Range	Oahu																									
	Coast Guard AS Barbers Point/ Kalaeloa Airport	Oahu																									
	PMRF Warning Areas#	Ocean Areas																									
	Oahu Warning Areas#	Ocean Areas																									
	Open Ocean Areas#	Ocean Areas																									
	U.S. Command Ship	Ocean Areas																									
Marines	Marine Corps Base Hawaii	Oahu																									
	Marine Corps Training Area Bellows	Oahu																									
Air Force	Hickam Air Force Base	Oahu																									
Army	Kahuku Training Area	Oahu																									
	Makua Military Reservation	Oahu																									
	Dillingham Military Reservation	Oahu																									
	Wheeler Army Airfield	Oahu																									
	K-Pier, Kawaihae	Hawaii																									
	Bradshaw Army Airfield	Hawaii																									
	Pohakuloa Training Area	Hawaii																									
State	Keehi Lagoon	Oahu																									

* Includes Port Allen and Makaha Ridge

** Includes Ford Island and all other areas within the harbor.

These areas are included in the HRC. The HRC is now used to define the outer limits of the ocean areas used during Major fleet Exercises.

Locations where events can occur (grey) — Future RIMPAC (Additional Exercises) (yellow)

Training Events:

A-A MISSILEX	Air-to-Air Missile Exercise (formerly AAMEX)	C2	Command and Control
AAW[1]	Anti-Air Warfare	DEMO	Demolition Exercise
AIROPS	Aircraft Operations	FCLP	Field Carrier Landing Practice
AMPHIBEX	Amphibious Landing Exercise (now Expeditionary Assault)	GUNEX	Gunnery Exercise
Air MIWEX	Air Mine Warfare Exercise (formerly AMWEX)	HA/DR	Humanitarian Assistance/Disaster Relief
A-S MISSILEX	Air-to-Surface Missile Exercise (formerly ASMEX)	HAO/NEO	Humanitarian Assistance Operation/Non-Combatant Evacuation Operation
ASUW[2]/ASW[3]	Anti-Surface Warfare/ Anti-Submarine Warfare Exercise	IN-PORT	In-port Briefings and Activities
		LFX	Live Fire Exercise
ASW	Anti-Submarine Warfare Exercise (formerly ASWEX)	MCM	Mine Countermeasures
CASEX	Close Air Support	MINEX	Mine Exercise
		MIW[4]	Mine Warfare
SALVAGE OPS	Salvage Operations		
S-A MISSILEX	Surface-to-Air Missile Exercise (formerly SAMEX)		
SINKEX	Sink Exercise		
SMWEX	Ship Mine Warfare Exercise		
SPECWAROPS	Special Warfare Operations (NSW Operations?)		
S-S MISSILEX	Surface-to-Surface Missile (formerly SSMEX)		
STW	Strike Warfare Exercise (formerly STWEX)		
SUBOPS	Submarine Operations		
SUPPORTEX	In-Port Support Exercise		
UMWEX	Underwater Mine Warfare Exercise		

Note: Since the publication of the RIMPAC PEA, new terminology and/or categories of exercises have come into use. They are as follows:

[1] AAW includes AIROPS, S-A MISSILEX, A-A MISSILEX, and A-S MISSILEX

[2] ASUW includes GUNEX, S-S MISSILEX, and ASW

[3] ASW includes S-S MISSILEX and ASW

[4] MIW encompasses two subsets, MINEX and MCM. MINEX is the act of laying mines. MCM is the act of locating and countering mining by others and includes SMWEX, AMWEX, and UMWEX.

Table D-5 Proposed Multiple Carrier Strike Group Matrix

			Training Events																									
					AAW				ASUW / ASW		MIW				ASUW													
												MCM																
Service	Location	Island	IN-PORT/ SUPPORTEX	C2	AIROPS	S-A MISSILEX	A-A MISSILEX/ ACM	A-S MISSILEX	S-S MISSILEX	ASW	MINEX	SMWEX	Air MIWEX	UMWEX	STW, CASEX	GUNEX	SINKEX	LFX	HAO/NEO	HA/DR	SPECWAROPS	DEMO	SALVAGE OPS	Expeditionary Assault	SUBOPS	SSeaglider	FCLP
U.S. Navy	Pacific Missile Range Facility*	Kauai																									
	Niihau	Niihau																									
	Kaula	Kaula																									
	Pearl Harbor**	Oahu																									
	Iroquois Land/Underwater Range	Oahu																									
	Puuloa Underwater Range – Pearl Harbor	Oahu																									
	Barbers Point Underwater Range	Oahu																									
	Coast Guard AS Barbers Point/Kalaeloa Airport	Oahu																									
	PMRF Warning Areas#	Ocean Areas																									
	Oahu Warning Areas#	Ocean Areas																									
	Open Ocean Areas#	Ocean Areas																									
	U.S. Command Ship	Ocean Areas																									
U.S. Marines	Marine Corps Base Hawaii	Oahu																									
	Marine Corps Training Area Bellows	Oahu																									
U.S. Air Force	Hickam Air Force Base	Oahu																									
U.S. Army	Kahuku Training Area	Oahu																									
	Makua Military Reservation	Oahu																									
	Dillingham Military Reservation	Oahu																									
	Wheeler Army Airfield	Oahu																									
	K-Pier, Kawaihae	Hawaii																									
	Bradshaw Army Airfield	Hawaii																									
	Pohakuloa Training Area	Hawaii																									
State	Keehi Lagoon	Oahu																									

* Includes Port Allen and Makaha Ridge

** Includes Ford Island and all other areas within the harbor.

These areas are included in the HRC. The HRC is now used to define the outer limits of the ocean areas used during major range events.

Locations where events can occur

Multiple Carrier Strike Group

Training Events:

A-A MISSILEX	Air-to-Air Missile Exercise (formerly AAMEX)
AAW[1]	Anti-Air Warfare
AIROPS	Aircraft Operations
AMPHIBEX	Amphibious Landing Exercise (now Expeditionary Assault)
Air MIWEX	Air Mine Warfare Exercise (formerly AMWEX)
A-S MISSILEX	Air-to-Surface Missile Exercise (formerly ASMEX)
ASUW[2]/ASW[3]	Anti-Surface Warfare/ Anti-Submarine Warfare Exercise
ASW	Anti-Submarine Warfare Exercise (formerly ASWEX)
CASEX	Close Air Support
C2	Command and Control
DEMO	Demolition Exercise
GUNEX	Gunnery Exercise
HA/DR	Humanitarian Assistance/Disaster Relief
HAO/NEO	Humanitarian Assistance Operation/ Non-Combatant Evacuation Operation
IN-PORT	In-port Briefings and Activities
LFX	Live Fire Exercise
MCM	Mine Countermeasures
MINEX	Mine Exercise
MIW[4]	Mine Warfare
SALVAGE OPS	Salvage Operations
SAMEX	Surface-to-Air Missile Exercise (now S-A MISSILEX)
SINKEX	Sinking Exercise
SMWEX	Ship Mine Warfare Exercise
SPECWAROPS	Special Warfare Operations (NSW Operations?)
SSMEX	Surface-to-Surface Missile (now S-S MISSILEX)
STWEX	Strike Warfare Exercise
SUBOPS	Submarine Operations
SUPPORTEX	In-Port Support Exercise
UMWEX	Underwater Mine Warfare Exercise

Note: Since the publication of the RIMPAC PEA, new terminology and/or categories of exercises have come into use. They are as follows:

[1] AAW includes AIROPS, S-A MISSILEX, A-A MISSILEX, and A-S MISSILEX

[2] ASUW includes GUNEX, S-S MISSILEX, and ASW

[3] ASW includes S-S MISSILEX and ASW

[4] MIW encompasses two subsets, MINEX and MCM. MINEX is the act of laying mines. MCM is the act of locating and countering mining by others and includes SMWEX, AMWEX, and UMWEX.

Appendix E
Weapon Systems

APPENDIX E
WEAPON SYSTEMS

Table E-1. Typical Missile Exercise Weapons Used at Pacific Missile Range Facility

TYPE	CHARACTERISTICS				
	Weight	**Length**	**Diameter**	**Range**	**Propulsion**
Surface-to-Air Missiles					
Short Range					
Stinger (FIM-92A)	10.0 kg (22 lb)	1.5 m (5 ft)	70 mm (2.8 in)	4.8 km (3.4 nm)	Solid fuel
Sea Sparrow (RIM-7)	204 kg (450 lb)	3.7 m (12 ft)	203-2 mm (8 in)	14.8 km (10.6 nm)	Solid fuel
Rolling Airframe (RIM-116)	73.5 kg (162 lb)	2.8 m (9 ft 3 in)	127 mm (5 in)	7 km (5.0 nm)	Solid fuel
Medium Range					
Standard SM-1 MR (RIM-66B)	499 kg (1,100 lb)	4.5 m (14 ft 8 in)	342.9 mm (13.5 in)	46.3 km (33 nm)	Solid fuel
Standard SM-2 (RIM-66C)	612 kg (1,350 lb)	4.4 m (14 ft 7 in)	342.9 mm (13.5 in)	74.1 km (53 nm)	Solid fuel
Long Range					
Standard SM-2 ER (RIM-67A/B and 67-C/D)	1,325 kg (2,920 lb)	8.2 m (27 ft)	342.9 mm (13.5 in)	166.7 km (90 nm)	Solid fuel
Standard SM-2 AER (RIM-67B)	1,452 kg (3,200 lb)	6.7 m (22 ft)	342.9 mm (13.5 in)	150 km (107.1 nm)	Solid fuel
Air-to-Air Missiles					
Short Range					
Sidewinder (AIM-9)	84.4 kg (186 lb)	2.9 m (9 ft 6 in)	127 mm (5 in)	18.5 km (10 nm)	Solid fuel
Medium Range					
Sparrow (AIM-7)	231 kg (510 lb)	3.6 m (11 ft 10 in)	203.2 mm (8 in)	55.6 km (30 nm)	Solid fuel
Long Range					
Phoenix (AIM-54)	447 kg (985 lb)	4 m (13 ft)	381 mm (15 in)	203.9 km (110 nm)	Solid fuel
Air-to-Surface Missiles					
Short Range					
Skipper II (AGM-123)	582 kg (1,283 lb)	4.3 m (14 ft)	355.6 mm (14 in)	9.6 km (5.2 nm)	Solid fuel

ft feet; lb pounds
in inches; m meters
kg kilograms; mm millimeters
km kilometers; nm nautical miles

Table E-1. Typical Missile Exercise Weapons Used at Pacific Missile Range Facility (Continued)

TYPE	CHARACTERISTICS				
	Weight	**Length**	**Diameter**	**Range**	**Propulsion**
Air-to-Surface Missiles (Concluded)					
Medium Range					
HARM (AGM-88)	366.1 kg (807 lb)	4.2 m (13 ft 9 in)	254 mm (10 in)	18.5 km (10 nm)	Solid fuel
Shrike (AGM-45)	177 kg (390 lb)	3 m (10 ft)	203.2 mm (8 in)	18.5 km (10 nm)	Solid fuel
Sidearm (AGM-122)	90.7 kg (200 lb)	3 m (10 ft)	127 mm (5 in)	17.8 km (9.6 nm)	Solid fuel
Long Range					
Harpoon (AGM-84/ RGM-84/UGM-84)*	797 kg (1,757 lb)	5.2 m (17 ft 2-in)	342.9 mm (13.5 in)	278 km (150 nm)	Solid fuel
Surface-to-Surface Missiles (Cruise)					
Harpoon (AGM-84/ RGM-84/UGM-84)*	797 kg (1,757 lb)	5.2 m (17 ft 2-in)	342.9 mm (13.5 in)	278 km (150 nm)	Solid fuel

*Characteristics vary according to variant. Those for RGM-84F are shown.

ft	feet	lb	pounds
in	inches	m	meters
kg	kilograms	mm	millimeters
km	kilometers	nm	nautical miles

Source: Laur and Llanso, 1995

Table E-2. Typical Aerial Target Drones and Missiles Used at Pacific Missile Range Facility

TYPE	CHARACTERISTICS			
	Length	**Speed (Maximum)**	**Operational Altitude (Maximum)**	**Time on Station (Maximum)**
Subsonic				
BQM-34S	7 m (23 ft)	Mach 0.9	15,240 m (50,000 ft)	60 minutes
BQM-74C	4 m (13 ft)	430 knots	10,668 m (35,000 ft)	75 minutes
Supersonic				
MQM-8G (ER)	7.6 m (25 ft)	Mach 2.7	1,524 m (5,000 ft)	N/A
AQM-37C	4.1 m (13.6 ft)	Mach 4.0	30,480 m (100,000 ft)	N/A

ft feet
m meters
N/A Not Applicable

Source: Pacific Missile Range Facility, 1991

Table E-3. Typical Existing Target Systems Used at Pacific Missile Range Facility

Type	Category	Name	Propellant Type
Ballistic Missile			
	Small	AQM-37C	Liquid
		Black Brant V	Solid
		Hawk	Solid
		Recruit	Solid
		Malemute	Solid
		HERMES	Solid
		Lance	Liquid
		Standard	Solid
		Tomahawk (Rocket)	Liquid/Solid
		Honest John (Booster)	Solid
		Nike (Booster)	Solid
		PATRIOT as a Target (PAAT)	Solid
		Apache	Solid
		Cajun	Solid
		Genie (14" diameter)	Solid
	Medium	Terrier	Solid
		Talos	Solid
		Castor	Solid
		STRYPI	Solid
		Antares (Stack)	Solid
		Aries	Solid
		Spartan	Solid
		Talos	Solid
		SR-19 (Air Drop)	Solid
		STORM	Solid
		MA-31	Liquid
		Liquid Fuel Target System	Liquid
	Large	Strategic Target System	Solid
		Hera	Solid
		Terrier	Solid
	Supersonic	AQM-37C	Liquid
		Vandal	Liquid/Solid

Table E-3. Typical Existing Target Systems Used at Pacific Missile Range Facility (Continued)

Type	Category	Name	Propellant Type
Aircraft			
	Subsonic	QF-4	Liquid
		AF-16	Liquid
Balloon			
		Balloon	N/A
Towed			
	Aerial	TDU-34A	N/A
Subsurface			
		MK 30 Mod 1	Liquid
		EMATT	Liquid
		SPAT-1 (Self Prop Acoustic Target)	Liquid
		MK-17 (Stationary Target for MK-46)	N/A
Surface			
		QST 35	Liquid
		HULK (TBD)	N/A
		ISTT (Improved Surface Towed Target)	N/A
Cruise Missiles			
	Subsonic	BQM-34S	Liquid
		BQM-74/CHUKAR	Liquid
		AQM-34	Liquid
		MQM-107	Liquid
		Harpoon	Liquid
		Liquid Fuel Target System	Liquid
		Tactical Air Launched Decoy (TALD ADM-141A)	Liquid
		ITALD (Improved version ADM-141C)	Liquid
	Supersonic	Vandal	Liquid/Solid
		MA-31	Liquid
		Terrier	Solid
		Liquid Fuel Target System	Liquid

Table E-4. Typical Existing Weapon Systems Used at Pacific Missile Range Facility

Type	Category	Name	Propellant Type (Liquid/Solid)
Missiles			
	Ship	ASROC	Liquid/Solid
	Ship	Harpoon (RTM-84)	Liquid
	Ship	MK 46 VLA	Liquid/Solid
	Ship	SM-2 BLK II	Solid
	Ship	SM-2 BLK III	Solid
	Ship	SM-2 BLK IV	Solid
	Ship	Sparrow (A1M7)	Solid
	Surf/Ship/Sub	Harpoon (R/UGM-84)	Liquid/Solid
	Air	AGM-45 (SHRIKE)	Solid
	Air	Harpoon (AGM-84)	Liquid
	Air	Phoenix	Solid
	Air	Sidewinder	Solid
	Air	Sparrow	Solid
	Air/Surf/Sub	Tomahawk	Liquid/Solid
	Land	Hawk	Solid
	Land/Ship	Stinger	Solid
Guns			
	Ship	Naval Guns	N/A
	Ship	Phalanx/Vulcan	N/A
	Air	Aircraft Mounted Guns	N/A
Weather Rocket			
	Land	PWN-11D	Solid
	Land	PWN-12A	Solid
Torpedoes			
	Sub	MK 48 ADCAP	Liquid
	Sub	MK 48	Liquid
	Air/Ship	MK 44 (PLLT)	Battery
	Air/Ship	MK 30	Battery
	Air/Ship	MK 50	Liquid
	Air/Ship	MK 54	Liquid
	Air/Ship	Type 80 (Japanese)	Liquid
	Air/Surf	MK 46	Liquid

N/A Not Applicable

Table E-4. Typical Existing Weapon Systems Used at Pacific Missile Range Facility (Continued)

Type	Category	Name	Propellant Type (Liquid/Solid)
Sub Launched Mines			
	Sub	MK-67-2 Sub Launched Mobile Mine (SLMM)	Battery
Air Deployed Mines			
	Air	MK-25	N/A
	Air	MK-36	N/A
	Air	MK-36 DST	N/A
	Air	MK-52	N/A
	Air	MK 76	N/A
Bombs			
	Air	BDU-45	N/A
	Air	MK-82	N/A

N/A Not Applicable

Table E-5. Typical Electronic Warfare Assets Used at Pacific Missile Range Facility

TYPE	CHARACTERISTICS		
	Frequency Bands	Power Output (Maximum)	Location Used
Air and Seaborne Electronic Warfare Assets			
Airborne Simulator Systems			
APS-504(V)5	8.9925 to 9.375 GHz	8 kW	PMRF RC-12F Aircraft
MK-67	907.2 kg (2,000 lb)	4.00 m (13 ft 5 in)	533 mm (21 in)
Expendable Radar Transmitter Sets			
AN/DPT-1(V)	7.8 to 9.6, 14.0 to 15.2 GHz	80 kW	BQM-334S Targets
AN/DPT-2(V)	9.375 GHz	20 kW	BQM-74C Targets
Airborne Electronic Countermeasures Systems			
Traveling Wave Tube Countermeasures System	425 to 445 MHz, 902 to 928 MHz, 2 to 4 GHz	100 W	PMRF RC-12F Aircraft
ALT-41	425 to 445 MHz	100 W	PMRF RC-12F Aircraft
ALT-42	902 to 928 MHz	100 W	PMRF RC-12F Aircraft
DLQ-3	2 to 4 GHz	100 W	PMRF RC-12F Aircraft
ULQ-21	8 to 10.5 GHz	100 W	PMRF RC-12F Aircraft

Table E-5. Typical Electronic Warfare Assets Used at Pacific Missile Range Facility (Continued)

TYPE	CHARACTERISTICS		
	Frequency Bands	**Power Output (Maximum)**	**Location Used**
Seaborne Simulator Systems			
AN/DPT-1(V)	7.8 to 9.6, 14.0 to 15.2 GHz	80 kW	Range Boats
AN/DPT-2(V)	7.8 to 9.6, 14.0 to 15.2 GHz	150 kW	Range Boats
Land-Based Electronic Warfare Assets			
Simulator Systems - Fixed			
AN/DPT-1(V)	7.8 to 9.6, 14.0 to 15.2 GHz	70 kW	Makaha Ridge, Kauai
ENSYN	2 to 4, 7 to 11 GHz	1 kW	Makaha Ridge, Kauai
I/J-TES	7.8 to 9.6, 14.0 to 15.2 GHz	70 kW	Makaha Ridge, Kauai
AN/DPT-1(V)	7.8 to 9.6, 14.0 to 15.2 GHz	70 kW	Mauna Kapu, Oahu
Simulator Systems - Mobile			
AN/DPT-1(V)	2.9 to 3.1, 7.8 to 9.6, 14.0 to 15.2 GHz	70 kW	Barking Sands, Kauai
AN/UPT-2A(V)	2.9 to 3.1, 7.8 to 9.6, 14.0 to 15.2 GHz	150 kW	Barking Sands, Kauai
AN/D/DPT-1(V)	7.8 to 9.6, 14.0 to 15.2 GHz	70 kW	Perch Site, Niihau
AN/UPT-2A(V)	2 to 4, 8 to 18 GHz	150 kW	Perch Site, Niihau
ENSYN	2 to 4, 8 to 18 GHz	1 kW	NAS Barbers Point, Oahu
AN/DPT-1(V)	2.9 to 3.1, 7.8 to 9.6, 14.0 to 15.2 GHz	70 kW	NAS Barbers Point, Oahu
Electronic Countermeasures Systems - Fixed			
ALT-41	425 to 445 MHz	100 W	Makaha Ridge, Kauai
ALT-42	902 to 928 MHz	100 W	Makaha Ridge, Kauai
ULQ-26	2 to 4 GHz	100 W	Makaha Ridge, Kauai
ULQ-21	8.0 to 10.5-GHz	100 W	Makaha Ridge, Kauai
Electronic Countermeasures Systems - Mobile			
DLQ-3	425 to 445 MHz 14.0 to 15.2 GHz	100 W	Range Boats, Remote Sites
ULQ-26	425 to 445 MHz 14.0 to 15.2 GHz	100 W	Range Boats, Remote Sites
ULQ-21	425 to 445 MHz 14.0 to 15.2 GHz	100 W	Range Boats, Remote Sites
ALT-41/42	425 to 445 MHz 14.0 to 15.2 GHz	100 W	Range Boats, Remote Sites

ft feet in inches kW kilowatts m meters mm millimeters
GHz gigahertz kg kilograms lb pounds MHz megahertz W watts
Source: Chun, 1996, Dec

Table E-6. Existing Pacific Missile Range Facility Radars, Locations, and Characteristics

Emitter	Comments	Location	Power Peak (kW)	Scan Rate	Frequency (MHz) Low	Frequency (MHz) High	Pulse Width (μS)	PRF (PPS)	Ant. Gain (dBi)	Ant. Elev. (m)	Remarks
AN/MPS-25	Monopulse Tracking (2 each)	Main Base	1,000	--	5,400	5,900	0.25, 0.5, 1	160, 640	46	18	AZ=0 to 360 degrees. Elevation=-5 to +185 degrees
AN/SPS-10	Surveillance	Main Base	250	15 rpm	5,450	5,825	0.5, 1.3	640	30	22	
AN/UPX-27	AN/SPS-10 IFF Interrogator	Main Base	1	15 rpm	1,030	1,030	0.8	640	23	22	Uses AN/SPS-10 antenna
AN/FPS-106	Weather Radar	Main Base	500		5,450	5,650	0.5	320	35	20	
AN/WRF-100	DOE Radar Facility	Main Base	250	--	9,375	9,375	1	640	32	10	
AN/MPS-25	Monopulse Tracking (2 each)	Makaha Ridge	1,000	--	5,400	5,900	0.25, 0.5, 1	160, 640	46	500	AZ=0 to 360 degrees. Elevation=-5 to +185 degrees
AN/FPQ-10	Monopulse Tracking (2 each)	Makaha Ridge	1,000	--	5,400	5,900	0.25, 0.5, 1	160, 640	43	473	AZ=0 to 360 degrees. Elevation=-5 to +90 degrees
AN/SPS-48E	Track-While-Scan Surveillance	Makaha Ridge	2,400	15 rpm	2,908	3,110	27	Various	39.1	462	
AN/UPX-27	AN/SPS-48E IFF Interrogator	Makaha Ridge	1	15 rpm	1,030	1,030	0.8	Various	19	462	
AN/APS-134	Surface Surveillance	Makaha Ridge	500	15 rpm	9,500	10,000	0.5	500	42	457	Linear frequency chirp each pulse
AN/FPS-16	Monopulse Tracking	Kokee	1,000	--	5,400	5,900	0.25, 0.5, 1	160, 640	43	1,155	AZ=0 to 360 degrees. Elevation=-5 to +185 degrees
AN/FPQ-10	Monopulse Tracking	Kokee	1,000	--	5,400	5,900	0.25, 0.5, 1	160, 640	43	1,150	AZ=0 to 360 degrees. Elevation=-5 to +90 degrees
USB	Unified S-Band System	Kokee	20	--	2,090	2,120	CW	CW	44	1,110	
AN/FPS-117	Surveillance	Kokee	24.75	5 rpm	1,215	1,400	51.2, 409.6	241	38.6	1,310	
OX-60/FPS-117	AN/FPS-117 IFF Interrogator	Kokee	2	5 rpm	1,030	1,030	Various	241	21	1,310	
AN/APS-134	Surveillance	Niihau	500	15 rpm	9,500	10,000	0.5	500	42	375	
R73-6	Raytheon Pathfinder (3 each)	Weapons Recovery Boat and Torpedo Weapons Recovery	10	24 rpm	9,410	9,410	0.08, 0.4, 0.8, 1.2	2,000, 1,500, 750, 500	16	8	
APS-134	Surveillance	HIANG Kokee	500	15 rpm	9,500	10,000	0.5	500	42	375	

Source: Modified from Miller, 1996

Table E-7. Representative Proposed Action Target Systems

Type	Category	Name	Propellant Type
Ballistic Missile			
	Small		
	Medium		
	Large	Orion 50S XLG	Solid
		Orion 50 XL	Solid
Cruise Missiles			
	Subsonic		
	Supersonic		

Table E-8. Target Launch Pad—Rail and Stool Requirements

Item/Facility Type	Requirements 0 to 1,200 kilometers (0 to 647.9 nautical miles)
Dimensions of Launch Pads/Construction Materials Assumed	12.2 meters x 15.2 meters + 15.2 meters (40 x 50 feet + 50 feet) for environmental shelter = 12.2 meters x 30.5 meters (40 x 100 feet) = 371.6 square meters (4,000 square feet). Concrete pad with outer gravel or coral area.
Cleared Area/No Vegetation Zone Surrounding Launch Pad	15.2 to 30.5 meters (50 to 100 feet)
ESQDs by Category Type [Intraline (IL), Public Transportation Route (PTR), Inhabited Building (IB)]	85.3 meters (280 feet) IL 228.6 meters (750 feet) PTR 381 meters (1,250 feet) IB ESQD
GHA Radius	For most unguided systems, GHA = 609.6 meters (2,000 feet) For guided systems, GHA = 1,828.8 to 3,048 meters (6,000 to 10,000 feet)
Electromagnetic Radiation Constraints to Personnel, Fuels, or Ordnance	Consider HERO (ordnance electronic triggering mechanisms potentially set off due to electromagnetic radiation).
Launch Pad Fencing/Security Needs	Should have access control to the hazardous operations/ launching area. The target payload may be classified.
Utilities to Launch Pad/Type Needed	Will bring some portable electrical generator capability (campaign). Will require a power distribution system, fuel storage, and containment area to avoid soil contamination.
Road Access to Launch Pad/Hazardous Transportation Route/ % Grade	Prefer gravel road of less than 6 percent grade. Prefer to stay off public highways.
Environmental Shelter/Pad/Dimensions	Depends on the type of missile system and site environmental constraints (some missiles are temperature, humidity, and salt spray dependent). At KTF, only tarps are used in some cases. Some booster rockets must be maintained between 15.5 to 26.7 degrees Celsius (60 to 80 degrees Fahrenheit). Also stool launch items will require wind protection.
Soil Conditions Desired	Stable soil, cleared gravel or paved area around the launcher.
Minimum Distance to Shoreline If Any	None. Consider waves, salt spray.

Table E-9. Target Support/Preparation and Launch Control Facilities Requirements

Item/Facility Type	Requirements
Missile Assembly—Need missile assembly building on Island or Build-up at Another Location (Specify if Known), Ship by Aircraft or Barge to Island, or Other Logistics Based on Distance, Weight, Airfield, etc.	No new missile assembly building needed. Build up at PMRF. Transport by aircraft or barge to island. May have an environmental shelter (stool) and/or clamshell (rail) at the launch site. Possible Environmental Control addition to Rocket Motor Staging Area at KTF—may want to add air conditioning.
Vertical Target Missile Service Tower Needed, Dimensions	None required.
Launch Control Van or Building	Mobile Launch Control Van [could be a van brought in by air or barge or a trailer like Kokole Point at PMRF with a berm (if a rail), or a van in a hardened van shelter (if a stool)].
Launch Pad Equipment Building	Equipment building [8 x 8 feet] next to pad.
Missile Storage Facility	May need missile storage if the number of launches per year justifies the cost.
Warehousing	Would use existing warehousing if available. If not, keep supplies on a barge or fly in/out. May use military vans or enclosed semi trailers.
Road Access Dimensions/Minimum Radii	12 feet wide road minimum, 50 feet turning radius to launch pad, 8 feet minimum to launch control.
Min. Distance to Shoreline If Any	None. Wave action? Salt spray?
Utilities to Facilities/ Type Needed	Electricity.
Security/Fencing/Clear Zone Needed/Dimensions	Not required unless there is a need to provide security protection or to mitigate for bird control (site specific—Tern). Dimensions undefined.
Electromagnetic Radiation Constraints to Personnel, Fuels, or Ordnance	Consider HERO (ordnance electronic triggering mechanisms potentially set off as a result of electromagnetic radiation).
View of Launch Pad Needed from Control Van/Building	Desired.

Table E-10. Representative Defense Missile Systems

Type	Category	Name	Propellant Type (Liquid/Solid)
Missiles			
	Ship	SM-2 BLK IVA	Solid
	Ship	SM-3	Solid
	Air	AMRAAM	Solid
	Land	MEADS	Solid
	Land	PATRIOT (PAC-2)	Solid
	Land	PAC-3	Solid
	Land	THAAD	Solid

Table E-11. Land-based Interceptor Launch Site (Mobile) Requirements

Item/Facility Type	Requirements 0 to 1,200 kilometers (0 to 647.9 nautical miles)
Desired Operational Launch Orientation/Flight Path	Need target range of between 350 and 1,000 kilometers (217.5 and 621.4 miles)
Dimensions of Launch Pads/Construction Materials Assumed	Need a hardstand area (prefer gravel or coral) and relatively level ground. Need an area of approximately 42.1 x 20.1 meters = 846 square meters (138 x 66 feet = 9,108 square feet). The launchers are to be sited within the 120 degree angle of the radar signal (60 degrees either side of the boresight). The launchers are to be located between 130.1 meters (427 feet) and 10 kilometers (6.2 miles) from the radar set. Several launchers may be sited within this area.
Cleared Area/No Vegetation Zone Surrounding Launch Pad	None. Consider security/visibility.
ESQD by Category Type (IL, PTR, and IB)	381 meters (1,250 feet) for IB ESQD, 85.3 meters (280 feet) IL, 228.6 meters (750 feet) PTR Note—Should plan for 381 meters (1,250 feet)—Dual mode Area Interceptors.
GHA Radius	1,829-meter (6,000-foot) radius
Electromagnetic Radiation Constraints to Personnel, Fuels, or Ordnance	120.1 meters (394 feet) in front of the radar - 60 degrees both sides of boresight (refer to PAC-3 environmental document).
Launch Pad Fencing/ Security Needs/Dimensions	Security guards required.

Table E-11. Land-based Interceptor Launch Site (Mobile) Requirements (Concluded)

Item/Facility Type	Requirements 0 to 1,200 kilometers (0 to 647.9 nautical miles)
Utilities to Launch Pad/Type Needed	Utilities are required for aerospace ground equipment and test instrumentation.
Road Access to Launch Pad/Percent Grade	Require road access through rough terrain, gravel preferred. Turning radius of 15.2 meters (50 feet). System designed to be mobile.
Soil Conditions Desired	Stable soil. Gravel surface desirable. Don't want equipment to sink.
Environmental Shelter/Pad/Dimensions	Re-enforced structures for Command and Control trailers.
Minimum Distance to Shoreline If Any	None. Consider wave action, salt spray.

Table E-12. Telemetry, Optics, and Radar Instrumentation Requirements

Item/Facility Type	Requirements
Instrumentation Devices/Facilities Required—Targets	Targets—Short- and medium-range multi-participant target and interceptor tracking and telemetry reception, additional range safety monitoring, and additional data products needed. Makaha Ridge: Radars (COSIP), optics, lasers, electronic warfare, telemetry (receivers, recorders, antennas) and internal power plant upgrades Kokee Parcel A: Radar (x band), Communications (CEC [tower], voice, data [telephone poles]) Parcel C: Telemetry antenna (phase array or dish), building (40x60) Parcel D: Radar (COSIP), telemetry antenna
Instrumentation Device(s)/Facilities Required - Interceptors	Area Interceptors—Assumes that Range assets are fixed or trailer mounted (portable).
Number of Interceptor Personnel Working/How Long	Radar site requires 15 people working 2 to 3 weeks.
Mobile Instrumentation Alternative	May consider mobile instrumentation at some sites if no or inadequate on-ground facilities exist. Example is the Wallops Flight Facility (NASA) system. Requires C-141 accessibility for airborne assets. On-ground assets require concrete pad for mobile radar pedestal, line of sight, adequate safety clear zone, and generator use. May also consider military P-3 aircraft use.

Table E-13. Communications, Command, and Control Requirements

Item/Facility Type	Requirements
Number of Interceptor Personnel Working/How Long	Battle management, communications, command, and control, and intelligence—15 people for 2 to 3 weeks.
Command and Control Enhancements—Targets/ Interceptors	Command and control needed; enhanced range safety monitoring needed; and FTS enhancement needed. Possible use of Building 105—Control Center at PMRF. Expand fiber optics. Expand office space. Add transmitters and receivers, other communication equipment. Could be mobile in aircraft.

Table E-14. Support Infrastructure Requirements

Item/Facility Type	Requirements
Electric Power/Portable Generator/Backup	For Interceptors—Need power under Test mode, no power under Tactical mode. Self contained. For Targets—Power needed, either local power or a generator.
Sanitation/Septic/Waste Treatment	For Interceptors—Total sanitation need is for 47 personnel for 2 to 3 weeks/launch. For Targets—Total sanitation need is for 6 to 10 personnel for 1 to 2 weeks/launch.
Solar Power	None for Interceptors. Targets—No need defined.
Natural Gas/Propane	None for Interceptors. Targets—No need defined.
Potable Water/Fire Flow/Storage	Interceptors and Targets—Drinking water for personnel, minor fire control.
Solid Waste Disposal/Transfer	Interceptors and Targets—Temporary on site storage and/or transport away.
Hazardous Materials Temporary Storage Transfer–Liquid and Storage	Interceptors and Targets—Temporary storage.
Storage/Warehousing/ Logistics Support and Services—Campaign Only	Interceptors and Targets—Use existing space, if available.
On-Island Road Access/Vehicle Storage, Maintenance, and Parking—Campaign Only	Interceptors and Targets—Semi-trailer road access to assets required. Campaign—No storage.
Off-Island Transportation (Air, Barge, Other)	Interceptors and Targets—Air transport (C-130, C-141, and C-5/C-17) and landing craft or ship. Aircraft use desirable.
Fire Station/Pumper/Training/Equipment/ Emergency Medical Team	As defined by PMRF Safety.

Table E-14. Support Infrastructure Requirements (Concluded)

Item/Facility Type	Requirements
Security Forces/Training	Interceptors and Targets—Security guards will be required during launches. No permanent support.
Recreation Facilities/Services	Interceptor and Targets—No need defined.
Fuel Storage	Interceptor and Targets—Electric generator and vehicle fuel storage.
Transient Quarters/Berthing Quarters-Barges	Interceptor and Targets—Need defined. Self-contained onshore camp concept or ship/barge quarters. See personnel numbers. Depends on frequency/location.
Permanent Housing (Base UEPH/Family Housing or Private Rental Housing)	Interceptor and Targets–No need defined.
Administrative Services/Office Space/ Campaign Trailer	Interceptor and Targets—Possible use of Building 105 at PMRF or SNL/KTF complex. Possible use of campaign trailer(s).
Medical Facility and Services	Interceptors and Targets—No special facilities required. Typical services assumed.
Mess Hall/Laundry Facility and Services	Interceptors and Targets—Self-contained onshore camp concept or ship/barge facilities.
Communications Facility and Services	Interceptors and Targets—No need defined.
Liquid Propellant Storage (Hypergolic)	Interceptor—May require temporary storage. Targets—Need defined for targets.
Small Explosives/Igniter/Squib Storage/Setbacks	Interceptor—No need defined. Targets—May require squib storage.
Heavy Equipment/Crane	Interceptor—No need defined. Targets—May require crane.
Lightering Boat and Marine Crew Services/Stevedoring	Interceptor and Targets—Need defined.
Berthing/Moorage/Dock and Ramp	Interceptor and Targets–Need defined if no adequate airfield.
Helipad	Interceptor and Targets–Need helipad support capability for emergency medical evacuation and supplies delivery, or airfield capability.
Aircraft Runway (C-130, C-141, C-5, C-17 or Other)/Airfield operations and maintenance/Hotpad/Aircraft Parking and Maintenance	C-130, C-141, and C-5/C-17.

Table E–15. Representative TMD Propellant and Exhaust Components

Missile	Propellant Class	Major Propellant Components	Major Exhaust Components
Weapon Systems			
MEADS	Solid	Aluminum, HTPB	Aluminum Oxide, Carbon Dioxide, Carbon Monoxide, Hydrogen, Hydrogen Chloride, Nitrogen, Water
PAC-2	Solid	Aluminum, Ammonium Perchlorate, Iron Oxide, Polymer Binder	Aluminum Oxide, Carbon Dioxide, Carbon Monoxide, Hydrogen, Hydrogen Chloride, Nitrogen, Water
PAC-3	Solid	Aluminum, HTPB	Aluminum Oxide, Carbon Dioxide, Carbon Monoxide, Hydrogen, Hydrogen Chloride, Nitrogen, Water
Standard Missile	Solid	Aluminum, Ammonium Perchlorate, HMX	Aluminum Chloride, Aluminum Oxide, Ammonia, Carbon Dioxide, Carbon Monoxide, Ferric Chloride, Ferric Oxide, Hydrogen, Hydrogen Chloride, Nitric Oxide, Nitrogen, Water
THAAD	Solid	Aluminum, Ammonium Perchlorate, Binder	Aluminum Oxide, Carbon Dioxide, Carbon Monoxide, Hydrogen, Hydrogen Chloride, Nitrogen, Water
Target System			
HERA	Solid	Aluminum, Ammonium Perchlorate, CTPB, HMX, Nitrocellulose-Nitroglycerine	Aluminum Oxide, Carbon Dioxide, Carbon Monoxide, Hydrogen, Hydrogen Chloride, Nitrogen, Water
LANCE	Liquid	IRFNA (Hydrogen Fluoride, Nitric Acid, Nitrogen Dioxide), UDMH, Water	Carbon Dioxide, Carbon Monoxide, Nitrogen, Oxygen, Water
STRYPI	Solid	Aluminum, Ammonium Perchlorate, CTPB, Nitrocellulose-Nitroglycerine, Polysulfide Elastomer	Aluminum Oxide, Carbon Dioxide, Carbon Monoxide, Chlorine, Hydrogen, Hydrogen Chloride, Hydrogen Sulfide, Nitrogen, Sulfur Dioxide, Water

CTPB = Carboxyl-terminated Polybutadiene
HTPB = Hydroxyl-terminated Polybutadiene
HMX = Cyclotetramethylenetetranitramine
UDMH = Unsymmetrical Dimethyl Hydrazine
IRFNA = Inhibited Red Fuming Nitric Acid

Appendix F
2006 Rim of the Pacific Exercise
After Action Report

APPENDIX F

2006 Rim of the Pacific Exercise After Action Report:

Analysis of the Effectiveness of the Mitigation and Monitoring Measures as Required Under the Marine Mammal Protection Act (MMPA) Incidental Harassment Authorization and National Defense Exemption from the Requirements of the MMPA for Mid-Frequency Active Sonar Mitigation Measures

Dated December 7, 2006

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INTRODUCTION

This report is presented to fulfill the requirements conditional to the 2006 Rim of the Pacific Exercise (RIMPAC 06) Marine Mammal Protection Act (MMPA) Incidental Harassment Authorization (IHA) and the National Defense Exemption from the Requirements of the MMPA for Certain DoD Mid-Frequency Active Sonar Activities (NDE).

Pursuant to the MMPA, an IHA was sought from the National Marine Fisheries Service (NMFS), which was issued by the NMFS Division of Permits, Conservation, and Education, Office of Protected Resources for 2006 RIMPAC Exercise on 27 June 2006. On 30 June 2006, the Deputy Secretary of Defense issued the NDE, which specified that for the conduct of RIMPAC 2006, the Navy would comply with all mitigation measures set out in the IHA. The IHA required that the Navy, "Submit a report to the Division of Permits, Conservation, and Education, Office of Protected Resources, NMFS and the Pacific Islands Regional Office, NMFS, within 90 days of the completion of RIMPAC."[1] The IHA further specifies that the report contain and summarize the following information:

> (1) "An estimate of the number of marine mammals affected by the RIMPAC ASW exercises and a discussion of the nature of the effects, if observed, based on both the modeled results of real-time exercises and sightings of marine mammals";
> (2) "An assessment of the effectiveness of the mitigation and monitoring measures with recommendations on how to improve them";
> (3) "Results of the marine species monitoring (real-time monitoring from all platforms, independent aerial monitoring, shore-based monitoring at chokepoints, etc.) before, during, and after the RIMPAC exercises"; and
> (4) "As much information (unclassified and, to appropriately cleared recipients, classified "secret") as the Navy can provide including, but not limited to, where and when sonar was used (including sources not considered in take estimates, such as submarine and aircraft sonars) in relation to any measures received levels (such as sonobuoys or on PMRF range), source levels, numbers of sources, and frequencies so it can be coordinated with observed cetacean behaviors."

This report, which contains only unclassified material, provides the necessary information and analyses, and thus fulfills these requirements. The report is organized by section following the order of the requirements in the IHA.

Section 1 provides an estimated number of marine mammals affected by the RIMPAC 06 ASW events based on analysis of actual events and sightings of marine mammals, noting the nature of any observed effects where possible.

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1 Given that the last day of the RIMPAC 2006 exercise was 26 July 2006, this report is due no later than 24 October 2006.

Section 2 of this report assesses the effectiveness of the mitigation and monitoring measures required during RIMPAC 2006 with regard to minimizing the use of Mid-Frequency Active Sonar (MFAS) in the vicinity of marine mammals. This section also includes an assessment of the practicality of implementation of the mitigation measures, the scientific basis behind those measures, and the impact some of the measures had on safety and the effectiveness of the required military readiness activities.

Section 3 presents the results of the marine species monitoring comprised of independent aerial reconnaissance, shore-based monitoring in the vicinity of the chokepoint events, and results from the NMFS observers embarked on the USS LINCOLN during one of the choke-point exercises. Also included in this section is a summary of the 29 marine mammal detections made by exercise participants during RIMPAC 06.

Section 4 of this report provides data on the location and hours of active MFAS used during RIMPAC 06 placed in context with observations of cetacean behaviors resulting from the aerial reconnaissance and shore-based monitoring and exercise participants.

SECTION 1: Marine Mammals Affected

The requirements stipulated in the IHA are to provide; "An estimate of the number of marine mammals affected by the RIMPAC ASW exercises and a discussion of the nature of the effects, if observed, based on both the modeled results of real-time exercises and sightings of marine mammals". To meet this requirement, Section 1 provides an estimated number of marine mammals affected by the RIMPAC 06 ASW events based on Navy's original calculations using a threshold of 190dB for sub-TTS effects, and analysis of actual events and sightings of marine mammals, noting the nature of any observed effects. It is compared to the estimated number of marine mammals affected as calculated when applying the 173dB sub-TTS threshold required by NMFS for issuance of the IHA.

The RIMPAC 2006 Supplemental Environmental Assessment predicted 532 hours of hull mounted MFAS use by exercise participants based on what had occurred in the previous RIMPAC exercise (RIMPAC 2004) and based on the present tactical ASW training requirements. In actuality, 472 hours of MFAS use from hull mounted sources occurred during RIMPAC 06 exercise.[2]

The types of ASW training conducted during RIMPAC 06 involved the use of ships, submarines, aircraft, non-explosive exercise weapons, and other training related devices. While ASW events would occur throughout the Hawaiian Islands Operating Area, most events would occur within six areas that were used for the modeling analysis since they were representative of variation in the marine mammal habitats and the bathymetric, seabed, wind speed, and sound velocity profile conditions within the entire Hawaiian Islands Operating Area (OPAREA). Figure 1 on the following page displays the areas used for modeling and the OPAREA for the RIMPAC 06 exercise.

For purposes of the impacts analysis, all likely RIMPAC 06 ASW events were modeled as occurring in these areas. In fact, the majority of MFAS use occurred in the modeled areas as predicted (see Section 4 for a more detailed discussion), but any deviation from this would have been immaterial since the modeled areas were delineated so as to encompass the variation occurring in the entire Hawaiian Islands Operating Area.

Modeling a predicted number of marine mammals affected by the RIMPAC 06 ASW events was undertaken based on acoustic thresholds derived from experimental data – 190 dB Sound Exposure Level (SEL), which Navy believed, in a worst case analysis, indicated the potential to affect 289 marine mammals (for further details see the 2006 Supplement to the 2002 Rim of the Pacific Programmatic Environmental Assessment). This number was calculated from the modeling without consideration for reductions resulting from the standard Navy protective measures mitigating exposure to MFAS or the additional measures imposed by the IHA.

2 Three days of planned MFAS use were precluded by a temporary restraining order resulting from a lawsuit.

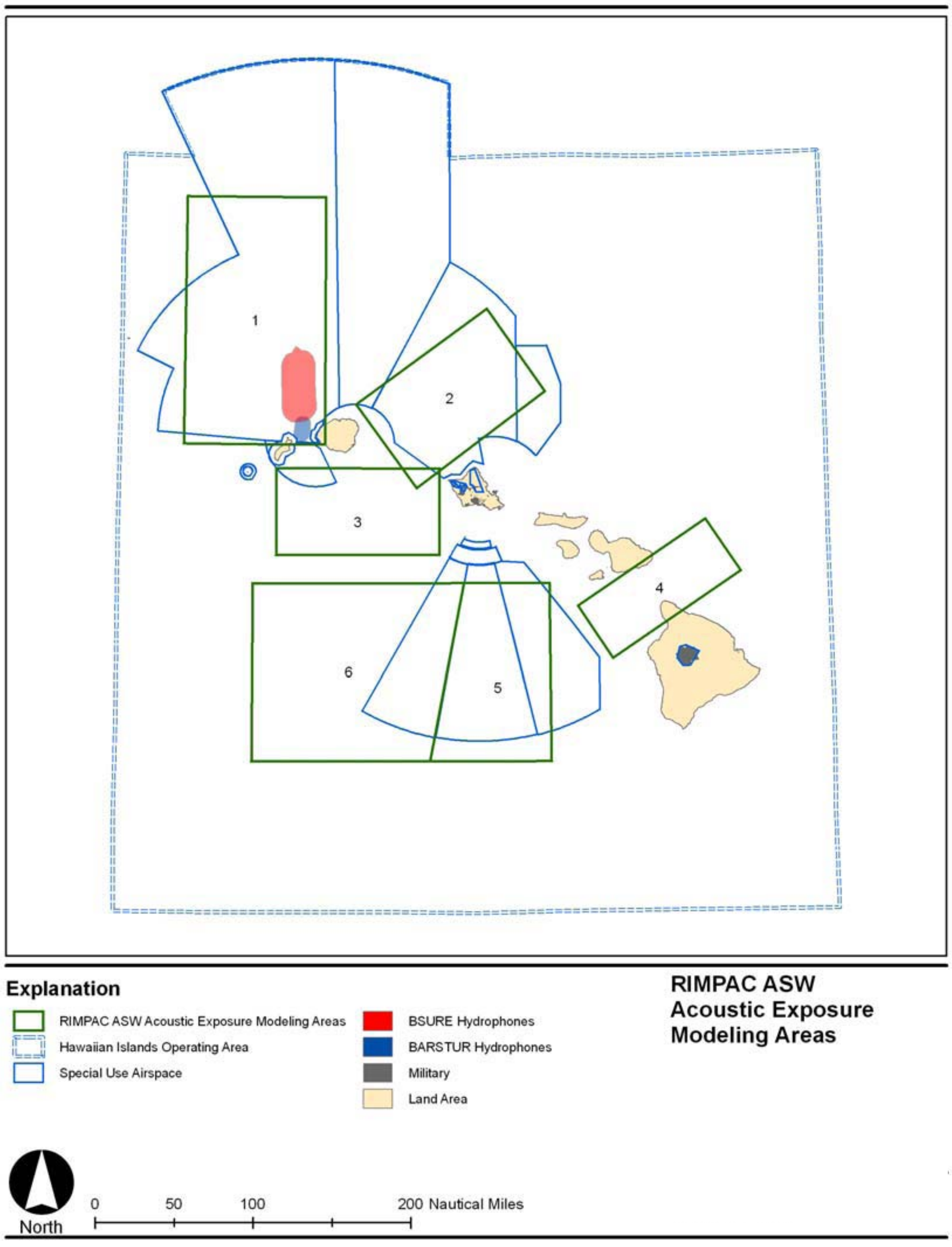

Figure 1. RIMPAC 2006 Exercise Operating Area depicting the areas used for modeling purposes in the analysis of effects on marine mammals.

Based on the reduction of MFAS hours from the modeled 532 to the actual 472 hours, the estimated potential number of marine mammals affected may be reduced to approximately 256 marine mammals (based on a ratio of marine mammal exposures exceeding the threshold to hours of MFAS operation).

Following the modeled calculation of marine mammals affected, if required to determine the actual number of marine mammals affected by the exercise as mandated by the IHA, it is necessary to take into consideration standard Navy protective measures including decreasing the source level and then shutting down MFAS when detected marine mammals are approached. This must be done since the mitigative effect of the protective measures were not factored into the modeling calculations. While there is no clear metric value that can be assigned to mitigative effect of these measures, there was a reduction in potential to impact marine mammals by their implementation.

During the exercise, there were 29 instances when marine mammals (individuals or pods) were detected by exercise participants. All detections were made by standard lookout and aircraft reporting procedures except for one case of passive acoustic detection, which is also a standard Navy practice protective measure. As a result of the protective measures in place and the high-level emphasis placed upon marine mammal protection, MFAS was shutdown by 12 exercise participants due to the detected marine mammals as detailed in Table 1.

Table 1. Details of the 29 marine mammal detections and actions by exercise participants during RIMPAC 06.

	July Date-Time (Z)	Modeled Area (Fig. 1)	Lost Hours	Description of Actions Taken
1	7/10-1738	1	0.5	Helicopter sighted “marine mammal” >30Kyds from two active ships. Two ships shutdown MFAS for 15 min until further information from reporting unit was obtained and assessed in regard to requirements. Submarines in vicinity.
2	7/10-1912	5	1.5	Surface ship sighted “marine mammal” and shutdown MFAS. Other Surface Action Group (SAG) units notified. Helicopter obtained visual on “a whale”; notified nearest ship in SAG. Second helicopter 11 nm west detected another “whale” four minutes later but contact then immediately lost on both whales. Ship in SAG obtained visual on “pod of dolphins”, which then approached w/in 1000 yards so MFAS reduced sonar by 6 dB. Second pod of dolphins appeared soon thereafter and then a third “whale” appeared inside 200 yards MFAS shutdown for all three 3 SAG surface and 2 air units 30 min. MFAS resumed 30 minutes later after range opened. Submarine in vicinity. Note: 6 total marine mammal detections this event.
3	7/11-1314	2		Surface ship sighted “dolphin” at 500 yds. MFAS not active.
4	7/11-1522	2		Surface ship sighted “pod of whales” range at 300 yds. Maneuvered to open range. MFAS not active.
5	7/11-1641	2		Surface ship sighted “whale” at 200 yds. MFAS not active.
6	7/12 0215	2	0.5	Sighted “marine mammal” and shutdown MFAS opened range prior to recommencing active.

Table 1 (cont.). Details of marine mammal detections and actions by exercise participants during RIMPAC 06

	July Date-Time (Z)	Modeled Area (Fig. 1)	Lost Hours	Description of Actions Taken
7	7/12-1827	5	2.0	P-3 aircraft detected passive acoustic marine mammal traces within 4000 yards. Active tracking of submarine ceased with limitation to passive only and lost contact. Four submarines in vicinity.
8	7/14-1909	1		Ship sighted "whale" >1000 yards. MFAS remained active.
9	7/14-1923	1		Ship sighted "marine mammal" >1000 yards. MFAS remained active.
10	7/17-1625	1		Ship sighted a "dolphin". MFAS not active.
11	7/17 2248	2	0.5	P-3 aircraft sighted two "whales". Could not use active (DICASS) buoys. Submarine in vicinity.
12	7/19 0046	1	0.25	Ship sighted "2 pods of 10 pilot whales". Shutdown MFAS.
13	7/19 0320	1	0.5	Ship sighted "pod of three pilot whales" to the south bearing 040T @200 yds. Shutdown MFAS.
14	7/19 1819	2	0.25	Ship sighted "whales" 1000 yards off port beam. Shutdown MFAS.
15	7/20 0346	5	1.0	Ship sighted "pod of whales". Shutdown MFAS.
16	7/20 1612	2	0.5	Ship sighted "marine mammals". Shutdown MFAS. Submarine in vicinity.
17	7/20 2013	6		Ship sighted "dolphins" off bow. MFAS not active.
18	7/20 2128	6		P-3 aircraft sighting of 8 "whales". DICASS not available for tactical development. Submarine in immediate vicinity.
19	7/20 2300	5		Ship sighted 5 "dolphins" moving SE at 8 kts. MFAS not active Two submarines in vicinity.
20	7/21 1742	5		Ship sighted pod of approx 20 "dolphins" moving to SE. MFAS not active. Two submarines in vicinity.
21	7/22 0429	5		Ship sighted "porpoises" 1-2 miles off starboard beam. MFAS not active. Two submarines in vicinity.
22	7/23 0457	3		Ship sighted "pilot whale". MFAS not active.
23	7/23 1913	5	0.5	Ship sighted 20 "whales" heading SW and shutdown MFAS. Two submarines in the area.
24	7/25 0015	4		**NMFS** passed along report of pod of approx 400-500 melon-headed whales in channel between Maui and Hawaii. P-3 tasked to investigate but verification precluded due to cloud cover.
25	7/25 0430	5		Ship sighted "whale". MFAS not active.
		Participant Hours Lost	**8.0**	

As noted previously, instances of marine mammal detection by exercise participants with the resulting implementation of protective measures was unaccounted for by the predictive modeling assessing potential exercise effects on marine mammals. In RIMPAC 06, there were 29 marine mammal detections by exercise participants, which resulted in protective measures being implemented for approximately 70 marine mammals and eight additional "pods" of marine mammals (Table 1). Assuming that each detected (un-quantified) pod of marine mammals consisted of at least four marine mammals, then the total number of detected marine mammals for which exposure to MFAS was limited by standard Navy lookouts was approximately 100 marine mammals.

Also required for the analysis in this section was consideration of "the nature of any observed effects" resulting from MFAS use. The reports from exercise participants contained nothing that could be construed as abnormal or "observed effects" of MFAS. There were no instances where marine mammals behaved in an erratic, unusual, or anything other than a normal manner.

Details regarding sightings and behaviors resulting from the aerial reconnaissance and the shore-based observers are presented in Section 3 of this report. In short, there were no abnormal behaviors or unusual distributions of marine mammals observed during these monitoring efforts and, therefore, no observed effects resulting from MFAS use.

Of the estimated potential 256 marine mammals affected by 472 hours of MFAS use, approximately 100 were precluded from exposure to MFAS by implementation of the protective measures. Therefore, an estimate of the number of marine mammals affected by the RIMPAC ASW exercises was 156 marine mammals based on the modeled results of real-time exercises, actual events, and sightings.

NMFS believed that the 190dB SEL sub-TTS threshold was not sufficiently precautionary and required Navy to apply for its IHA using 173dB SEL. Using the 173dB threshold with the same modeling program and marine mammal density estimates as before, we arrived at in excess of 33,000 behavioral disturbances, or takes. For perspective, this is about twice the number of marine mammals estimated to inhabit the waters around Hawaii in which the exercise took place.

There were no affected marine mammals observed by exercise participants, aerial or shore based monitors, or via any other reports. Therefore, further analysis based on observed effects, as mandated by this reporting requirement, is not possible and was not attempted.

In summary, the pre-exercise estimate of marine mammals behaviorally affected in RIMPAC 06 was 289 using 190dB sub-TTS threshold and over 33,000 using 173dB. No observers, from any platform or vantage point, noted in any reports that any marine mammals were affected by sonar. Conclusions are:

- Using 173dB SEL, a discrete decibel level, to define sub-TTS threshold was overly precautionary to a significant degree.

- There was no evidence of any behavioral affects on marine mammals throughout the exercise.

SECTION 2: Mitigation And Monitoring

As required under the IHA the report must contain, “An assessment of the effectiveness of the mitigation and monitoring measures with recommendations on how to improve them”. This section of the report, therefore, provides an assessment of the effectiveness of the mitigation and monitoring measures, the scientific validity behind each measure, and recommendations on how to improve them with regard to practicality of implementation, their impact on exercise safety, and their impact on the effectiveness of the military readiness training activity.

During RIMPAC 06, there were 199 anti-submarine warfare (ASW) events and 472 total hours of mid-frequency active sonar (MFAS) use. There were no reported stranding events or observations of behavioral disturbance of marine mammals linked to sonar use during the exercise. Specifically, there were three monitored choke-point exercises with observations by aerial reconnaissance and shore-based monitors before, during, and after. There was no indication from the Navy monitors or from the non-governmental civilian monitors of any effects on marine mammals. These results are consistent with the previous 19 RIMPAC exercises in which no strandings linked to sonar use.

The only mitigation measures that prevented the use of MFAS in the vicinity of marine mammals were those that the Navy already had in place (Lookouts, aircraft reporting, and “safety zones”) with the exception of a modification of the Navy’s safety zone (450 yds) to 1000 m, agreed to for issuance of the IHA. The result of applying these standard mitigation measures was that exercise participants lost approximately eight hours of active sonar use.

In the 12 events where MFAS was shutdown by exercise participants, a total of approximately eight hours of ongoing MFAS use ceased, thus impacting the effectiveness of those military readiness activities. Some of the interrupted events involved lost time by multiple units operating in an integrated manner with the ramification being that shutdown of MFAS by a Surface Action Group (SAG) consisting of three vessels for 30 minutes resulted in 1.5 hours lost training time. Many of these events took place when submarines were in the vicinity of exercise participants and could have possibly been detected if MFAS had been available. It is important to realize that for the remainder of the instances for which marine mammals were detected, the option to use MFAS as tactically indicated was precluded and thus impacted the effectiveness of exercise event since commanders were operating without the option of their full sensor suite (e.g., helicopters operating with the SAG). This is especially true in the case of events involving sonobuoys where the inability to command-activate DICASS may have precluded the ability to track a contact or precluded development of attack criteria. In one case during RIMPAC 06 (Table 1, #7), a P-3 aircraft lost track on a submarine actively being prosecuted resulting in a major training impact to the unit involved.

ASW proceeds slowly and requires careful development of a tactical frame of reference over time as data is integrated from a number of sources and sensors. Once MFAS is turned off for a period of time, simply turning it back on minutes later does not usually allow a Commander to simply continue from the last frame of reference. Thus, 15 minutes of lost MFAS time does not equate to only 15 minutes of lost exercise time but should be considered in the fuller context of its overall impact on the tempo and tactical development of a Common Operational Picture shared among exercise participants as they trained with the goal of interoperability and improvement of ASW skills in general.

While the Navy's standard protective measures impacted the effectiveness of the training, a subset of the additional measures imposed by the IHA had no observed increased effectiveness in the protection of mammals during this exercise, and restricted the ability to train realistically in the known diesel submarine threat environments required for warfighting readiness. This subset of mitigation measures is as follows:

- Requirements regarding "strong surface ducting conditions"
- Requirements regarding "low visibility conditions"
- Restrictions from operating MFAS within 25 km of the 200 m isobath.
- Restrictions from operating MFAS in choke-points, constricted channels or canyon-like areas.

The following requirements associated with choke-point events were monitoring efforts mandated by NMFS as a sampling strategy to determine if there was any effect on marine mammals during these transits of the channels while conducting ASW operations..

- Additional requirements when conducting choke-point operations, to include:
    - Additional Non-Navy observers
    - Extensive additional aircraft monitoring
    - Shoreline reconnaissance
    - Additional Navy lookouts

These measures arose from a precautionary concern that MFAS use in the channels could possibly have greater potential to impact marine mammals, despite no evidence suggestive of this from previous RIMPAC exercises. The cost to implement these requirements was $66,000 for RIMPAC 06.

Analysis of results from RIMPAC indicates that the types of measures already in place in the Protective Measures Assessment Protocol (PMAP) were adequate to prevent operation of MFAS in the vicinity of detected marine mammals:

- There were no indications of any effects to any marine species throughout the exercise.
- Of the 29 instances where marine mammals were detected, MFAS was shutdown for 12 units and ASW events were interrupted by implementation of standard mitigation measures by Navy watch standers or aircraft (see Table 1). Mitigation

measures agreed to for this exercise that were in addition to Navy SOP protective measures did not provide observable increased protection to marine mammals.

- Burdensome administration of the IHA's additional mitigation measures distracted exercise participants, watchstanders, and exercise commanders at the headquarters level from their primary responsibility of exercise training and safety. While personnel seemed to adequately absorb this increased workload, there were no indications from all observations that the additional mitigation measures required provided additional protection to marine mammals during this exercise.

The following protective measures were already Navy SOP (PMAP) and were also mandated as mitigation measures for RIMPAC:

1. Personnel are trained on marine mammal awareness and mitigation measures.
2. There are personnel on lookout with binoculars at all times when the vessel is moving through the water.
3. On surface ships there are always at least three people on the bridge on lookout at all times and during ASW operations at least five people on lookout.
4. Lookouts report the sighting of any marine species, disturbance to the water's surface, or object in the water to the Officer of the Deck, who is the Commanding Officer's direct representative on watch.
5. A safety zone is established around an active sonar source and sonar power is reduced when marine mammals enter this zone.
6. Submarine sonar operators review detection indicators of close-aboard marine mammals prior to the commencement of ASW operations involving MFAS.
7. Aerial surveillance for marine species occurs whenever possible and detections are reported to ships in the vicinity.
8. Helicopters using active (dipping) sonar observe and employ a safety zone.
9. Sonar is always operated at the lowest practicable level to meet tactical training objectives.

The following mitigation measures agreed to for issuance of the IHA had no observable impact on the protection of mammals in this exercise and negatively affected training. Prohibitions against operating in shallow water or in choke-points are contrary to ASW training requirements. These measures affect the ability to train realistically in the known diesel submarine threat environment and directly impact vital military readiness activity:

1. The restriction from operating MFAS within 25 km of the 200 m isobath.
2. The restriction from conducting sonar activities in constricted channels or canyon-like areas.

The following measures had no observable effect on the protection of mammals during this exercise, and could not be accurately and uniformly employed:

1. Requirements regarding "strong surface ducting conditions"
2. Requirements regarding "low visibility conditions"

To organize the assessment of each mitigation measure, they are presented below in the order and organization as presented by in the IHA.

RIMPAC 06 IHA Mitigation and Monitoring Requirements

Measures (a) and (b)
The first two mitigation measures ((a) and (b)) detail training requirements for units participating in MFAS ASW exercises. All of the requirements within these two measures are redundant with the Marine Species Awareness Training (MSAT) that Navy lookouts and bridge personnel receive as Navy SOP. MSAT was developed in coordination with marine biology experts within the Navy and provides all effective marine species detection cues and information necessary to detect marine mammals and sea turtles. This material is part of the Navy Lookout watchstander qualification system, and will soon be available as online interactive training, and can also be provided in a video format for large audience presentations.

NMFS (Pacific Islands Region) reviewed and approved MSAT to meet the purposes of these first two mitigation measures.

Measure (a)
The MMPA Permit Monitoring and Mitigation Measure (a) read as follows:

(a) All RIMPAC participants will receive the following marine mammal training/briefing during the port phase of RIMPAC:

(i) Exercise participants (CO/XO/Ops) will review the C3F Marine Mammal Brief, available OPNAV N45 video presentations, and a NOAA brief presented by C3F on marine mammal issues in the Hawaiian Islands.

(ii) NUWC will train observers on marine mammal identification observation techniques.

(iii) Third fleet will brief all participants on marine mammal mitigation requirements.

(iv) Participants will receive video training on marine mammal awareness.

Assessment: Training was already standard for all units before RIMPAC and is effective as a mitigation measure.

Operational Impact of this mitigation measure:
None. Using standardized and required training materials and procedures is more practical and effective.

Recommendation
Training personnel in marine species detection and cues to enable operators to make informed decisions regarding potential interactions with protected marine species should be retained and is standard Navy practice. This measure should be rewritten as provided in Appendix (A).

Measure (b)

The MMPA Permit Monitoring and Mitigation Measure (b) read as follows:

> *(b) Navy watchstanders, the individuals responsible for detecting marine mammals in the Navy's standard operating procedures, will participate in marine mammal observer training by a NMFS-approved instructor. Training will focus on identification cues and behaviors that will assist in the detection of marine mammals and the recognition of behaviors potentially indicative of injury or stranding. Training will also include information aiding in the avoidance of marine mammals and the safe navigation of the vessel, as well as species identification review (with a focus on beaked whales and other species most susceptible to stranding). At least one individual who has received this training will be present, and on watch, at all times during operation of tactical mid-frequency sonar, on each vessel operating mid-frequency sonar.*

Assessment: Training as a mitigation measure can be captured in one requirement as provided in Appendix (A).

Operational Impact of this mitigation measure:
None. Using standardized and required training materials and procedures is more practical and effective.

Recommendation
For Navy authorizations, adopt the training measure provided in Appendix (A), which is based on the MSAT training video.

(1) The Navy's training and qualification program meets or exceeds the expectations of this mitigation measure. Navy personnel serving as lookouts and on bridge watch are highly qualified and experienced marine observers. At all times, they are required to sight and report all objects sighted in the water (regardless of the distance from the vessel) to the Officer of the Deck, because any object (e.g., trash, periscope) or disturbance (e.g., surface disturbance, discoloration) in the water may be indicative of a threat to the vessel. Navy lookouts undergo extensive training in order to qualify. This training includes on-the-job instruction under the supervision of an experienced lookout, followed by completion of the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). In addition to these requirements, many lookouts periodically undergo a 2-day refresher training course.

(2) The Navy includes MSAT as part of its regular training regimen for its bridge lookout personnel on ships and submarines. This training is the most appropriate material available to allow for the safe operation of Naval vessels while limiting interactions with marine mammals and has been approved by NMFS. This training addresses the lookout's role in environmental protection, laws governing the protection of marine species, Navy stewardship commitments, and general observation information to aid in avoiding interactions with marine mammals. Finally, Navy personnel are trained

in the most effective means to ensure quick and effective communication within the command structure and facilitate implementation of protective measures if marine species are spotted. Navy personnel are trained to act swiftly and decisively to ensure that information is passed to the appropriate supervisory personnel.

Measure (c)
This measure reads:

> *(c) All ships and surfaced submarines participating in the RIMPAC ASW exercises will have personnel on lookout with binoculars at all times when the vessel is moving through the water (or operating sonar). These personnel will report the sighting of any marine species, disturbance to the water's surface, or object to the Officer in Command.*

Assessment: This measure is included Navy's SOPs, but as written requires one change.

Operational Impact of this mitigation measure:
None.

Recommendation
This mitigation measure is standard Navy practice and necessary for safe navigation. Reference to surfaced submarines should be removed since surfaced submarines are never engaged in ASW or use MFAS for ASW when on the surface.

Measure (d)
This measure reads:

> *(d) All aircraft participating in RIMPAC ASW events will conduct and maintain, whenever possible, surveillance for marine species prior to and during the event. Marine mammal sightings will be immediately reported to ships in the vicinity of the event as appropriate.*

Assessment: This measure is part of Navy's SOPs.

Operational Impact of this mitigation measure:
None.

Recommendation
This mitigation measure is standard Navy practice and necessary for safe navigation.

Measure (e)
This measure reads:

> *(e) Submarine sonar operators will review detection indicators of close-aboard marine mammals prior to the commencement of ASW operations involving active mid-frequency sonar. Marine mammals detected by passive acoustic* (sic)[3]

3 The last sentence of this mitigation measure as published in both the IHA and the NDE is incomplete.

Assessment: This measure is in Navy's SOPs.

Operational Impact of this mitigation measure:
None.

Recommendation
These practices are already standard Navy procedures.

Measure (f)
This measure reads:

> *(f) Safety Zones - When marine mammals are detected by any means (aircraft, lookout, or acoustically) within 1000 m of the sonar dome (the bow), the ship or submarine will limit active transmission levels to at least 6 dB below normal operating levels. Ships and submarines will continue to limit maximum transmission levels by this 6-dB factor until the animal has been seen to leave the area, has not been seen for 30 minutes, or the vessel has transited more than 2000 m beyond the location of the sighting.*
>
> *Should a marine mammal be detected within or closing to inside 500 m of the sonar dome, active sonar transmissions will be limited to at least 10 dB below the equipment's normal operating level. Ships and submarines will continue to limit maximum ping levels by this 10-dB factor until the animal has been seen to leave the area, has not been seen for 30 minutes, or the vessel has transited more than 1500 m beyond the location of the sighting.*
>
> *Should the marine mammal be detected within or closing to inside 200 m of the sonar dome, active sonar transmissions will cease. Sonar will not resume until the animal has been seen to leave the area, has not been seen for 30 minutes, or the vessel has transited more than 1200 m beyond the location of the sighting.*
>
> *If the Navy is operating sonar above 235 dB and any of the conditions necessitating a power-down arise ((f), (g), or (h)), the Navy shall follow the requirements as though they were operating at 235 dB - the normal operating level (i.e., the first power-down will be to 229 dB, regardless of at what level above 235 sonar was being operated).*

Assessment: This mitigation measure is effective, and requires improvement.

Operational Impact of this mitigation measure:
During RIMPAC, marine mammals were visually detected three times by fixed-wing aircraft, three times by helicopters, and 23 times by lookouts aboard ships. Active MFAS use ceased in 12 exercise events, as the ships opened the range with the locations where the marine mammals had been detected. In three additional events, P-3 aircraft were not able to use active DICASS sonobuoys as tactics may have required. Due to this mitigation measure, a total of approximately eight hours of training time was lost.

This loss of MFAS training hours is more than a simple metric involving a loss of training time as a small percentage of the overall exercise hours since, in at least six cases, the proximity of a submarine in the vicinity meant there was a potential submarine detection opportunity missed by the exercise participants.

Recommendation
A "safety zone" mitigation measure was already SOP and this mitigation measure should be retained. Expansion of the safety zone beyond 1000 m (or 1000 yards) is not prudent. This distance is the maximum Navy should impose on its ship commanding officers to certify "safe" for marine mammals or decrease the output of MFA sonar.

The provision regarding the reduction of transmission power if operating sonar above 235 dB is reasonable and should be added as Navy SOP.

This mitigation measure involving "safety zones" should be retained with the following revisions:

- Yards should be used vice meters because all Navy training and operations use yards as a term reference and there is no substantive difference in sound propagation between 1000 meters and 1000 yards.
- The 2000 meter, 1500 meter, and 1200 meter variable distance for when active sonar can resume is unnecessarily complex and the expanded distances without scientific merit.

Measure (g)
This measure reads:

> *(g) In strong surface ducting conditions (defined below), the Navy will enlarge the safety zones such that a 6-dB power down will occur if a marine mammal enters the zone within a 2000 m radius around the source, a 10-dB power-down will occur if an animal enters the 1000 m zone, and shut down will occur when an animal closes within 500 m of the sound source.*
>
> *A strong surface duct (half-channel at the surface) is defined as having the all the following factors: (1) A delta SVP between 0.6 to 2.0 m/s occurring within 20 fathoms of the surface with a positive gradient (upward refracting); (2) Sea conditions no greater than Sea State 3 (Beaufort Number 4); and (3) Daytime conditions with no more than 50% overcast (otherwise leading to diurnal warming). This applies only to surface ship mid-frequency active mainframe sonar.*

Assessment: This mitigation measure could not be effectively implemented or uniformly employed in RIMPAC. Additionally, there is no evidence to indicate it is effective or that it provides protection for marine mammals in addition to that provided in measure (f).

Operational Impact of this mitigation measure:
This mitigation measure could not be accurately and uniformly employed during RIMPAC. The exercise headquarters found so many variations in water conditions

across the exercise area that the determination of "strong surfacing ducting" was futile. It was problematic for the following reasons:

(1) There is so much local variation in the Pacific Fleet training areas that it would be necessary for a ship to constantly monitor the local environment to accurately comply with this measure. Measurements taken during RIMPAC indicated large variation in the presence or absence of significant surface ducts over relatively short distances in the Hawaiian operating areas.

(2) The models used in forecasting a significant surface duct used high resolution that still resulted in a generalized sea state, SVP, and cloud cover over a large operational area covered by exercise participants. Measured local variations were so different from these forecasts that the determination that "significant surface duct condition do/do not exist" was inherently inaccurate.

(3) There is no means to know if the local SVP ahead of the ship is the same as the SVP being measured. Oceanographic models are years away from being able to model the ocean's structure in four dimensions at the resolution required to accurately predict SVP changes on a detailed scale.

(4) There is no allowance for local variations from tidal flux, differential sea states (as frequently seen in channels or shear lines to the southwest of most points of land in Hawaii), and currents/eddies - all of which have a significant effect on surface ducting.

<u>Recommendation</u>

Because the process to determine if a significant surface duct exists across the entire exercise area could not be effectively implemented or uniformly employed, recommend this measure not be included in future authorizations.
In addition, this measure seems to have been an outgrowth of the apparent evidence that significant surface ducting may have played a role in previous incidents involving stranding of beaked whales in certain conditions. There is no evidence to suggest that significant surface ducting in and of itself causes MFA sonar's overall effects to be increased, and it is still not known whether the presence of surface ducting was actually significant in the known beaked whale stranding incidents.

<u>Measure (h)</u>

This measure reads:

> *(h) In low visibility conditions (i.e., whenever the entire safety zone cannot be effectively monitored due to nighttime, high sea state, or other factors), the Navy will use additional detection measures, such as infrared (IR) or enhanced passive acoustic detection. If detection of marine mammals is not possible out to the prescribed safety zone, the Navy will power down sonar (per the safety zone criteria above) as if marine mammals are present immediately beyond the extent of detection. (For example, if detection of marine mammals is only possible out to 700 m, the Navy must implement a 6 dB power-down, as though an animal is present at 701 m, which is inside the 1000 m safety zone)*

Assessment: This mitigation measure was not necessary in RIMPAC since a condition of low visibility, as defined by the measure, was never encountered. In other words, at night lookouts were still able to monitor out to the limits of the safety zone. This mitigation measure has the potential to directly affect training and therefore the effectiveness of the military readiness activity.

<u>Operational Impact of this mitigation measure</u>:
This measure would preclude use of a sensor when tactically required and significantly affects the military readiness activity. Navy must be allowed to operate MFAS at night and in heavy seas using the full potential of sonar as a sensor.

There is no "enhanced passive acoustic detection" – Navy ships continuously use every passive device available, and the state of technology for detecting marine mammals passively is rudimentary at best.

<u>Recommendation</u>
This procedure has the potential to directly affect the military readiness activity. Recommend it not be incorporated in future authorizations or modified as to avoid impacting training realism in low visibility conditions.

<u>Measure (i)</u>
This measure reads:

> *(i) Helicopters shall observe/survey the vicinity of an ASW exercise for 10 minutes before deploying active (dipping) sonar in the water. Helicopters shall not dip their sonar within 200 yards of a marine mammal and shall cease pinging if a marine mammal closes within 200 yards after pinging has begun.*

Assessment: This measure is part of Navy's SOPs.

<u>Operational Impact of this mitigation measure</u>:
None.

<u>Recommendation</u>
Continue as standard Navy protective measures.

<u>Measure (j)</u>
This measure reads:

> *(j) The Navy will operate sonar at the lowest practicable level, not to exceed 235 dB, except for occasional short periods of time to meet tactical training objectives.*

Assessment: This measure is part of Navy's SOPs.

<u>Operational Impact of this mitigation measure</u>:
None.

Recommendation
Continue as standard Navy protective measures.

Measure (k)
This measure reads:

> *(k) With the exception of three specific choke-point exercises (special measures outlined in item (m)), the Navy will not conduct sonar activities in constricted channels or canyon-like areas.*

Assessment: This mitigation measure could not be precisely implemented, significantly impacts military readiness, has no scientific basis for implementation in the Hawaiian Islands, and provided no observable protection to marine mammals during this exercise.

Operational Impact of this mitigation measure:
Restricting Navy operations in choke-points are contrary to ASW training requirements. This measure limits the ability to train realistically in the known diesel submarine threat environment and directly impacts a vital military readiness activity.

This prohibition against MFAS use in "constricted channels or canyon-like areas" could not be precisely implemented or uniformly enforced because there were no defining metrics. The terms "constricted channels or canyon-like areas" have no meaning within the Navy or in maritime communities and were not defined by the IHA. Additionally, there is no scientific basis for a determination that such vaguely defined bathymetric features tend to concentrate marine mammals and/or have a greater potential to effect marine mammals, and therefore warrant prohibitive measures.

RIMPAC 2006 completed three monitored choke-point events with observations before, during, and after the events. There was no indication of any marine mammal impacts from the Navy monitors or from the non-governmental civilian monitors who were out in small vessels off Kauai and Hawaii Island during these events.

There is no data for the Pacific indicating the need for the precautionary prohibition against choke-point exercises, "constricted channels", or "canyon-like areas". There have been 19 previous RIMPAC exercises and numerous JTFEX, USWEX and COMTUEX exercises in SOCAL and Hawaii involving choke-point exercises that have occurred over many years without an indication of effect on any marine mammals.

Recommendation
This procedure had no observable effect on the protection of mammals during this exercise. Recommend future authorizations contain better definition of bathymetric features of concern and that the features of concern are based on definitive evidence of increased risk to marine mammals.

Measure (l)

This measure reads:

> *(l) With the exception of three specific "choke-point" exercises (special measures outlined in item (m)), the Navy will not operate mid-frequency sonar within 25 km of the 200 m isobath.*

Assessment: This is no scientific basis indicating this measure is warranted in the Pacific and no basis for the specific metrics (25 km of the 200 m isobath). In addition, there are no standard US nautical charts depicting depths in meters making this a difficult measure to implement in the field. This measure significantly impacts military readiness.

Operational Impact of this mitigation measure:

During RIMPAC this measure precluded active ASW training in the littoral region, which significantly impacted realism and training effectiveness. Prohibitions against operating in littoral areas are contrary to ASW training requirements. This measure affects the ability to train realistically in the known diesel submarine threat environment and directly impacts vital military readiness activity. (Note: Any reference to isobath curves should be in fathoms vice meters. There are no approved NOAA nautical charts that provide for a 200m isobath.)

Recommendation

This procedure had no observable effect on the protection of mammals during this exercise and therefore its value is uncertain. Its effect on realistic training is, however, clear and significant. The areas prohibited by this measure are the very ones where training against quiet submarines is most important. With respect to the presence of marine mammals, there is no scientific basis for the metrics particular to the 200 m isobath nor the 25 km distance from the 200 m isobath. In addition, the lengthy history of sonar use in the Hawaiian Islands and SOCAL without any strandings or apparent effect on marine mammals argues that this measure is unnecessary. Recommend it not be included in future authorizations.

Measure (m)

This measure deals with "choke-point" events, contains various subparts, and reads:

> *(m) The Navy will conduct no more than three "choke-point" exercises. These exercises will occur in the Kaulakahi Channel (between Kauai and Niihau) and the Alenuihaha Channel (between Maui and Hawaii). These exercises fall outside of the requirements listed above in (k) and (l), i.e., to avoid canyon-like areas and to operate sonar farther than 25 km from the 200 m isobath. The additional measures required for these three choke-point exercises are as follows:*

Assessment: This measure is not a mitigation and therefore requires no assessment.

Measure (m) Part (i)

This part of measure (m) reads:

(i) The Navy will provide NMFS (Stranding Coordinator and Protected Resources, Headquarters) and the Hawaii marine patrol with information regarding the time and place for the choke-point exercises 24 hours in advance of the exercises.

Assessment: This measure is a monitoring effort vice a mitigation and does not provide additional protection to marine mammals.

<u>Operational Impact of this mitigation measure</u>:
Notification to NMFS did not meet the "24 hours in advance" requirement for several reasons. Since choke-point events are scheduled to occur within a range of time, such as within a 24 hour period, the exercise participants could not provide specific times for when the choke-point transit would begin. The actual transit of the channel occurred based on the on-scene Commander's read of the tactical situation as it developed over the course of many hours. To address this issue during RIMPAC 2006, and in coordination with NMFS Pacific Islands Regional Office, NMFS was kept apprised of the timeframe as it became available.

<u>Recommendation</u>
The coordination with stranding offices and Navy's cooperation with NMFS in the event of a stranding are established procedures and should not be confused with mitigation measures mandated for a specific exercise. In addition, the emphasis on monitoring for strandings during naval exercises has the potential to perpetuate unsubstantiated correlations of strandings as being caused by MFAS use. If a comprehensive marine mammal monitoring program is warranted, it should be pursued by NMFS through implementation of statistically based monitoring protocols and a research and sampling design that objectively assesses stranding occurrence across all potential causal factors, resulting in a baseline understanding of strandings for a given region.

Note: There is no "Hawaii marine patrol" and as a result, this component of the mitigation requirement could not be implemented.

<u>Measure (m) Part (ii)</u>
This part of measure (m) reads:
(ii) The Navy will have at least one dedicated Navy marine mammal observer who has received the NMFS-approved training mentioned above in (a), on board each ship and conducting observations during the operation of mid-frequency tactical sonar during the choke-point exercises. The Navy has also authorized the presence of two experienced marine mammal observers (non-Navy personnel) to embark on Navy ships for observation during the exercise.

Assessment: The first component of this measure duplicates standard Navy training requirements and is unnecessary. The "experienced marine mammal observers (non-Navy personnel)" detected no marine mammals during the time they were embarked and therefore provided no additional capability or protection to marine mammals during this exercise.

Operational Impact of this mitigation measure:
None for this exercise, however, it is usually not feasible to provide transportation, berthing, and manning for non-navy personnel aboard exercise vessels. In some cases, inclusion of these observers would result in the inability to accommodate essential Navy personnel associated with the exercise such as trainers and data collection personnel.

The requirement for a "dedicated Navy marine mammal observer" indicates a fundamental misunderstanding of Navy practices. This measure duplicates the watch standing requirements inherent in measures (a) and (b), because all lookouts have been trained to be "dedicated Navy marine mammal observers". Any marine mammals detected are reported to the OOD as required under normal procedures, regardless of whether the ship is conducting a choke point transit.

NMFS embarked two observers on 19 July to the CVN during one of the Kaulakahi choke-point events, because this served as a superb viewing platform in the approximate center of ASW operations. These observers detected no marine mammals, and therefore provided no additional value as a mitigation measure during this exercise. As discussed under measures (a) and (b), Navy spotters receive sufficient training to undertake the required tasks. Use of Navy lookouts is the most effective means to ensure quick and effective communication within the command structure and facilitate implementation of protective measures if marine species are spotted.

Recommendation
Navy lookouts have the skills and training to detect marine mammals without augmentation by additional non-navy observers onboard ships. Additional non-navy observers have the potential to adversely impact an exercise, and did not appear to improve marine mammal detection cabability during RIMPAC. Recommend this measure not be included in future authorizations.

Measure (m) Part (iii)
This part of measure (m) reads:

> *(iii) Prior to start up or restart of sonar, the Navy will ensure that a 2000 m radius around the sound source is clear of marine mammals.*

Assessment: This is unnecessary given that the safety zones established in Measure (f) already provide adequate protection.

Operational Impact of this mitigation measure:
None.

Conclusion
This measure is inconsistent with the provisions required in Measure ((f); Safety Zones). Recommend it not be included in future authorizations.

Measure (m) Part (iv)

This part of measure (m) reads:

> *(iv) The Navy will coordinate a focused monitoring effort around the choke-point exercises, to include pre-exercise monitoring (2 hours), during-exercise monitoring, and post-exercise monitoring (1-2 days). This monitoring effort will include at least one dedicated aircraft or one dedicated vessel for real-time monitoring from the pre- through post-monitoring time period, except at night. The vessel or airplane may be operated by either dedicated Navy personnel, or non-Navy scientists contracted by the Navy, who will be in regular communication with a Tactical Officer with the authority to shut-down, power-down, or delay the start-up of sonar operations. These monitors will communicate with this Officer to ensure the 2000 m safety zone is clear prior to sonar start-up, to recommend power-down and shut-down during the exercise, and to extensively search for potentially injured or stranding animals in the area and down-current of the area post-exercise.*

Assessment: This measure is relatively costly and did not result in any marine mammal sightings requiring MFAS source reduction or shutdown.

Operational Impact of this mitigation measure:

The time and money spent to provide this mitigation measure appeared to provide no additional protection to marine mammals.

Observations

The monitoring efforts consisted of shore-based observers, aerial surveys and the routine patrols of Torpedo Recovery Boats. Though these surveys spotted numerous marine mammals, none of the mammal detected were in the vicinity of exercise participants or provided protection from exercise MFAS. For marine mammals detected before the event, there was no way to determine if they were likely to move into or out of an exercise that was miles from a given observation/detection location.

The capability of sighting marine mammals from both surface and aerial platforms participating in the exercise provides excellent survey capabilities using the Navy's existing exercise assets. Six of the 29 marine mammal detections were made by Navy aerial assets participating in the RIMPAC exercise.

Given the vast distances involved, it was impossible to ensure a 2000 m safety zone was clear of every single participant by these additional monitors. The monitors could not recommend power-down or shut-down during the exercise because the focus of their efforts was so dispersed.

Although monitors did serve to extensively search for potentially injured or stranded animals in the area they were assigned to observe, none were detected and the value provided by this time consuming and expensive search is questionable.

Other comments on this measure: The provision for searching "down-current of the area post-exercise" fails to recognize that an exercise area may involve many hundreds of square miles of ocean with variable currents.

Shore-based monitors' observations: Resident groups of spinner dolphins nearshore at Kekaha, Kauai on five consecutive mornings before, during, and after two choke point exercises taking place in the Kaulakahi Channel. Three days of shore-based observation from the Kohala Coast of Hawaii Island occurred around a choke-point exercise taking place in the Alenuihaha Channel. A pod of bottlenose dolphins was observed feeding nearshore a few hours apart on the first day of observation. Over the eight days of shore-based observation, there were no unusual behaviors exhibited by these animals.

Aerial survey observations: Aerial surveys covered these same channels over six days (18 hours). This aerial survey effort was generally hampered by rough sea state conditions. Two days of aerial survey had to be cancelled due to safety requirements concerning the use of unmanned drones and weapon firing on the range at PMRF on those days. There were a total of 13 sightings of marine mammals over the six days with no unusual behavior or activity observed.

Finally, of note, the aerial surveys conducted around the time of the choke point exercises showed that "the densities of marine mammal species reported here is identical with that normally seen for the Hawaiian Islands, albeit at different times of the year." Therefore, although some 30-40 ships conducted a wide ranging exercise over more than three weeks and employed MFA sonar extensively, marine mammal densities remained stable, and observers detected no unusual behavior in the marine mammals they saw.

Recommendation

This procedure is a monitoring measure vice a mitigation measure and had no demonstrable impact on the protection of mammals during RIMPAC. Due to the experience of Navy aircrews and their sensitivity to detecting marine mammals, as well as the cost involved in contracting these services, recommend that for future authorizations, only Navy assets be considered for increased monitoring, and then only when required in the aggregations of conditions which show the most potential for risk to marine mammals.

Measure (m) Part (v)

This part of measure (m) reads:

> *(v) The Navy will further contract an experienced cetacean researcher to conduct systematic aerial reconnaissance surveys and observations before, during, and after the choke-point exercises with the intent of closely examining local populations of marine mammals during the RIMPAC exercise.*

Assessment: This measure duplicates measure (m)(iv) and provides no additional protection for marine mammals.

Operational Impact of this mitigation measure:
None. However, the money spent to provide this mitigation measure provided no observable protection to marine mammals during this exercise and cannot be resourced for routine Navy's exercises.

Conclusion
The contracted "experienced cetacean researcher" did not spot any marine mammals in the vicinity of the exercise. Recommend this measure not be included in future authorizations.

Measure (m) Part (vi) and (vii)
These parts of measure (m) reads:

> *(vi) Along the Kaulakahi Channel (between Kauai and Niihau), shoreline reconnaissance and nearshore observations will be undertaken by a team of observers located at Kekaha (the approximate mid point of the Channel). Additional observations will be made on a daily basis by range vessels while enroute from Port Allen to the range at PMRF (a distance of approximately 16 nmi) and upon their return at the end of each day's activities. Finally, surveillance of the beach shoreline and nearshore waters bounding PMRF will occur randomly around the clock a minimum four times in each 24 hour period.*
>
> *(vii) In the Alenuihaha Channel (between Maui and Hawaii), the Navy will conduct shoreline reconnaissance and nearshore observations by a team of observers rotating between Mahukona and Lapakahi before, during, and after the exercise.*

Assessment: This measure does not appear to provide additional protection for marine mammals and is unnecessary.

Operational Impact of this mitigation measure:
None. However, the personnel resources spent to provide this mitigation measure provided no demonstrable protection to marine mammals during this exercise and cannot be routinely resourced for Navy's exercises.

Conclusion
This procedure did not result in any effective mitigation during RIMPAC. Tasking personnel to observe a portion of the shoreline during a choke-point as a monitoring measure has no scientific basis (no research questions, research design, or sampling approach).
Although the shore based observers saw marine mammals and sea turtles, and these observations were reported to the RIMPAC Battle Watch as required, the observed marine species were miles from any exercise events and hours before the choke-point transits began. These observations were of no utility as a mitigation measure. Recommend this measure not be included in future authorizations.

Measure (n)
This measure reads:

> *(n) The Navy will continue to coordinate with NMFS on the "Communications and Response Protocol for Stranded Marine Mammal Events During Navy Operations in the Pacific Islands Region" that is currently under preparation by NMFS PIRO to facilitate communication during RIMPAC. The Navy will coordinate with the NMFS Stranding Coordinator for any unusual marine mammal behavior, including stranding, beached live or dead cetacean(s), floating marine mammals, or out-of-habitat/milling live cetaceans that may occur at any time during or shortly after RIMPAC activities. After RIMPAC, NMFS and the Navy (CPF) will prepare a coordinated report on the practicality and effectiveness of the protocol that will be provided to Navy/NMFS leadership.*

Assessment: This measure documents what is standard procedure.

Operational Impact of this mitigation measure:
None.

Recommendation
This requirement documents Navy's standard procedure.

SECTION 2 SUMMARY

During RIMPAC 06, there were 472 total hours of mid-frequency active sonar (MFAS) use. There were no reported observations of behavioral disturbance of marine mammals during the exercise. The Navy's previously developed and used mitigation measures from PMAP, as modified for RIMPAC 06, appeared to be effective in protecting marine mammals observed near exercise ships. Mitigation measures agreed to for issuance of the IHA that went beyond standard Navy measures had no observable effect on protection of marine mammals in this exercise, and their application unnecessarily increased the cost of the exercise or had a negative effect on the fidelity of training.

As the first major exercise for which Navy applied for an authorization under MMPA, RIMPAC '06 presented unique challenges from the perspective of regulatory requirements and public perception. We anticipate that future authorizations for exercises and operating area coverage will recognize the differences in those areas as well as how developing science will inform our understanding of the role of mitigation measures.

SECTION 3: Monitoring Results

The IHA requires this report contain, "Results of the marine species monitoring (real-time monitoring from all platforms, independent aerial monitoring, shore-based monitoring at chokepoints, etc.) before, during, and after the RIMPAC exercises". This section of the report, therefore, provides a summary of the detections of marine species from all exercise participants, the aerial reconnaissance survey, and shore-based monitoring efforts associated with the RIMPAC 06 exercise.

Figure 2. Location of marine mammals sighted by exercise participants depicted in red. Locations with multiple sightings are depicted by a single box. The line of longitude shown is 160˚ West and the latitude is 20˚ North.

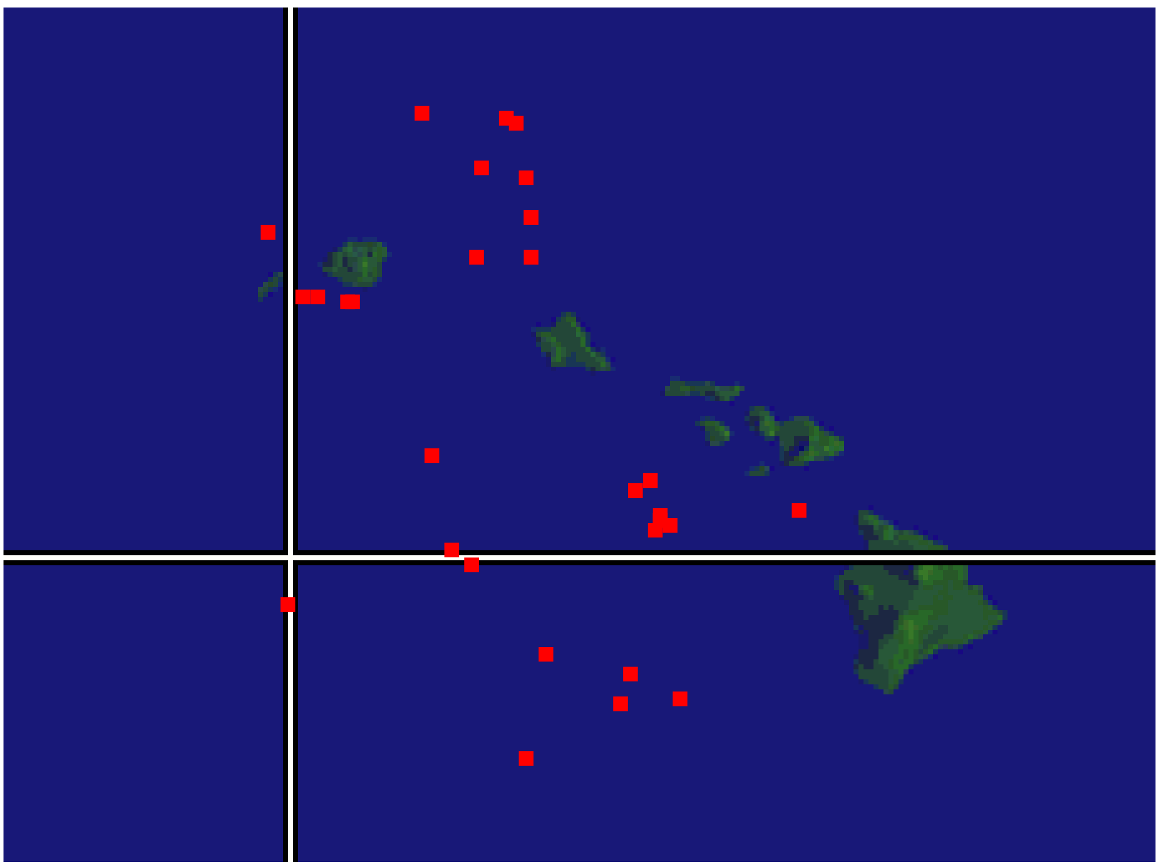

Figure 2 depicts the approximate location of marine mammals that were sighted by exercise participants. This is a skewed sample since there were no attempts made to detect marine mammals by other means in areas not being used by exercise participants. In addition to these sightings, marine species detections occurred as a result of two other

IHA mandated measures consisting of an aerial reconnaissance effort and shore-based monitors.

As noted previously, the additional monitoring requirements consisting of aerial and shipboard monitoring, and shore-based observations before, during, and after choke-point events. These monitoring efforts were required by NMFS as a sampling strategy to determine if there was any observable effect on marine mammals during ASW training events taking place in the channels between two sets of islands. These measures arose from a precautionary concern that MFAS use in the channels could possibly have greater potential to impact marine mammals, despite the lack of evidence suggestive of any problems in this regard from any of the previous 19 RIMPAC exercises. The cost to implement these monitoring requirements was approximately $66,000 for RIMPAC 06

A separate report providing details from the shore-based monitors' observations is presented in Appendix B and summarized here. These shore-based observations took place centered on two channels between the islands. The first of these monitoring efforts took place at Kekaha on Kauai. This is the approximate mid point along the Kaulakahi Channel between Kauai and Niihau, and spanned five consecutive days before, during, and after two choke point exercises taking place in that channel. Each morning of the five days, a pod of spinner dolphins were present 300-400 meters offshore. There were no unusual or abnormal behaviors observed. Sea turtles were also observed on two days.

Additional observations made on a daily basis by range vessels while enroute from Port Allen through the channel to the range at PMRF and surveillance of the beach shoreline and nearshore waters bounding PMRF did not result in any marine mammal detections.

Shore-based observation also took place on the Kohala Coast of Hawaii Island for three full days occurred around a choke-point exercise taking place in the Alenuihaha Channel between Hawaii Island and Maui. A pod of bottlenose dolphins was observed feeding during the first day of observation. There were no unusual or abnormal behaviors observed. Sea turtles were also observed on two days.

Aerial surveys covered these same channels over six days (approximately 18 hours flight time) as detailed in Appendix C. This aerial survey effort was generally hampered by rough sea state conditions. Two days of aerial survey had to be cancelled due to safety requirements concerning the use of unmanned drones and weapon firing on the range at PMRF on those days. There were a total of 13 sightings of marine mammals over the six days with no unusual behavior or activity observed.

Navy also authorized the presence of two experienced marine mammal observers (non-Navy personnel) to embark on a Navy ship for observation during a choke-point exercise. NMFS did not have any marine mammal observers available and alternatively embarked two Fisheries Program observers on 19 July to an available CVN during one of the Kaulakahi choke-point events. This ship was chosen since it served as a superb viewing platform with a large height of eye and unobstructed visibility in the approximate center of ASW operations. These observers detected no marine mammals.

In summary, there were 13 sightings of marine mammals from the air over approximately 18 hours of flight time. Shore based observation for 80 hours of effort by two people produced five sightings of a resident pod of spinner dolphins over five consecutive days on Kauai and a pod of bottlenose dolphins offshore of Hawaii Island. The results of these monitoring efforts provided no evidence of indicating there were any effects on the detected marine mammals as a result of the ASW exercises, which took place in the adjacent channels.

SECTION 4: Sonar Usage and Marine Mammals

The IHA requires that this report contain, "As much information (unclassified and, to appropriately cleared recipients, classified “secret”) as the Navy can provide including, but not limited to, where and when sonar was used (including sources not considered in take estimates, such as submarine and aircraft sonars) in relation to any measures received levels (such as sonobuoys or on PMRF range), source levels, numbers of sources, and frequencies so it can be coordinated with observed cetacean behaviors." Section 4 of the report provides information on the location and hours of active MFAS used during RIMPAC 06. The IHA also required as much data as could be provided on measured received levels, source levels, numbers of sources and frequencies so it could be coordinated with observed cetacean behaviors. Typically, there are no measurements (calibrated or otherwise) of actual sound levels made during an exercise and none were made during RIMPAC 06. Source levels, numbers of sources, and frequencies are classified since that information would provide potential adversaries with important tactical data. The observance of marine mammals by Navy assets only occurred as very brief encounters given the mitigation measures are designed to limit interaction to a minimum.

Observations of marine species and their behaviors resulting from the aerial reconnaissance and shore-based monitoring (as previously detailed in Section 3) observed no unusual behaviors for coordination with MFAS use. There were no indications from the observations that the presence of exercise participants had any affect on any marine mammals.

The requirement to report where and when sonar was used so it can be coordinated with observed cetacean behaviors can not be completed since no animals were observed doing anything unusual or behaving in any overt manner. Information presented previously in Table 1 provides a list of instances when marine mammals were detected and sonar was being used.

As noted previously, during RIMPAC 06, there were 199 anti-submarine warfare (ASW) events and 472 total hours of hull mounted MFAS. This was less than the anticipated number of hours (532) presented in the RIMPAC 2006 Supplemental Environmental Assessment as a result of a temporary restraining order (TRO) restricting the use of MFAS arising from a lawsuit (NRDC v. Winter) in effect for the first days of the exercise. During the period of this TRO, three days of scheduled MFAS training (25 events) were lost including 4 live fire events, 14 P-3 ASW events, and 7 surface ASW events.

In addition to the 472 hours of hull mounted MFAS use, there were approximately 115 hours of operations involving both passive DIFAR and active DICASS sonobuoys reported for RIMPAC 06. This quantity of operational hours does not equate to 115 hours of active sonar use since only approximately 10% of the sonobuoys expended[4] were active DICASS and they are commanded to transmit an active ping only as required by the tactical situation. In short, an individual DICASS sonobuoy, even though deployed, may never be activated during an event. In other instances, DICASS buoys are not deployed until a possible contact is identified and the need to localize the target arises. There is no standard data collection reporting that would serve as a means to determine how much actual active sonar time resulted from DICASS sonobuoy use during RIMPAC.

Finally, there were approximately 45 hours of operations involving the use of dipping sonars deployed from helicopters. Similar to the case for sonobuoys, there is no standard data collection reporting that would serve as a means to determine how much actual active sonar time resulted from this number of hours of dipping sonar operation. During RIMPAC, dipping sonars were not in a search capacity but instead used for localization or confirmation of suspected contacts. In can be estimated that in this capacity dipping sonars, which are used very briefly (2-5 pulses a few hundred msec in duration) approximately every 10 minutes, would have resulted in approximately 11-12 minutes of active sonar over a 20 day period spread across the RIMPAC exercise area.

4 There were 2,713 passive and 292 active sonobuoys expended in RMPAC 06.

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Appendix (A)

PROPOSED MITIGATION MEASURES FOR MFAS DURING MAJOR ASW EXERCISES

I. General Maritime Protective Measures: Personnel Training:

1. All lookouts onboard platforms involved in ASW training events will review the NMFS approved Marine Species Awareness Training (MSAT) material prior to MFAS use.

2. All Commanding Officers, Executive Officers, and officers standing watch on the Bridge will have reviewed the MSAT material prior to a training event employing the use of MFAS.

3. Navy lookouts will undertake extensive training in order to qualify as a watchstander in accordance with the Lookout Training Handbook (NAVEDTRA 12968-B).

4. Lookout training will include on-the-job instruction under the supervision of a qualified, experienced watchstander. Following successful completion of this supervised training period, Lookouts will complete the Personal Qualification Standard program, certifying that they have demonstrated the necessary skills (such as detection and reporting of partially submerged objects). This does not forbid personnel being trained as lookouts counted as those listed in previous measures so long as supervisors monitor their progress and performance.

5. Lookouts will be trained in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of protective measures if marine species are spotted.

II. General Maritime Protective Measures: Lookout and Watchstander Responsibilities:

6. 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.

7. All surface ships participating in ASW exercises will, in addition to the three personnel on watch noted previously, have at all times during the exercise at least two additional personnel on watch as lookouts.

8. Personnel on lookout and officers on watch on the bridge will have at least one set of binoculars available for each person to aid in the detection of marine mammals.

9. On surface vessels equipped with MFAS, pedestal mounted "Big Eye" (20x110) binoculars will be present and in good working order to assist in the detection of

marine mammals in the vicinity of the vessel.

10. Personnel on lookout will employ visual search procedures employing a scanning methodology in accordance with the Lookout Training Handbook (NAVEDTRA 12968-B).

11. After sunset and prior to sunrise, lookouts will employ Night Lookouts Techniques in accordance with the Lookout Training Handbook.

12. Personnel on lookout will be responsible for reporting all objects or anomalies sighted in the water (regardless of the distance from the vessel) to the Officer of the Deck, since any object or disturbance (e.g., trash, periscope, surface disturbance, discoloration) in the water may be indicative of a threat to the vessel and its crew or indicative of a marine species that may need to be avoided as warranted.

III. Operating Procedures

13. A Letter of Instruction, Mitigation Measures Message or Environmental Annex to the Operational Order will be issued prior to the exercise to further disseminate the personnel training requirement and general marine mammal protective measures.

14. Commanding Officers will make use of marine species detection cues and information to limit interaction with marine species to the maximum extent possible consistent with safety of the ship.

15. All personnel engaged in passive acoustic sonar operation (including aircraft, surface ships, or submarines) will monitor for marine mammal vocalizations and report the detection of any marine mammal to the appropriate watch station for dissemination and appropriate action.

16. During MFAS operations, personnel will utilize all available sensor and optical systems (such as Night Vision Goggles to aid in the detection of marine mammals.

17. Navy aircraft participating in exercises at sea will conduct and maintain, when operationally feasible and safe, surveillance for marine species of concern as long as it does not violate safety constraints or interfere with the accomplishment of primary operational duties.

18. Aircraft with deployed sonobuoys will use only the passive capability of sonobuoys when marine mammals are detected within 200 yards of the sonobuoy.

19. Marine mammal detections will be immediately reported to assigned Aircraft Control Unit for further dissemination to ships in the vicinity of the marine species as appropriate where it is reasonable to conclude that the course of the

ship will likely result in a closing of the distance to the detected marine mammal.

20. Safety Zones - When marine mammals are detected by any means (aircraft, shipboard lookout, or acoustically) within 1,000 yards of the sonar dome (the bow), the ship or submarine will limit active transmission levels to at least 6 dB below normal operating levels.

    (i) Ships and submarines will continue to limit maximum transmission levels by this 6-dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 1,000 yards beyond the location of the last detection.

    (ii) Should a marine mammal be detected within or closing to inside 500 yards of the sonar dome, active sonar transmissions will be limited to at least 10 dB below the equipment's normal operating level. Ships and submarines will continue to limit maximum ping levels by this 10-dB factor until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 1,000 yards beyond the location of the last detection.

    (iii) Should the marine mammal be detected within or closing to inside 200 yards of the sonar dome, active sonar transmissions will cease. Sonar will not resume until the animal has been seen to leave the area, has not been detected for 30 minutes, or the vessel has transited more than 1,000 yards beyond the location of the last detection.

    (iv) Special conditions applicable for dolphins and porpoises only: If, after conducting an initial maneuver to avoid close quarters with dolphins or porpoises, the Officer of the Deck concludes that dolphins or porpoises are deliberately closing to ride the vessel's bow wave, no further mitigation actions are necessary while the dolphins or porpoises continue to exhibit bow wave riding behavior.

    (v) If the need for power-down should arise as detailed in “Safety Zones” above, Navy shall follow the requirements as though they were operating at 235 dB - the normal operating level (i.e., the first power-down will be to 229 dB, regardless of at what level above 235 sonar was being operated).

21. Prior to start up or restart of active sonar, operators will check that the Safety Zone radius around the sound source is clear of marine mammals.

22. Sonar levels (generally) - Navy will operate sonar at the lowest practicable level, not to exceed 235 dB, except as required to meet tactical training objectives.

23. Helicopters shall observe/survey the vicinity of an ASW exercise for 10 minutes before the first deployment of active (dipping) sonar in the water.

24. Helicopters shall not dip their sonar within 200 yards of a marine mammal and shall cease pinging if a marine mammal closes within 200 yards after pinging has

begun.

25. Submarine sonar operators will review detection indicators of close-aboard marine mammals prior to the commencement of ASW operations involving active mid-frequency sonar.

26. Increased vigilance during major ASW training exercises with tactical active sonar when critical conditions are present.

Navy should avoid planning major ASW training exercises with MFAS in areas where they will encounter conditions which, in their aggregate, may contribute to a marine mammal stranding event. Of particular concern are beaked whales, for which strandings have been associated, in theory, with MFAS operations.

The conditions to be considered during exercise planning include:

(1) Areas of at least 1000 m depth near a shoreline where there is a rapid change in bathymetry on the order of 1000-6000 meters occurring across a relatively short horizontal distance (e.g., 5 nm).

(2) Cases for which multiple ships or submarines (≥ 3) operating MFAS in the same area over extended periods of time (≥ 6 hours) in close proximity (≤ 10NM apart).

(3) An area surrounded by land masses, separated by less than 35 nm and at least 10 nm in length, or an embayment, wherein operations involving multiple ships/subs (≥ 3) employing MFAS near land may produce sound directed toward the channel or embayment that may cut off the lines of egress for marine mammals.

(4) Though not as dominant a condition as bathymetric features, the historical presence of a strong surface duct (i.e. a mixed layer of constant water temperature extending from the sea surface to 100 or more feet).

If the major exercise must occur in an area where the above conditions exist in their aggregate, these conditions must be fully analyzed in environmental planning documentation. Navy will increase vigilance by undertaking the following additional protective measure:

A dedicated aircraft (Navy asset or contracted aircraft) will undertake reconnaissance of the embayment or channel ahead of the exercise participants to detect marine mammals that may be in the area exposed to active sonar. All safety zone power down requirements described above apply.

IV. Coordination and Reporting

27. Navy will coordinate with the local NMFS Stranding Coordinator for any unusual marine mammal behavior and any stranding, beached live/dead or floating marine mammals that may occur at any time during or within 24 hours after completion of mid-frequency active sonar use associated with ASW training activities.

28. Navy will submit a report to the Office of Protected Resources, NMFS, within 120 days of the completion of a Major Exercise. This report must contain a discussion of the nature of the effects, if observed, based on both modeled results of real-time events and sightings of marine mammals.

29. If a stranding occurs during an ASW exercise, NMFS and Navy will coordinate to determine if MFAS should be temporarily discontinued while the facts surrounding the stranding are collected.

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Appendix (B)

RIMPAC 2006
NEARSHORE MONITORING
FIELD REPORT

JULY 2006

Prepared by:
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INTRODUCTION

In support of RIMPAC 2006, nearshore monitoring for marine mammals and sea turtles was conducted during July 16-20 from Kekaha Beach, Kauai, Hawaii and July 24-26 from Mahukona and Kapa`a Beach Park, Kohala Coast, Hawaii. The locations were chosen based upon their proximity to the Kalaukahi (between Kauai and Ni`ihau) and Alanuihaha (between Hawaii and Maui) Channels. The purpose of the monitoring was to 1) provide the Navy ships with information on species in the nearshore waters, 2) provide observations of marine mammal behavior before, during and after swept-channel (choke point) exercises, and 3) to monitor the beach and nearshore waters for marine species exhibiting abnormal behavior (offshore animals nearshore, congregations of offshore animals, strandings, etc).

METHODS

Shore-based monitoring was conducted from 0700 to 1830 hours with two observers using hand-held 10x42 binoculars and un-aided eye. Monitoring schedule corresponds to one day before and after each planned swept-channel exercise, two in the Kalaukahi channel and one in the Alanuihaha Channel. All observations were conducted by one experienced Navy marine mammal observer and one field assistant.

Kekaha Beach observations were conducted essentially at sea level. The sandy beach allowed for observers to walk the length of the beach north to the PMRF, Barking Sands Boundary and south to the end of Kehaka Beach (3 miles). Walks were conducted between two and four times per day. One observer would remain on station (near the lifeguard tower) as the other walked up the beach. The horizon from sea level is a distance of approximately 5 km.

Observations were conducted from Mahukona on July 23rd from 0700 to 1200 hours, but Kapa`a Beach Park was chosen for the rest of the 2.5 days since it offered a better view of the Alanuihaha Channel. Kapa`a Beach Park is a boulder beach, and observations were conducted at approximately 7m above sea level (horizon distance approximately 5 miles). A point to the north of the beach park resulted in a consistently lower sea state close to shore than in the open channel. On two days, portions of the coastline to the north of Kapa`a Beach Park (between Upolu Point and Mo`okini Heiau) was driven using a 4x4 vehicle to check the boulder beaches for stranded or distressed animals.

Data were collected on visibility, Beaufort sea state, marine mammals observed, sea turtles observed, and Navy ships/operations observed. While at Kehaka, data were also collected on commercial tour boats that were observed interacting with resident spinner dolphins.

RESULTS

Table 1 provides daily observation information. Only two species of marine mammals were observed, spinner dolphins (*Stenella longitrostris*) and bottlenose dolphins (*Tursiops aduncus*). Both are typically nearshore species. Two species of sea turtles were observed – green (*Chelonia mydas*) and leatherback (*Dermochelys coriacea)*. All were observed exhibiting normal behaviors.

The following is provided as a summary of marine mammals and sea turtles observed during the two nearshore monitoring periods.

Kekaha:

16 July 2006: A school of approximately 100 spinner dolphins (*Stenella longirostris*) are observed approximately 300m offshore (0747 hrs). Animals are slowly heading south and are being followed by a catamaran. When first vessel leaves, a series of RHIBs and catamarans stop and follow animals, one after the other. Animals are last seen at 0826 hrs approximately 0.5 miles offshore. Behavior overall is slow travel to south, with several spins. This is largest group that was seen during the five day period.

16 July 2006: A turtle (presumed green) is seen surfacing approximately 100m offshore.

17 July 2006: A school of approximately fifteen spinner dolphins is observed heading slowly south (0830 hrs) being followed by a tour catamaran. Dolphins are last observed at 0910 hrs. Behavior overall is slow travel to south, with several aerial spins.

17 July 2006: Green sea turtle is observed approximately 4 m offshore.

18 July 2006: A small school of ten to fifteen spinner dolphins are observed approximately 0.25 miles offshore, with two tour boats (0835 hrs). Dolphins are very low in the water and would be very difficult to see without boats as “cue”. Dolphins not seen after boats leave at 0845 hrs.

19 July 2006: Unidentified dolphins, cue is splash and idling tour boat, at horizon (0715 hrs.).

19 July 2006: Unidentified dolphins (presumed spinners) observed at southwestern horizon splashing, heading north (0858 hrs.).

19 July 2006: Spinner dolphins observed heading north towards Barking Sands (0922 hrs.). They continue to north out of view.

20 July 2006: Spinner dolphins observed in resting mode about 400m off southern shore of Kekaha Beach. Group size is approximately 20 animals, and they are milling at 0730 hrs. At 0745 hrs, they are traveling slowly to the north towards Barking Sands. They bowride as a boat approaches and follows them. Dolphins last seen at 0847 hrs.

Mahukona:

(0730 hrs to 1300 hrs.)

24 July 2006: Leatherback turtle (*D. coriacea)* observed approximately 300m offshore. Turtle is identified as a leatherback based upon very large carapace size (estimated 5-6 ft across) and huge rounded head. Back and head were seen simultaneously at the animal breathed. Turtle was observed at the surface for 1-2 minutes then dove (0759 hrs).

Kapa`a Beach Park:

24 July 2006: Group of approximately 20 bottlenose dolphins (*Tursiops aduncus*) are observed, first seen heading southwest (1630 hrs). A third of the group are calves. Animals travel steadily to the SW, except stopping to mill for about 3 minutes near a group of shearwaters and tuna feeding on bait fish. Dolphins contour shoreline to the south and disappear from view at 1646 hrs.

Bottlenose dolphins reappear from the south, heading west (1725 hrs). The dolphins are much more surface-active during this sighting, porpoising and leaping out of the water. At 1749 hrs, after a long dive (5 minutes), they resurface with obvious blows and change direction to the southwest and appear to be feeding along the edge of a large aggregation of shearwaters, tuna and bait fish.

25 July 2006: Small turtle (green?) observed just offshore (0858 hrs).

26 July 2006: Small green turtle observed hugging coastline and "riding" the surge (1415 hrs).

DISCUSSION AND CONCLUSIONS

All marine mammals and turtles were observed exhibiting normal behavior. No adverse behavior, strandings, or offshore species were observed.

Land based, stationary monitoring has known deficiencies. The low height of eye above water provides a limited distance to the horizon and species identification can be difficult as there is no option to approach animals. However, given the purpose of this project, the goals were achieved. This monitoring gathered adequate data on the lack of behavioral change exhibited by resident groups of spinner dolphins at Kekaha, Kauai and Kohala, Hawaii. Additionally, we were able to monitor the length of Kekaha Beach, by foot, for stranded or distressed animals. The Kohala coast presented more of a challenge as it was comprised of boulder beaches. However, a 4x4 vehicle was utilized to access areas to the North (towards the channel) from the monitoring station at Kapa`a Beach.

Additionally, anecdotal data collected on interactions between commercial tour catamarans and RHIBs might prove to be useful to regulatory agencies such as the State of Hawaii and National Oceanographic and Atmospheric Association.

TABLE 1

Date 2006	**Location**	**Time (24 hr)**	**Beaufort Sea State**	**Species**	**Observations**
7/16	Kekaha	0700	2		Begin watch. Great visibility, overcast skies
	Kekaha	0747		*S. longirostris*	Spinners with catamaran. Slowly bowriding on vessel (Aladin?). Couple of spins seen after cat leaves. Located about 300m offshore, moving south. Group size ~100.
7/16	Kekaha	0750		*S. longirostris*	Catamaran leaves dolphins
7/16	Kekaha	0755		*S. longirostris*	RHIB runs up to animals and follows them
7/16	Kekaha	0759		*S. longirostris*	RHIB leaves dolphins
7/16	Kekaha	0809		*S. longirostris*	Still heading slowly S
7/16	Kekaha	0826			Two new RHIBs with S.l., about 0.5 mile offshore
7/16	Kekaha	0850		*C. mydas*	Green turtle seen about 100m offshore
7/16	Kekaha	1230	3		Sea state change
7/16	Kekaha	1430	4		Occasional rain squalls passing over
7/16	Kekaha	1600	3		Squalls clear. Navy ship seen on horizon heading from N coast to the S
7/16	Kekaha	1655	2		Sea state change
7/16	Kekaha	1745			Complete watch
7/17	Kekaha	0700	3		Begin watch, sunny skies, good visibility
7/17	Kekaha	0745			Two helicopters and 3 Navy ships seen on horizon. Helos ahead of ships along with three small red RHIBs inshore of ships
7/17	Kekaha	0815			Three Navy ships seen N of Barking Sands and head SW

Date 2006	Location	Time (24 hr)	Beaufort Sea State	Species	Observations
					through the channel, one right after the other.
7/17	Kekaha	0830		*S. longirostris*	Spinners seen bowriding on catamaran. Cat is heading N but stops and does u-turn through spinners and follows them south for ~ 5 min.
7/17	Kekaha	0835		*S. longirostris*	Just as cat leaves dolphins, a RHIB goes through them while heading N.
7/17	Kekaha	0850	4	*S. longirostris*	Na Pali Kai III catamaran seen doing u-turn and following dolphins to S. They stay with the dolphins heading S until 0910 hrs. Few spins from dolphins. Visibility changes to moderate due to higher Beaufort.
7/17	Kekaha	1015	4		Glare, moderate visibility. Have lost sight of dolphins due to sea conditions.
7/17	Kekaha	1053	3=inshore 4=offshore		Visibility improves as wind dies down.
7/17	Kekaha	1345	4		Sea state change
7/17	Kekaha	1612	4	*C. mydas*	Turtle seen at surface about 4 m offshore.
7/17	Kekaha	1830			Complete watch
7/18	Kekaha	0700	1		Begin watch
7/18	Kekaha	0835		*S. longirostris*	Small group of spinners (~15 animals) observed ~.25 miles offshore. One RHIB and one cat stop with dolphins and proceed slowly through them.
7/18	Kekaha	0845		*S. longirostris*	Boats leave dolphins and head N
7/18	Kekaha				Catamaran seen stopping ~ 0.5 miles offshore towards N. Can't see dolphins but assume that is why they are stopping.
7/18	Kekaha	1005	3		Still sunny…
7/18	Kekaha	1700			Cruise ship comes from N, heads through channel and continues to the S over horizon

Date 2006	Location	Time (24 hr)	Beaufort Sea State	Species	Observations
7/18	Kekaha	1830			Complete watch
7/19	Kekaha	0700	1		Begin watch, swell 2-3 ft.
7/19	Kekaha	0715		Unidentified dolphin	Catamaran and two RHIBs are stopped on horizon. Appear to be slowly following marine mammals, but other than one splash, I cannot identify them to species.
7/19	Kekaha	0858		Unidentified dolphin	School of dolphins (presumed spinners) seen at SW horizon, splashing, heading N
7/19	Kekaha	0922		*S. longirostris*	Spinners seen heading N off Kekaha. Catamaran comes up to them and slowly moves through them. Group size ~20.
7/19	Kekaha	0955	3		Sea state change
7/19	Kekaha	1515			Three red RHIBs head out of Portlock heading N through channel (we are later told these are part of RIMPAC ops).
7/19	Kekaha	1530	2		Swell 1-2 ft.
7/19	Kekaha	1644			1st Navy destroyer enters channel. Second one ~1 mile behind it. Helo overhead and doing sweeps ahead of ships (and has been for about an hour over the horizon). Ships appear to be moving slowly through channel.
7/19	Kekaha	1703			Second ship leaves channel. Helo has been dipping sonar ahead of 2nd ship. 1st ship N of Lehua and over horizon.
7/19	Kekaha	1706			2nd ship passes Lehua heading N and goes over horizon.
7/19	Kekaha				3 red Navy RHIBs pass Kekaha.
7/19	Kekaha	1800			Complete watch
7/20	Kekaha	0700	1		Begin watch with great visibility, partly cloudy.
7/20	Kekaha	0715		*S. longirostris*	Spinners in resting mode about 400m offshore, off southern shore of beach. Milling

Date 2006	Location	Time (24 hr)	Beaufort Sea State	Species	Observations
					behavior, group size ~20. No boats with dolphins, the boats appear to not see them.
7/20	Kekaha	0730		*S. longirostris*	Spinners are now just N of lifeguard tower heading N.
7/20	Kekaha	0753		*S. longirostris*	Tour boat Makana stops with dolphins and they slowly bowride.
7/20	Kekaha	0800	0		Sea state change
7/20	Kekaha	0804		*S. longirostris*	Makana still slowly following spinners to the N, then S. They are really staying with them longer than most boats do, following the milling dolphins back and forth.
7/20	Kekaha	0811		*S. longirostris*	Makana leaves dolphins
7/20	Kekaha	0814		*S. longirostris*	Tour RHIB runs up on dolphins, then u-turns and follows them.
7/20	Kekaha	0820		*S. longirostris*	As RHIB leaves, catamaran “Lucky Lady” comes slowly up to them and sits with dolphins.
7/20	Kekaha	0828		*S. longirostris*	“Lucky Lady” leaves dolphins
7/20		0840		*S. longirostris*	Another cat on spinners, N of Kehaka. Does u-turns and runs through them a few times at slow speed.
7/20	Kekaha	0847	1	*S. longirostris*	Cat leaves dolphins, heads N
7/20	Kekaha	1234	2		Overcast skies, great visibility
7/20	Kekaha	1800			Complete watch. Total beach monitored with 2-3 beach walks daily is 3 miles (includes all of Kekaha Beach to Barking Sands boundary)
7/24	Mahukona	0730	2=inshore 3=offshore		Begin watch. Walked up to point north of harbor for better view of channel and Maui. Partly cloudy skies, good visibility.

Date 2006	Location	Time (24 hr)	Beaufort Sea State	Species	Observations
7/24	Mahukona	0759		*D. coriacea*	Leatherback turtle observed. Carapace was 5-6 ft across and a huge rounded head, which is seen simultaneously during surfacing. (There is a kayaker offshore of turtle which we used for a size comparison). Turtle is observed breathing at surface for about 1 minute, then dives.
7/24	Mahukona	0951	4=offshore 3=inshore		Sea state change
7/24	Kapa`a Beach Park	1330	2=inshore 4=offshore		Change monitoring station to Kapa`a Beach Park, which is just N of Mahukona towards Hawi. It offers a better view of the channel, Maui and provides a protected inshore area with better viewing conditions. Cloud cover is 90%.
7/24	Kapa`a	1630		*T. aduncus*	Group of ~ 20 bottlenose dolphins are observed heading SW, about 400m offshore. Does not appear to be mixed species, however, about 1/3 of the group are calves. Group is traveling slowly and steadily to the SW, except for stopping for about 3 minutes near a group of shearwaters and tuna feeding on bait fish. Group stayed about the same distance offshore and heads SW out of view (at 1646 hrs.)
7/24	Kapa`a	1725		*T. aduncus*	Group of ~20 bottlenose dolphins are observed again, coming from around the point where they were last seen. They are heading to the W. They are moving more quickly this time, porpoising out of the water. As they lift heads higher to prepare for a dive, several of

Date 2006	Location	Time (24 hr)	Beaufort Sea State	Species	Observations
					them flip their tails up. Reappear after five minutes with very visible blows.
7/24	Kapa`a	1749		*T. aduncus*	Ta change direction to SW and appear to be feeding. They are working the margin of a large school of tuna and shearwaters which feeding on bait fish. The dolphins behavior includes direction change, leaps out of the water, and a few tail slaps. The group is a little more spread out too, than before. They continue this behavior for about 5 minutes, then regroup and head slowly offshore to the SW out of sight.
7/24	Kapa`a	1800			Complete watch. Drive up 4x4 road towards Hawi to check coastline for any strandings or other animals that might be out of sight.
7/25	Kapa`a Beach Park	0715	2=inshore 4=offshore		Begin watch. Three Navy ships and one other unid ship are observed over horizon towards Maui, in the channel. They are heading W.
7/25	Kapa`a	0745			Ships have disappeared over W horizon
7/25	Kapa`a	0858		*C. mydas* ?	Small turtle (green?) seen just off cove, about 100m offshore.
7/25	Kapa`a	0917	3=inshore 4=offshore		Sea state change
7/25	Kapa`a	1200			Leave beach park to drive up to Upolu Point and down to Mookini Heiau and Kam I birthplace to monitor other boulder beaches closer to channel.
7/25	Kapa`a	1300			Return to Kapa`a Beach Park
7/25	Kapa`a	1400	4=inshore 5=offshore		Sea state change

Date 2006	**Location**	**Time (24 hr)**	**Beaufort Sea State**	**Species**	**Observations**
7/25	Kapa`a	1830			Complete watch for the day.
7/26	Kapa`a	0700	2=inshore 3/4offshore		Begin watch, excellent visibility inshore. Mostly sunny skies.
7/26	Kapa`a	1200	3=inshore 4=offshore		Sea state change
7/26	Kapa`a	1415		*C. mydas*	Small green turtle observed hugging coastline. Observed for about 30 minutes riding the surge back and forth around the rocks. Last seen at 1445 hrs. Lots of glare inshore.
7/26	Kapa`a	1630	4=inshore 5=offshore		Continues to be lots of glare, covering approximately 1/3 of viewing range.
7/26	Kapa`a	1800			Complete watch (head to airport).

Appendix C

Results of 2006 RIMPAC Surveys of Marine Mammals in Kaulakahi and Alenuihaha Channels

Final Report Submitted by:
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Marine Mammal Research Consultants, Ltd.

Date:

August 25, 2006

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Results of 2006 RIMPAC Surveys of Marine Mammals in Kaulakahi and Alenuihaha Channels

Abstract

A total of six aerial surveys of marine mammals were performed on dates corresponding with scheduled dates for "choke point" maneuvers of the "Rim of the Pacific" (RIMPAC) joint military exercises in Hawaiian waters. Three surveys were performed in the vicinity of the Kaulakahi Channel (between Kauai and Niihau) (July 16, 17 and 20) and three were performed in the Alenuihaha Channel (between Hawaii and Maui) (July 24-26). The mission of the surveys was to detect, locate and identify all marine mammal species in the target areas using methods consistent with modern distance sampling theory. Marine mammals were sighted on four of the six surveys, comprising a total of 13 groups. All sightings consisted of small to medium-sized odontocetes (toothed cetaceans), including one sighting each of bottlenose dolphins, spotted dolphins, Cuvier's beaked whale, false killer whale, unidentified beaked whale and eight sightings of unidentified delphinid species. Encounter rates of odontocete sightings (sightings/km surveyed) in this series were identical to those seen during earlier survey series (1993-03) albeit at different times of the year. No unusual observations (e.g., sightings of stranded or dead animals) were noted during the total of ca. 18 hrs of survey effort.

Background

During the summer of 2006, The United States Pacific Command hosted the joint "Rim of the Pacific Exercises" (RIMPAC) military exercises in the Hawaiian Islands. Due to concerns over possible responses of marine mammal species to sonar and other aspects of the naval operations (e.g., ICES, 2005), aerial surveys were scheduled for dates before, during and after scheduled "choke point" maneuvers. Specifically this involved the Kaulakahi Channel, between the islands of Kauai and Niihau, on July 16, 17 and 20; and the Alenuihaha Channel, between the islands of Hawaii and Maui, on July 24, 25 and 26. The mission of the surveys was to detect, locate and identify all marine mammals in these channel areas, as well as to report any unusual behavior, including sightings of stranded or dead cetaceans.

Since the month of July falls outside the normal seasonal residency of humpback whales (Jan-Apr) (Mobley 2004), the less abundant odontocete species (toothed cetaceans) were the target species in the present survey series. Shallenberger (1981) described 15 odontocete species as resident in Hawaii. Based on aerial surveys conducted between 1993-98, Mobley et al. (2000) estimated abundance for 11 odontocete species for the waters within 25 nautical miles (nmi) of the major Hawaiian Islands based on surveys conducted during Jan-Apr of 1993-98. An updated summary of aerial survey results for near-shore Hawaiian waters conducted from 1993-2003 identified a total of 15 odontocete species (Mobley, unpublished data, Appendix A). Barlow (2006) provided abundance estimates for 21 cetacean species, including 18 odontocetes, based on shipboard transect surveys conducted in Aug-Nov 2002 in the Hawaiian Exclusive Economic Zone (EEZ).

Method

Three surveys were performed in each of the Kaulakahi (July 16, 17 and 20) and Alenuihaha (July 24, 25, 26) channels for a total of six surveys. Survey protocol was based on distance sampling methods, which is the standard accepted approach for estimating abundance of free ranging animal populations (Buckland et al. 2001).

Surveys in both regions followed pre-determined tracklines constructed to optimize area sampled within range limits of the aircraft (Figures 1 & 2). For the Kaulakahi Channel surveys, tracklines ran mostly north-south and were spaced 7.5 km apart comprising a total length of ca 556 km.[1] For the Alenuihaha surveys, tracklines ran from northeast to southwest and were spaced 15 km apart and comprised a total length of ca. 740 km. Starting longitudes in both regions were randomly chosen per distance sampling methodology (Buckland et al. 2001) so that the exact trackline configuration varied slightly for each survey.

The survey aircraft for the first survey (July 16) was a single-engine Cessna 177RG Cardinal[1]. For the remaining five surveys a twin-engine Piper PA34 Seneca was used. Both aircraft flew at a mean ground speed of 100 knots and an average altitude of 244m (800 ft). Two experienced observers made sightings of all marine mammal species, one on each side of the aircraft. Sightings were called to a data recorder who noted the species sighted, number of individuals, presence or absence of a calf, angle to the sighting (using hand-held Suunto clinometers), and any apparent reaction to the aircraft. Additionally, GPS locations and altitude were automatically recorded onto a laptop computer at 30-sec intervals, as well as manually whenever a sighting was made. Environmental data (seastate, glare and visibility) were manually recorded at the start of each transect leg and whenever conditions changed. The two data sources (manual and computer) were later merged into a single data file. Species identifications were typically made by orbiting an initial sighting until sufficient diagnostic features were discernible to permit positive identification. When the initial sighting could not be recaptured upon orbiting, the species was recorded as “unidentified.”

[1] Due to PMRF Range Ops on July 16, 2006, flying in the Kaulakahi Channel region was not permitted. We therefore surveyed an adjacent region off the central and southwest coast of Kauai in order to avoid the warning area on that date.

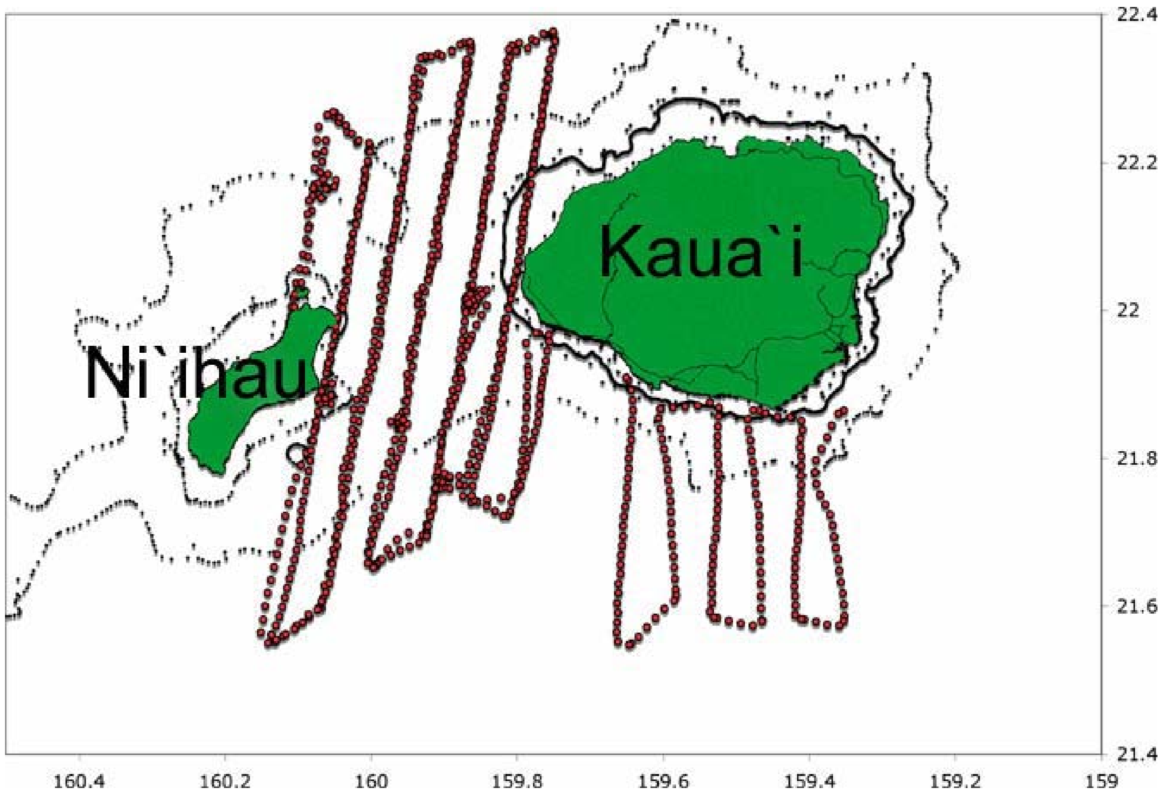

Figure 1. Survey effort for Kaulakahi Channel. GPS data (red lines) for surveys performed on July 16,17 and 20. Tracklines were 7.5 km apart and extended 13 km past the 1000 fathom contour. Total transect length was ca. 556 km. The tracklines to the south of Kauai were flown on July 16 only, when the waters of Kaulakahi Channel were closed due to scheduled operations of the Pacific Missile Range Facility (PMRF) at Barking Sands, Kauai.

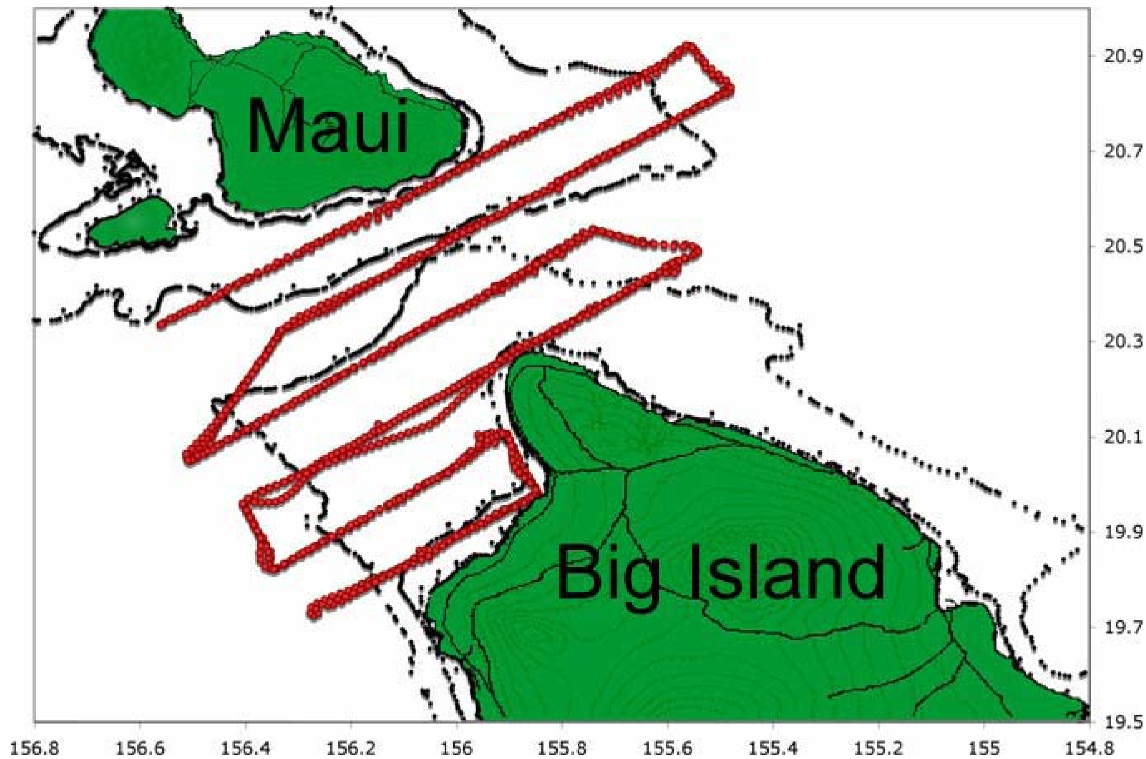

Figure 2. Survey effort for Alenuihaha Channel. GPS position data (red lines) are shown for July 24-26 surveys. Tracklines were 15 km apart and extended 13 km past the 1000 fathom limit. Total trackline distance for each survey was approximately 740 km.

Results

Overview. The six surveys comprised a total of ca. 18 hrs and ca. 3300 km of linear survey effort (Table 1). The number of sightings as well as the ability to identify species was generally hampered by poor seastate conditions that prevailed on all but one of the survey dates (July 20) (Table 1, Figure 3). Seastate is the primary factor affecting the ability to detect marine mammals (Buckland et al. 2001).

Summary of sightings. Cetacean species were detected on five of the six surveys (Table 1), including four identified species (bottlenose dolphins, spotted dolphins, false killer whales and Cuvier's beaked whale), one unidentified beaked whale species (likely *Mesoplodon densirostris*) and eight unidentified delphinid species (Table 2, Figures 4 & 5). All four of the identified species are among those typically seen in nearshore Hawaiian waters (Mobley et al. 2000; Shallenberger 1981). No unusual behavior or activity (e.g., stranded or dead animals) was observed during the six surveys.

Encounter rate comparison. One method of normalizing sightings for performing comparisons is to calculate encounter rates (groups sighted/km surveyed) (Buckland et al.

2001). In the present series a total of 13 sightings were made across ca. 3,334 km of survey effort which corresponds to an encounter rate of .0004 sightings/km. This rate is identical with the encounter rate for all odontocetes combined observed during the 1993-2003 survey series for inshore waters around the main Hawaiian Islands during the months Jan-Apr (Mobley, unpublished data, Appendix A). Therefore, the densities of marine mammal species reported here is identical with that normally seen for the Hawaiian Islands, albeit at different times of the year.

Table 1. Summary of Survey Effort and Sightings

Region	Date	No. of sightings	Survey effort (hrs)	Mean Beaufort seastate
Kaulakahi Channel	July 16	0	1.25	4.38
	July 17	2	3.96	4.06
	July 20	3	3.08	1.47
Alenuihaha Channel	July 24	1	3.28	4.36
	July 25	5	3.33	4.17
	July 26	2	3.02	4.80
	Total:	13	17.92	

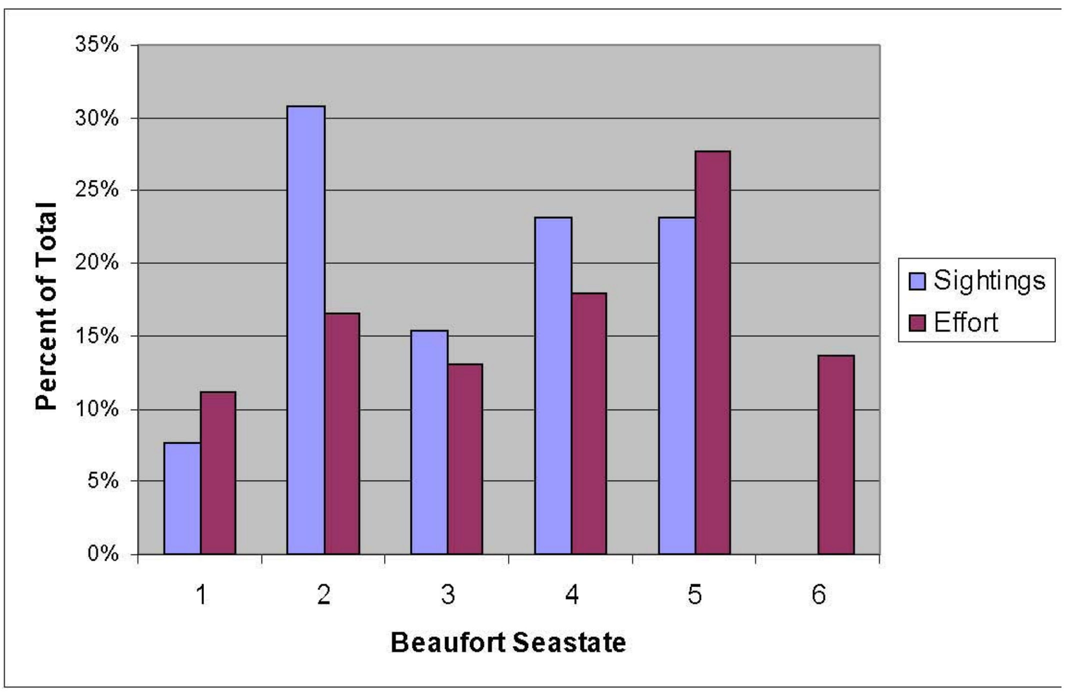

Figure 3. Summary of Beaufort Seastate Conditions. Beaufort seastate is one of the main factors affecting the ability to detect marine mammals. Normally, the ability to detect drops substantially beyond Beaufort 3. As shown, the majority of survey effort occurred in Beaufort 5, whereas the greater number of sightings occurred in Beaufort 2.

Table 2. Summary of Species Sightings by Region

Region / Species	No. groups	No. individuals
Kaulakahi Channel:		
Spotted dolphins (*Stenella attenuata*)	1	14
Unidentified delphinid species	4	21
Alenuihaha Channel:		
Bottlenose dolphin (*Tursiops truncatus*)	1	1
False killer whales (*Pseudorca crassidens*)	1	4
Cuvier’s beaked whale (*Ziphius cavirostris*)	1	1
Unidentified beaked whale	1	1
Unidentified delphinid species	4	29

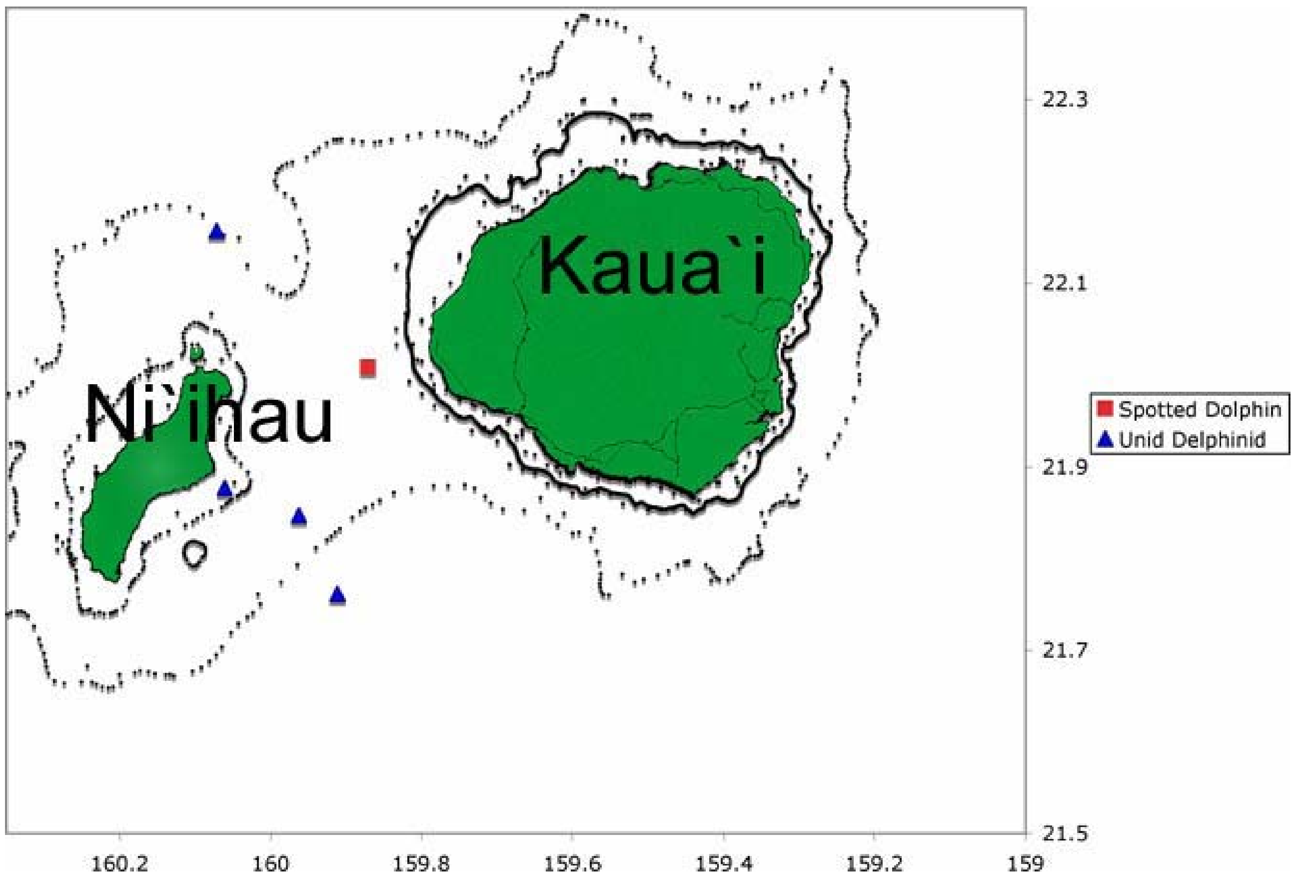

Figure 4. Kaulakahi Channel sightings. A total of five sightings occurred in the Kaulakahi Channel including one pod of spotted dolphins and four of unidentified delphinid species. Inner and outer bathymetry lines refer to 100 and 1000 fathom contours, respectively.

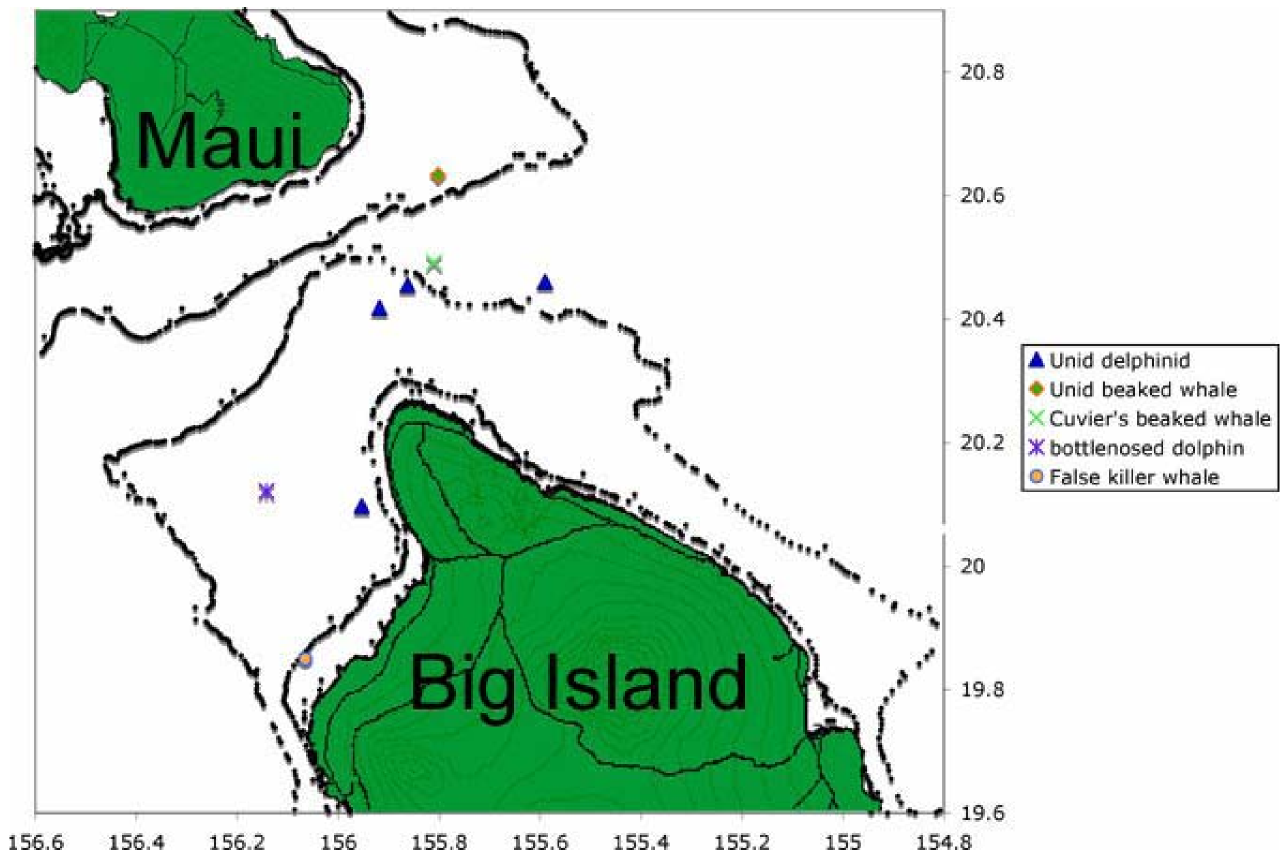

Figure 5. Alenuihaha Channel sightings. A total of 8 sightings occurred in the Alenuihaha Channel, including one pod of each of the following species: bottlenose dolphin, false killer whale, Cuvier's beaked whale and an unidentified beaked whale species (likely *Mesoplodon densirostris*). Additionally four pods of unidentified delphinids were sighted. Inner and outer bathymetry lines refer to the 100 and 1000 fathom contours, respectively.

Discussion

From the total of 13 sightings only four (31%) were positively identified to species. One sighting in the Alenuihaha Channel was identified as a beaked whale (likely Blainville's beaked whale, *M. densirostris*) but was not resighted upon orbiting, thus obviating positive species identification. The low rate of species identification was likely due to the poor seastate conditions that prevailed on all but one of the six surveys (Table 1, Figure 3) thereby making it difficult to recapture the sighting when orbiting.

The sighting of a group of four false killer whales (*Pseudorca crassidens*) was significant given recent concerns over the possible decline in their population around the Hawaiian Islands, possibly due to fisheries interactions (Baird and Gorgone 2005). In the 1993-03 aerial survey series, false killer whales were not seen after 1998 (Mobley, unpublished data), so the current sighting is the first aerial sighting since that time, though shipboard observations have been recorded (e.g., Barlow 2006).

Similarly, the sighting of a single Cuvier's beaked whale (*Ziphius cavirostris*), also in the Alenuihaha Channel, was significant given the fact that previous reports of adverse reactions to mid-range sonar primarily involved this species (ICES, 2005). It was sighted on 25July when RIMPAC activities were scheduled to occur in the channel, and was sighted mid-channel in waters deeper than 1000 fathoms (Figure 5).

As noted, the encounter rate for sightings in the present survey series (.0004 sightings/km surveyed) was identical to that recorded for odontocete species during the 1993-03 aerial survey series for the months Jan-Apr (Mobley 2004). This suggests that densities in the Kaulakahi and Alenuihaha Channels were no more or less than those normally seen throughout Hawaiian waters, albeit at different times of the year. Barlow (2006) commented on the low densities of odontocete species noted during 2002 shipboard surveys of the Hawaiian Exclusive Economic Zone (EEZ), noting them to be lower than most warm-temperate and tropical locations worldwide. He attributed this low density to the low productivity of the subtropical gyre that affects Hawaiian waters.

In conclusion, these surveys provided no evidence of impact of RIMPAC activities on resident populations of cetaceans in the Kaulakahi and Alenuihaha Channels. No differences in cetacean densities were detected, and no unusual behavior or event (e.g., unusual aggregations or near strandings) was observed. This statement should not be interpreted as evidence of no impact, merely that no such evidence was detected during these 18 hrs of surveys.

Acknowledgements

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Appendix A

1993 - 2003 Hawaiian Islands Aerial Survey Results

Species Name	No. pods	No. indiv.
Humpback whale (*Megaptera novaeangliae*)	2352	3907
Spinner dolphin (*Stenella longirostris*)	52	1825
Spotted dolphin (*Stenella attenuata*)	31	1021
Short-finned pilot whale (*Globicephala macrorhynchus*)	73	769
Melon-headed whale (*Peponocephala electra*)	6	770
Bottlenosed dolphin (*Tursiops truncatus*)	54	492
False killer whale (*Pseudorca crassidens*)	18	293
Sperm whale (*Physeter macrocephalus*)	23	106
Rough-toothed dolphin (*Steno bredanensis*)	8	90
Blainville's beaked whale (*Mesoplodon densirostris*)	9	32
Pygmy or dwarf sperm whale (*Kogia* spp.)	4	28
Striped dolphin (*Stenella coeruleoalba*)	1	20
Pygmy killer whale (*Feresa attenuata*)	2	16
Cuvier's beaked whale (*Ziphius cavirostris*)	7	13
Risso's dolphin (*Grampus griseus*)	1	8
Killer whale (*Orcinus orca*)	1	4
Fin whale (*Balaenoptera physalus*)	1	3
Unid. Dolphin	96	452
Unid. Stenella spp.	11	196
Unid. Whale	28	39
Unid. beaked whale	9	23
Unid. Cetacean	14	27
Totals:	2801	10134

Appendix G
Essential Fish Habitat and Coral Reef Assessment for the Hawaii Range Complex EIS/OEIS

APPENDIX G ESSENTIAL FISH HABITAT AND CORAL REEF ASSESSMENT FOR THE HAWAII RANGE COMPLEX EIS/OEIS

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1.0 BACKGROUND

1.1 ESSENTIAL FISH HABITAT ASSESSMENT

This assessment of Essential Fish Habitat (EFH) is provided in accordance with amendments to the regulations implementing the Magnuson-Stevens Fishery Management and Conservation Act (MSFMCA; Federal Register 62, 244, December 19, 1997). This amendment set forth new mandates for the National Marine Fisheries Service (NMFS), eight regional fishery management councils (Councils), and other federal agencies to identify and protect important marine and anadromous fish habitat. The Councils (with assistance from NMFS) are required to delineate EFH for all managed species. Federal agencies which fund, permit, or carry out activities that may adversely impact EFH are required to consult with NMFS regarding potential impacts on EFH, and respond in writing to NMFS recommendations.

The MSFMCA defines EFH as those waters and substrates necessary (required to support a sustainable fishery and the managed species) to fish for spawning, breeding, feeding, or growth to maturity (i.e., full life cycle) (16 U.S.C. Section 1802). These waters include aquatic areas and their associated physical, chemical, and biological properties used by fish, and may include areas historically used by fish. Substrate types include sediment, hard bottom, structures underlying the waters, and associated biological communities.

EFH can consist of both the water column and the underlying surface (e.g. seafloor) of a particular area. Areas designated as EFH contain habitat essential to the long-term survival and health of our nation's fisheries. Certain properties of the water column such as temperature, nutrients, or salinity are essential to various species. Some species may require certain bottom types such as sandy or rocky bottoms, vegetation such as seagrasses or kelp, or structurally complex coral or oyster reefs.

EFH includes those habitats that support the different life stages of each managed species. A single species may use many different habitats throughout its life to support breeding, spawning, nursery, feeding, and protection functions. EFH encompasses those habitats necessary to ensure healthy fisheries now and in the future.

Habitat Areas of Particular Concern (HAPC) are discrete subsets of EFH that provide extremely important ecological functions or are especially vulnerable to degradation. Councils may designate a specific habitat area as an HAPC based on one or more of the following reasons:

- Importance of the ecological function provided by the habitat
- Extent to which the habitat is sensitive to human-induced environmental degradation
- Whether, and to what extent, development activities are, or will be, stressing the habitat type
- Rarity of the habitat type

The HAPC designation does not confer additional protection or restrictions upon an area, but can help prioritize conservation efforts. Healthy populations of fish require not only the relatively small habitats identified as HAPCs, but also other areas that provide suitable habitat functions. HAPCs alone will not suffice in supporting the larger numbers of fish needed to maintain sustainable fisheries and a healthy ecosystem.

Since coral reefs are considered EFH, this EFH Assessment also includes a Coral Reef Assessment in accordance with Executive Order (E.O.) 13089 Coral Reef Protection and subsequent guidance documents from the DOD and the Navy. EO 13089 on Coral Reef Protection (63 FR 32701) was issued in 1998 "to preserve and protect the biodiversity, health, heritage, and social and economic value of U.S. coral reef ecosystems and the marine environment." It is DOD policy to protect the U.S. and International coral reefs and to avoid impacting coral reefs to the maximum extent possible. No concise definition of coral reefs has been promulgated, with regard to regulatory compliance of E.O. 13089. In general, coral reefs shall consist of tropical reef building Scleractinian and Hydrozoan corals, as well as calcified Octocorals in the families Tubiporidae and Helioporidae, non-calcified Octocorals (soft corals) and Gorgonian corals, all growing in the 0 to 300 foot depth range. Deep water (300 to 3,000 foot depth range) precious corals and other deep water coral communities will only be considered in the case of a SINKEX, where the vessel might ultimately land on a deep water coral community.

2.0 PROPOSED ACTION

Navy ranges, operating areas (OPAREAs), and airspace must be maintained to support national security objectives and to ensure that Navy and other DoD forces remain in a high state of readiness, to include RDT&E activities. The Hawaii Range Complex (HRC) is one of thirteen Navy range complexes used for training and testing. The HRC has extensive existing range assets and is strategically located geographically. The importance of the HRC location is best described by looking at the importance of this range to locally based forces, transiting forces, and multinational forces.

The HRC surrounds the major Navy homeport of Pearl Harbor where a large number of ships and submarines are based. Hawaii is also the home for Navy aircraft from five operational squadrons and seven major Navy commands. Other Services are also strongly represented with numerous major Army, Air Force and Marine Corps commands, and two unified commands (U.S. Pacific Command and Special Operations Command, Pacific). Without exception, these forces require a “backyard” range for meeting necessary training requirements.

The HRC geographically encompasses offshore, nearshore, and onshore areas located on or around the major islands of the Hawaiian Island chain. Figure 2-1 shows the range boundaries. The geographic scope of this EFH includes the Hawaii Offshore OPAREAs, which are comprised of 235,000 nm^2 of ocean, generally from 17 to 26 degrees north latitude and from 154 to 162 degrees west longitude, and the PMRF Temporary Operating Area, consisting of 2.1 million nm2 to the north and west of Kauai. The study area includes the Hawaii Offshore Areas (Table 2-1), facilities used by the U.S. Navy Undersea Warfare Center (NUWC) Detachment Pacific on west Oahu (Table 2-2), the Explosive Ordnance Disposal (EOD) Shore Area in West Loch (Table 2-3), and Hawaii Onshore Areas (Table 2-4). These ranges and OPAREAS are used to conduct operations and training involving military hardware, personnel, tactics, munitions, explosives, and electronic combat systems. Several of the areas are also used for RDT&E, including missile defense programs.

The purpose of the Proposed Action is:

- Maintain current levels of military readiness by training in the HRC;
- Accommodate future increases in operational training tempo in the HRC and support the rapid deployment of naval units or strike groups;
- Achieve and sustain readiness of ships and squadrons so that the Navy can quickly surge significant combat power in the even of a national crisis or contingency operation, and consistent with the FRTP;
- Support the acquisition and implementation into the Fleet of advanced military technology. The HRC must adequately support the testing and training needed for new platforms and weapons systems (e.g.: the Littoral Combat Ship (LCS) and the MH-60R Seahawk helicopter); and,
- Maintain the long-term viability of the HRC while protecting human health and the environment, and enhancing the quality and communication capability and safety of the range complex.

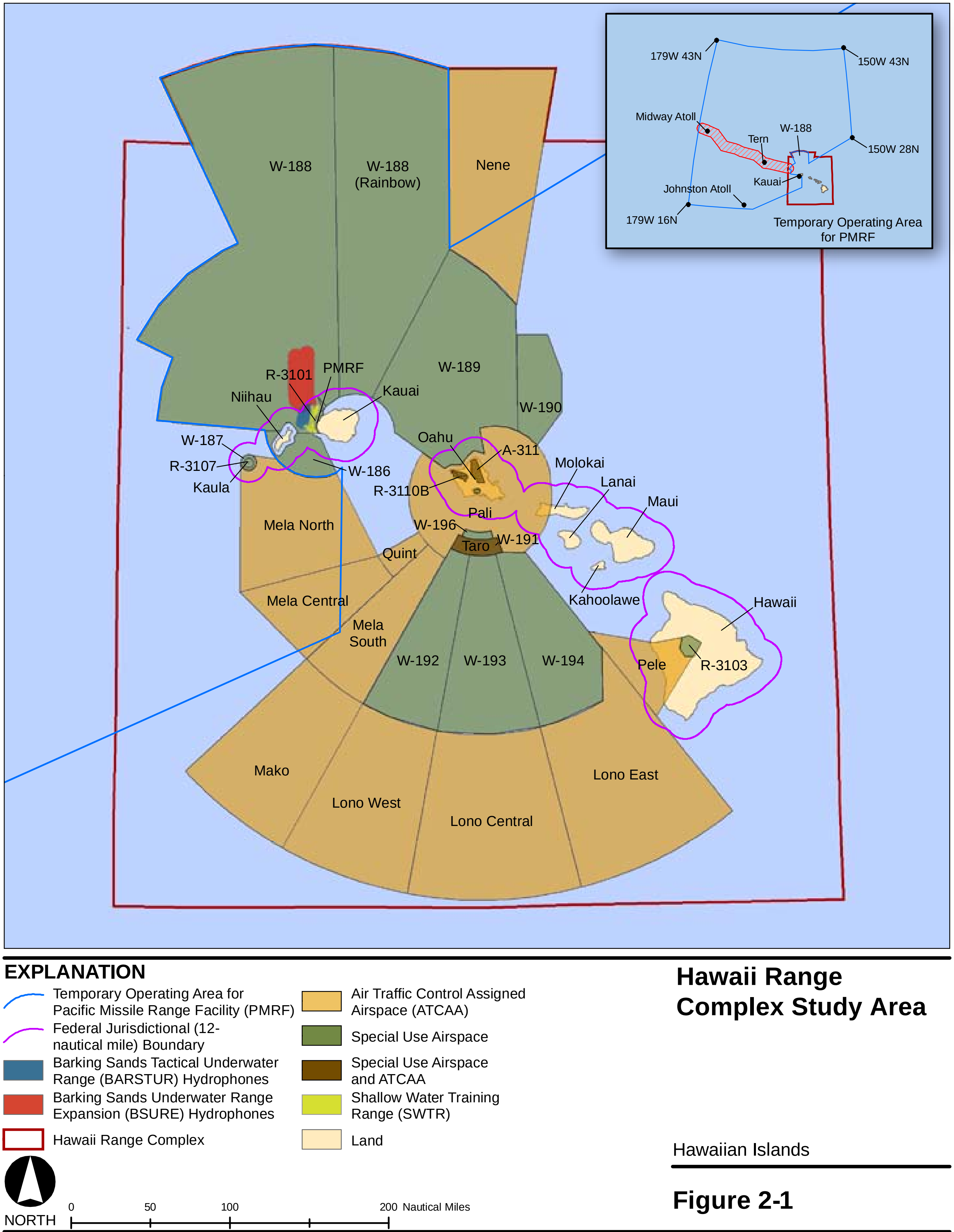

179W 43N
150W 43N
Midway Atoll
W-188
Tern
150W 28N
Kauai
Johnston Atoll
179W 16N
Temporary Operating Area for PMRF
W-188
W-188 (Rainbow)
Nene
W-189
W-190
PMRF
R-3101
Kauai
Niihau
W-187
R-3107
Kaula
W-186
Oahu
A-311
R-3110B
Molokai
Lanai
Maui
Pali
W-196
W-191
Taro
Quint
Mela North
Mela Central
Mela South
Kahoolawe
Hawaii
Pele
R-3103
W-192
W-193
W-194
Mako
Lono West
Lono Central
Lono East
EXPLANATION
Temporary Operating Area for Pacific Missile Range Facility (PMRF)
Federal Jurisdictional (12-nautical mile) Boundary
Barking Sands Tactical Underwater Range (BARSTUR) Hydrophones
Barking Sands Underwater Range Expansion (BSURE) Hydrophones
Hawaii Range Complex
Air Traffic Control Assigned Airspace (ATCAA)
Special Use Airspace
Special Use Airspace and ATCAA
Shallow Water Training Range (SWTR)
Land
NORTH
0
50
100
200 Nautical Miles
Hawaii Range Complex Study Area
Hawaiian Islands

Figure 2-1

Table 2-1. Hawaii Offshore Area Descriptions

OPAREA	OPAREA Description
Northern Warning Areas	
W-188 Rainbow, W-189, W-190	The Northern Warning Areas lie north of Oahu. These areas are available from the surface to an unlimited altitude and are used for surface and air operations.
Southern Warning Areas	
W-192, W-193, W-194	The Southern Warning Areas are located south of Oahu. Available from the surface to an unlimited altitude.
W-191	W-191, located directly south of Oahu, is available from the surface to 3,000 ft. for air and surface operations.
W-196	W-196 is used only for surface and helicopter operations. The airspace extends from the surface to 2,000 feet (ft), and is not available to fixed-wing aircraft.
Kapu/Quickdraw, Wela Hot Areas	Kapu/Quickdraw and Wela Hot Areas, also known as Special Operating Area (SOA) 4 and SOA 6, respectively, are located completely within W-192.
Air Traffic Control Assigned Airspace (ATCAA)[1]	
Nene	Nene is the only ATCAA associated with the Northern Warning Areas.
Pali	Pali is a roughly 40-nautical mile (nm) circular area over Oahu, from flight level (FL) 250[2] to an unlimited altitude, although it is normally not available below FL 280.
Taro	Taro overlies W-191, sharing the same borders and, when available, extending its airspace from 3,000 ft to 16,000 ft.
Quint	Quint is located 45 nm southwest of Honolulu, with available airspace from FL 250 to an unlimited altitude, although it is usually not available below FL 280.
Mela North, Mela Central, Mela South	The Mela ATCAAs connect the western border of W-192 with the southern border of W-186 (Pacific Missile Range Facility [PMRF]). They are available from the floor of controlled airspace (1,200 ft) to an unlimited altitude, except for Mela North which has a ceiling of 15,000 ft.
Mako, Lono West, Lono Central, Lono East	The Mako and Lono ATCAAs are available to extend the airspace of Mela South, W-192, W-193, and W-194 by an additional 104 nm. All are available from the floor of controlled airspace to an unlimited altitude.
Pele	Pele provides a transit corridor from W-194 and Lono East into R-3103 airspace over Pohakuloa Training Area. When activated, Pele extends from 16,000 ft to FL 290.
Kaula Rock	
Kaula Rock, R-3107, W-187	Kaula Rock is a 0.5-nm by 0.7-nm island surrounded by a 3-nm radius restricted area (R-3107), and a 5-nm radius warning area (W-187). Both R-3107 and W-187 extend from surface to FL 180.

1 ATCAAs are areas of airspace that are not special use airspace. They have been established as areas that the military may request for temporary use when needed. When not in use, they revert back to Honolulu Combined Center/Radar Approach Control (CERAP).

2 Altitudes above 17,999 ft are referenced in terms of hundreds of feet, called flight levels (FL). For example, FL 250 is equivalent to 25,000 ft.

Table 2-1. Hawaii Offshore Area Descriptions (Continued)

OPAREA	OPAREA Description
Pacific Missile Range Facility	
W-186, W-188	W-186 extends from surface to 9,000 ft, and W-188 extends from surface to unlimited.
R-3101, Majors Bay	R-3101 extends from surface to unlimited and provides necessary airspace to support training and RDT&E operations at PMRF. Majors Bay lies beneath R-3101 and includes beach area on PMRF land.
Barking Sands Tactical Underwater Range (BARSTUR)	BARSTUR is an instrumented underwater range that provides approximately 120 nm^2 of underwater tracking of participants and targets
Barking Sands Underwater Range Expansion (BSURE)	BSURE extends BARSTUR to the north, providing an additional 900 nm^2 of underwater tracking capability.
Other Restricted Areas	
Ewa Training Minefield	The Ewa Training Minefield is an ocean area extending from Ewa Beach approximately 2 nm toward Barbers Point, and out to sea approximately 4 nm. This restricted area has been used in the past for surface ship mine avoidance training.
Submarine Operating Area	The Grid Operating Area encompasses the entire area of the HRC. The area is bounded by 17N, 25N, 154W, and 162 W.

Table 2-2. Naval Undersea Warfare Center (NUWC) Detachment Pacific Ranges

OPAREA	OPAREA Description
Fleet Technical Evaluation Center (FTEC)	The FTEC range operations building is located on the southern shore of Oahu, west of the former Barbers Point Naval Air Station.
Shipboard Electronic Systems Evaluation Facility (SESEF)	The SESEF range is located south and west of FTEC. Ships operate and maneuver in this area as necessary to remain within electronic signal reception range of FTEC.
Fleet Operational Readiness Accuracy Check Site (FORACS)	The FORACS range includes an approximately 5-nm by 5-nm ocean area just offshore of the southwestern coast of Oahu, northwest of the SESEF range.

Table 2-3. Explosive Ordnance Disposal (EOD) Ranges

OPAREA	OPAREA Description
West Loch Explosive Ordnance Disposal (EOD) Shore Area	The EOD shore area consists of a 2.75-acre facility at Naval Magazine Pearl Harbor West Loch.
Lima Landing Underwater Area	Lima Landing is a small underwater area just off an abandoned concrete pier at the approach to Pearl Harbor near the entrance of West Loch.
Puuloa Underwater Range	The Puuloa Underwater Range is a 1-nm^2 area in the open ocean outside and to the west of the entrance to Pearl Harbor.

Table 2-4. Hawaii Onshore Area Locations

Island	OPAREA Description
Oahu	Activities occur at Naval Inactive Ship Maintenance Facility, Pearl Harbor, Marine Corps Training Area/Bellows, Pearl Harbor, Ford Island, Marine Corps Base Hawaii, Hickam Air Force Base, Wheeler Army Airfield, Schofield Barracks (R-3109), Coast Guard Station Barbers Point/Kalaeloa Airport, Makua Military Reservation (R-3110), Kahuku Training Area (A-311), Kaena Point, Mt Kaala, Wheeler Network Communications Control, and Dillingham Military Reservation.
Kauai	Activities occur at the following PMRF locations: Main Base, Makaha Ridge, Kokee, Kamokala Magazine, Hawaii Air National Guard, Kauai Test Facility, Port Allen, Kikiaola Boat Harbor, and Mt. Kahili.
Hawaii	Activities occur at Pohakuloa Training Area (R-3103) and adjacent leased property, Bradshaw Army Airfield, and Kawaihae Pier.
Maui	Activities occur at Maui Space Surveillance System, Maui High Performance Computing Center, and Sandia Maui Haleakala Facility.
Niihau	Activities occur at Perch site, etc… and other authorized areas.

The Proposed Action of the EIS/OEIS is to increase usage and to enhance capability of the HRC to achieve and maintain Fleet readiness and to conduct current, emerging, and future training and RDT&E operations. This chapter describes the No-action Alternative and two Alternatives to accomplish the Proposed Action. The No-action Alternative is the continuation of training operations, RDT&E activities, the ongoing base operations and maintenance of the technical and logistical facilities that support these operations and activities, and the marine mammal protective measures related to acoustic effects. The No-action Alternative includes the current level of training and test activities (which includes RIMPAC exercises). Alternative 1 includes the activities described in the No-action Alternative with the addition of increased training necessary to support the FRTP, Hawaii RCMP investments, planned RDT&E activities, and necessary force structure changes. Alternative 2 would include all of the activities described in Alternative 1 with the addition of major events, such as supporting three transient CSG training exercises simultaneously, increasing the tempo of training exercises, and additional RDT&E programs at PMRF. Additional RDT&E programs proposed as part of Alternative 2 would include directed energy programs involving lasers.

This EFH analysis does not discuss all actions and activities that occur in the Hawaii Range Complex, but focuses on current and proposed actions and alternatives that may potentially affect EFH.

2.1 NO-ACTION ALTERNATIVE

Under the No-action Alternative, the current baseline of activities includes over 9,300 training and RDT&E operations conducted in the HRC annually. Under the No-action Alternative, training operations, RDT&E activities, and major range events would continue at the baseline levels (which include RIMPAC exercises). The No-action Alternative includes the activities described in the 1998 PMRF Final EIS, the additional PMRF programs analyzed since December 1998, and the activities described in the RIMPAC 2002 Programmatic EA and the supplements to that document in 2004 and 2006. If this alternative is selected, the U.S. Navy would continue existing range training and operation activities and base operations and maintenance activities as described in the following paragraphs.

2.1.1 HAWAII RANGE COMPLEX TRAINING OPERATIONS

The current training operations within the HRC (Figure 2-1) that may potentially affect EFH are desribed below and shown in Table 2.1-1.

Table 2.1-1. Baseline Training Operations

Mission Area	Event	Area	Baseline (Events/Year)
OFFSHORE ACTIVITIES			
Anti-Air Warfare (AAW)	Air Combat Maneuver	W-188, 189, 190, 192, 193, 194	738
	Air-to-Air Missile Exercise	W-188	36
	Surface-to-Air Gunnery Exercise	W-188, 192, Mela South	86
	Surface-to-Air Missile Exercise	W-188	17
	Chaff Exercise	Hawaii Offshore	34
Amphibious Warfare (AMW)	Naval Surface Fire Support Exercise	W-188	22
Anti-Surface Warfare (ASUW)	Visit, Board, Search, and Seizure	Hawaii Offshore	60
	Surface-to-Surface Gunnery Exercise	W-191, 192, 193, 194, 196, Mela South, Pacific Missile Range Facility (PMRF)	69
	Surface-to-Surface Missile Exercise	Pacific Missile Range Facility (PMRF) (W-188)	7
	Air-to-Surface Gunnery Exercise	Hawaii Offshore, PMRF	128
	Air-to-Surface Missile Exercise	PMRF	36
	Bombing Exercise (Sea)	Hawaii Offshore, PMRF	35
	Sink Exercise	Hawaii Offshore, PMRF	6
	Antisurface Warfare Torpedo Exercise (Submarine-Surface)	Hawaii Offshore, PMRF	35
Anti-Submarine Warfare (ASW)	Antisubmarine Warfare Tracking Exercise	Hawaii Offshore, PMRF	372
	Antisubmarine Warfare Torpedo Exercise	Hawaii Offshore, PMRF	397
	Major Integrated ASW Training Exercise	Hawaii Offshore, PMRF	5
Electronic Combat (EC)	Electronic Combat Operations	W-188, 192, 193, 194, Lono West, Mela South	50
Mine Warfare (MIW)	Mine Countermeasures Exercise	PMRF, Submarine Operating Area	32
Naval Special Warfare (NSW)	Swimmer Insertion/Extraction	Hawaii Offshore, Marine Corps Training Area–Bellows (MCTAB), PMRF	80
Strike Warfare (STW)	Bombing Exercise (Land)	Kaula Rock, Pohakuloa Training Area (PTA)	97
	Air-to-ground Gunnery Exercise	Kaula Rock	16
Other	Command and Control (C2)	U.S. Command Ship at sea	1

Table2.1-1. Baseline Training Operations (Continued)

Mission Area	Event	Area	Baseline (Events/Year)
NEARSHORE OPERATIONS			
AMW	Expeditionary Assault	PMRF, MCTAB	11
ASUW	Flare Exercise	W-188	6
MIW	Mine Neutralization	Puuloa Underwater Range	62
	Mine Laying	PMRF	22
NSW	Swimmer Insertion/Extraction	Hawaii Offshore, MCTAB, PMRF	52
Other	Salvage Operations	Pearl Harbor, Puuloa Underwater Range, Keehi Lagoon	1
	In Port Ship Support Operations	Pearl Harbor	1
ONSHORE OPERATIONS			
MIW	Land Demolitions	Explosive Ordnance Disposal Land Range	85
Other	Command and Control (C2)	Pearl Harbor, Marine Corps Base Hawaii (MCBH), Hickam Air force Base (AFB), Wheeler Army Airfield (AAF), Bradshaw AAF	1
	Aircraft Support Operations	Pearl Harbor, Kalaeloa Airport, MCBH, Hickam AFB, Wheeler AAF, Bradshaw AAF, PMRF	1
	Personnel Support Operations	Oahu, Kauai	1
	Air Operations	Pearl Harbor, Kalaeloa Airport, MCBH, Hickam AFB, Wheeler AAF, Bradshaw AAF, PMRF	2,600
	Field Carrier Landing Practice (FCLP)	Kalaeloa Airport, MCBH, Barking Sands, Kona International Airport	0
	Live Fire Exercise	Makua Military Reservation, PTA	3
	Humanitarian Assistance / Non-combatant Evacuation Operations (HAO/NEO)	PMRF, Niihau, MCBH, MCTAB, Kahuku	1
	Humanitarian Assistance / Disaster Relief Operations (HA/DR)	MCBH, MCTAB, Kahuku	1

2.1.1.1 Hawaii Range Complex Support Operations

Numerous support functions take place as an integral part of training operations occurring in the Hawaii Range Complex. These support functions can generally be described as either supporting the command and control (C2) activities, or supporting ships, aircraft, or personnel. The support operations described in this section are not included in Table 2.1-1. Although critical to the completion of many Hawaii training operations, the nature of these support functions are primarily continuous, non-range events that do not conform to description in this table. In general, the level of these support operations increases as the level and tempo of range training and exercise operations increase.

Command and Control

The purpose of the Command and Control (C2) activities is to provide continuous command and control support for ongoing training operations and for major exercises. Each activity is monitored and coordinated for safety and on-time performance, as well as to ensure training objectives are accomplished, and to identify lessons learned for future training activities and exercises. Overall command functions can be performed from a command ship or from land facilities at Pearl Harbor or PMRF.

C2 is achieved through a network of communication devices strategically located at selected DoD installations around the islands to ensure positive communication with the training and exercise participants. C2 nodes include both ship and shore assets. Shore assets are located throughout the Hawaiian Islands and include coordination and control activities at range control offices and through air traffic centers of the participating installations, and other ongoing C2 activities.

In-port Ship Support Activities

The purpose of the in-port ship activities is to provide major support for Navy ships and submarines. In-port support includes the typical operations that are carried out when foreign and U.S. warships and submarines are berthed at Pearl Harbor. This includes in port briefings and debriefings and in-port training activities, including oil spill response training. Once berthed, ships would re-supply, plan for refueling, load ammunition, and conduct other maintenance activities, including the off loading of solid wastes and wastewater (black and gray water). In addition, non-typical orders are processed to acquire country unique items that are not normally handled by the U.S. Fleet. The Federal Industrial Supply Center located at Pearl Harbor is the organization responsible to complete these orders.

Pearl Harbor is a restricted area. No vessels are allowed into Pearl Harbor without permission of Commander Navy Region Hawaii. The restricted area extends outward from the mouth of the harbor and is defined by a rectangular-shaped boundary known as the Pearl Harbor Naval Defensive Sea Area.

Shore assets include berthing space and utility hookups, harbor coordination and control activities, space management activities for equipment and personnel, and other ongoing shore facilities management activities. Pearl Harbor has contained more than 60 warships during major exercises and on other occasions.

Aircraft Support Operations

Aircraft support operations are necessary to ensure the safe operation of all air activities. Aircraft support includes space for the various types of aircraft, equipment for refueling and maintenance.

U.S. and foreign aircraft (fixed wing, rotary, and airship) are supported from several locations. Future exercises could have as many as 260 aircraft, supported at Hickam AFB, Coast Guard Air Station Barbers Point/Kalaeloa Airport, Marine Corps Air Facility Kaneohe Bay, and Wheeler Army Airfield on Oahu; Bradshaw Army Airfield on Hawaii; and PMRF Barking Sands airfield on Kauai.

Personnel Support Activities

The purpose of the personnel support activities is to meet the housing and facilities needs of the personnel that support range operations. This includes in-port briefings and debriefings and in-port training activities. In addition, some exercises conclude with receptions, athletic events, and other social activities.

Housing is provided both on and off installation as necessary to house transient aircraft crews and temporary support personnel. Off-installation housing requirements can range from 700 to 1,500 units.

2.1.1.2 Current Training Operations Within The Hawaii Offshore OPAREA

Current training operations include swimmer insertion/extraction training, visit, board, search, and seizure operations, humanitarian assistance and non-combatant evacuation exercises, and humanitarian assistance and disaster relief training. Current training exercises include mine countermeasures exercises, mine neutralization, mine laying, land demolitions, expeditionary assault (formerly known as an amphibious exercise), various gunnery and missile exercises, bombing exercises, sink exercises, torpedo exercises, antisubmarine warfare tracking and torpedo exercises, air combat maneuvers, electronic combat operations, fire support exercises, flare exercises, chaff exercises, live fire exercises, and salvage operations The detailed descriptions of current training operations within the Hawaii offshore OPAREA are found in appendix D of the HRC EIS.

Swimmer Insertion/Extraction

Naval Special Warfare (NSW) personnel conduct underwater swimmer insertion and extraction training in the Hawaii Offshore Areas using either the SEAL Delivery Vehicle (SDV), or the Advanced SEAL Delivery System (ASDS). Both submersibles are designed to deliver special operations forces for clandestine operations. The SDV is an older, open-design delivery vehicle. The ASDS is a new dry compartment vehicle that keeps the SEALs warmer during transit. The battery-powered ASDS is capable of operating independently or with submarines.

Unit training with the ASDS consists of the SDV Team operating the ASDS independently. Integrated training operations involve the SDV Team working with a submarine and the ASDS. Underwater swimmer insertion and extraction training is focused on undersea operation of the SDV or ASDS, and does not typically involve SEAL personnel landing ashore or conducting shore operations. Although undersea range areas are usually reserved for a 24-hour period, the insertion/extraction operation itself lasts approximately 8 hours.

Swimmer Insertion and Extraction operations can also include the use of helicopters to insert or extract NSW personnel using a variety of techniques. Depending on use over water or over land, these techniques could include landing, hoisting, fastrope, rappel, paradrop, Special Purpose Insertion and Extraction (SPIE) rig, and Combat Rubber Raiding Craft (CRRC).

Mine Countermeasures Exercise

Mine Countermeasures (MCM) exercises train forces to detect, identify, classify, mark, avoid, and/or disable mines using a variety of methods including air, surface, sub-surface, and ground assets. The exercises include detection by mine countermeasure assets as well as avoidance by non-mine countermeasure capable units.

Organic Mine Countermeasures

Five OAMCM systems (Figure 2.1.1-1) will be deployed by the MH 60S, including:

- Advanced Mine Hunting Sonar: The AN/AQS-20A Advanced Mine Hunting Sonar is a single-pass multi-sonar system designed to detect, classify, localize and identify mines on the sea floor and in the water column.
- AN/AES-1 Airborne Laser Mine Detection System (ALMDS): The AN/AES-1 ALMDS is a sensor designed to detect moored, near surface mines using light detection and ranging technology. Five OAMCM systems (Figure 2.1.1-1) will be deployed by the MH 60S, including:
- AN/ALQ-220 Organic Airborne and Surface Influence Sweep (OASIS): The AN/ALQ-220 OASIS System will ensure the Navy will maintain an assured access capability and counter influence mines that may not be found using other mine hunting systems. OASIS is a lightweight magnetic/acoustic influence sweep system employed by the MH-60S.
- AN/AWS-2 Rapid Airborne Mine Clearance System (RAMICS): The AN/AWS-2 RAMICS is being developed to counter by destruction near-surface and floating mines using a 30-mm cannon hydro-ballistic projectile and includes a target reacquisition pod co-located on the MH-60S.
- AN/ASQ-235 Airborne Mine Neutralization System (AMNS): The AN/ASQ-235 AMNS is a lightweight expendable system designed for rapid neutralization of bottom and moored mines.

One Organic Mine Countermeasures (OMCM) System, the Remote Minehunting System (RMS), would be deployed from a surface ship. Another OMCM system, the Long-term Mine Reconnaissance System (LMRS), would be deployed from a submarine. Initial Operational Capability (IOC) for these new systems is expected after FY 2007.

One Organic Mine Countermeasures (OMCM) System, the Remote Minehunting System (RMS), would be deployed from a surface ship. Another OMCM system, the Long-term Mine Reconnaissance System (LMRS), would be deployed from a submarine. Initial Operational Capability (IOC) for these new systems is expected after FY 2007.

Mine Neutralization

Mine Neutralization operations involve the detection, identification, evaluation, rendering safe, and disposal of mines and unexploded ordnance (UXO) that constitutes a threat to ships or personnel. Mine neutralization training can be conducted by a variety of air, surface and sub-surface assets.

Tactics for neutralization of ground or bottom mines involve the diver placing a specific amount of explosives, which when detonated underwater at a specific distance from a mine results in neutralization of the mine. Floating, or moored, mines involve the diver placing a specific amount of explosives directly on the mine. Floating mines encountered by fleet ships in open-ocean areas will be detonated at the surface. In support of an expeditionary assault, divers and U.S. Navy marine mammal assets deploy in very shallow water depths (10 to 40 feet) to locate mines and obstructions.

AN/AES-1

AN/AWS-2

TBD

AN/ASQ-235

AN/ASQ-20A

AN/ALQ-220 OASIS

EXPLANATION

Proposed New Organic Mine Countermeasures

Not To Scale

Figure 2.1.1-1

Divers are transported to the mines by boat or helicopter. Inert dummy mines are used in the exercises. The total net explosive weight used against each mine ranges from less than 1 pound to 20 pounds.

Various types of surveying equipment may be used during RIMPAC. Examples include the Canadian Route Survey System that hydrographically maps the ocean floor using multi-beam side scan sonar and the Bottom Object Inspection Vehicle used for object identification. These units can help in supporting mine detection prior to Special Warfare Operations (SPECWAROPs) and amphibious exercises.

Occasionally, marine mammals are used in mine detection training operations. The U.S. Navy's Very Shallow Water Mine Countermeasures Detachment of Commander Mine Warfare Command will deploy trained Atlantic bottlenose dolphins (*Tursiops truncatus*) of their marine mammal mine-hunting systems in several missions. Each mission will include up to four motorized small craft, several crew members and a trained dolphin. Each trained animal is deployed under behavioral control.

Mine neutralization operations take place offshore in the Pu'uloa Underwater Range (called Keahi Point in earlier documents), Pearl Harbor; Lima Landing; Barbers Point Underwater Range off-shore of Coast Guard Air Station Barbers Point/Kalaeloa Airport (formerly Naval Air Station [NAS] Barbers Point); PMRF, Kauai (Majors Bay area); PMRF and Oahu Training Areas; and in open-ocean areas.

All demolition activities are 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. Before any explosive is detonated, divers are transported a safe distance away from the explosive. Standard practices for tethered mines in Hawaiian waters require ground mine explosive charges to be suspended 10 feet below the surface of the water. For mines on the shallow water floor (less than 40 feet of water), only sandy areas that avoid/minimize potential impacts to coral would be used for explosive charges.

Mine Laying

Mine laying operations are designed to train forces to use air, and subsurface assets to conduct offensive (deploy mines to tactical advantage of friendly forces) and defensive (deploy mines for protection of friendly forces and facilities) mining operations. Mines can be laid from the air (FA-18/P-3) or by submarine.

Airborne mine laying involves one or more aircraft and either computer-simulated or inert exercise mines. Mine warfare operations are limited to either the simulated laying of aircraft-deployed mines, where no actual mine ordnance is dropped, or the use of inert exercise mines or inert exercise submarine-deployed mines.

Mining requires divers and a weapons recovery boat to recover the mines, and one or more helicopters.

Aerial mining lines are generally developed off the southwest coast of Kauai and the southeast coast of Niihau, within PMRF Warning Areas W-186 and W-188. Submarine mining exercises are conducted within PMRF Warning Area W-188. Aircraft operations are conducted within R3101.

The use of inert exercise mines is generally limited to areas greater than 100 fathoms, or 600 feet in depth. Before dropping inert exercise mines, the crew visually determines that the area is clear. Although the altitude at which inert exercise mines are dropped varies, the potential for drift during descent generally favors release at lower altitudes, where visual searches for marine mammals are more effective. When the inert exercise mine is released, a small parachute retards its entry into the ocean. The mine can be designed to float on the surface or near surface or to sink on a tether. Ultimately the mine would sink carrying the parachute with it. Standard Navy procedures would be followed for the deployment of inert mines from submarines.

Visit, Board, Search, and Seizure

Visit, Board, Search, and Seizure (VBSS) is conducted to train helicopter crews to insert personnel onto a vessel for the purpose of inspecting the ship's personnel and cargo for compliance with applicable laws and sanctions. VBSS training requires a cooperative surface ship. Typical duration of a VBSS operation is approximately 1.5 hours.

Surface-to-Surface Gunnery Exercise

Surface gunnery exercises (GUNEX) take place in the open ocean to provide gunnery practice for Navy and Coast Guard ship crews. GUNEX training operations conducted in the Offshore OPAREA involve stationary targets such as a MK-42 Floating At Sea Target (FAST) or a MK-58 marker (smoke) buoy. The gun systems employed against surface targets include the 5-inch, 76-millimeter (mm), 25-mm chain gun, 20-mm Close In Weapon System (CIWS), and .50-caliber machine gun. Typical ordnance expenditure for a single GUNEX is a minimum of 21 rounds of 5-inch or 76-mm ammunition, and approximately 150 rounds of 25-mm or .50-caliber ammunition. Both live and inert training rounds are used. After impacting the water, the rounds and fragments sink to the bottom of the ocean. A GUNEX lasts approximately 1 to 2 hours, depending on target services and weather conditions.

Five-Inch Gun Ordnance

There are three new rounds of 5-inch ordnance nearing introduction to the Fleet.

The High Explosive Electronically Timed Projectile (HE-ET) is a standard High Explosive (HE) round with an improved electronically timed (ET) fuse.

The Kinetic Energy Projectile (KE-ET), commonly called the "BB" round, contains 9,000 tungsten pellets and is designed to be fired down a bearing at incoming boats.

The EX-171 Extended Range Guided Munition (ERGM) projectile is a major component of the Navy's littoral warfare concept. The 5-inch, rocket-assisted projectile is capable of carrying a 4-caliber submunition, and will be fired from the new 5-inch, 62-caliber gun being installed on Arleigh Burke (DDG-51) class destroyers.

Surface-to-Surface Missile Exercise

Surface-to-surface missile exercise (MISSILEX [S-S]) involves the attack of surface targets at sea by use of cruise missiles or other missile systems, usually by a single ship conducting training in the detection, classification, tracking and engagement of a surface target. Engagement is usually with Harpoon missiles or Standard missiles in the surface-to-surface mode. Targets could include virtual targets or the seaborne powered target (SEPTAR) ship deployed surface target, or a hulk. MISSILEX (S-S) training is routinely conducted on individual ships with embedded training devices.

A MISSILEX (S-S) could include 4 to 20 surface-to-surface missiles, SEPTARs, a weapons recovery boat, and a helicopter for environmental and photo evaluation. All missiles are equipped with instrumentation packages or a warhead. Surface-to-air missiles can also be used in a surface-to-surface mode.

MISSILEX (S-S) activities are conducted within PMRF Warning Area W-188. Each exercise typically lasts 5 hours. Future (MISSILEX [S-S]) could range from 4 to 35 hours.

Air-to-Surface Gunnery Exercise

Air-to-Surface GUNEX operations are conducted by rotary-wing aircraft against stationary targets (FAST and smoke buoy). Rotary-wing aircraft involved in this operation would include a single SH-60 using either 7.62-mm or .50-caliber door-mounted machine guns. A typical GUNEX will last approximately 1 hour and involve the expenditure of approximately 400 rounds of .50-caliber or 7.62-mm ammunition.

Air-to-Surface Missile Exercise

The air-to-surface missile exercise (MISSILEX [A-S]) consists of the attacking platform releasing a forward-fired, guided weapon at the designated towed target. The exercise involves locating the target, then designating the target, usually with a laser. MISSILEX (A-S) training that does not involve the release of a live weapon can take place if the attacking platform is carrying a captive air training missile (CATM) simulating the weapon involved in the training. The CATM MISSILEX is identical to a live-fire exercise in every aspect except that a weapon is not released. The operation requires a laser-safe range as the target is designated just as in a live-fire exercise.

From 1 to 16 aircraft, carrying live, inert, or captive air training missiles, or flying without ordnance (dry runs) are used during the exercise. At sea, SEPTARs, Improved Surface Towed Targets (ISTTs), and excess ship hulks are used as targets.

MISSILEX (A-S) assets include helicopters and/or 1 to 16 fixed wing aircraft with air-to-surface missiles and anti-radiation missiles (electromagnetic radiation source seeking missiles). When a high-speed anti-radiation missile (HARM) is used, the exercise is called a HARMEX. Targets include SEPTARs, ISTTs, and excess ship hulks.

Bombing Exercise (BOMBEX [Sea])

Fixed-wing aircraft conduct BOMBEX (Sea) operations against stationary targets (MK-42 FAST or MK-58 smoke buoy) at sea. An aircraft will clear the area, deploy a smoke buoy or other floating target, and then set up a racetrack pattern, dropping on the target with each pass. At PMRF, a range boat might be used to deploy the target for an aircraft to attack.

Sink Exercise

A Sink Exercise (SINKEX) provides training to ship and aircraft crews in delivering live ordnance on a real target. Each 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 ship hull that is towed to a designated location where various platforms would use multiple types of weapons to fire shots at the hulk. Platforms can consist of air, surface, and subsurface elements. Weapons can include missiles, precision and non-precision bombs, gunfire, and torpedoes. If none of the shots result in the hulk sinking, either a submarine shot or placed explosive charges would be used to sink the ship. Charges ranging from 100 to 300 pounds, depending on the size of the ship, would be placed on or in the hulk.

The vessels used as targets are selected from a list of U.S. Environmental Protection Agency (EPA) approved destroyers, tenders, cutters, frigates, cruisers, tugs, and transports (Department of the Navy and U.S. Environmental Protection Agency, 1996). Examples of missiles that could be fired at the targets include AGM-142 from a B-52 bomber, Walleye AGM-62 from FA-18 aircraft, and a Harpoon from a P-3C aircraft. Surface ships and submarines may use either torpedoes or Harpoons, surface-to-air missiles in the surface-to-surface mode, and guns. Other weapons and ordnance could include, but are not limited to, bombs, Mavericks, and Hellfire. SINKEX vessels can number from one to as many as six during a major range exercise.

The EPA granted the Department of the Navy a general permit through the Marine Protection, Research, and Sanctuaries Act (MPRSA) to transport vessels “for the purpose of sinking such vessels in ocean waters…” (40 CFR Part 229.2) Subparagraph (a)(3) of this regulation states “All such vessel sinkings shall be conducted in water at least 1,000 fathoms (6,000 feet) deep and at least 50 nautical miles from land.” In Hawaii, SINKEX events take place within PMRF Warning Area W-188.

The duration of a SINKEX is unpredictable since it ends when the target sinks, sometimes immediately after the first weapon impact and sometimes only after multiple impacts by a variety of weapons.

Antisurface Warfare Torpedo Exercise (Submarine-Surface)

Submarines conduct most of their torpedo firings at PMRF, and many of those are against surface targets. Surface targets will typically be PMRF range boats or targets, or US Navy combatants. The ASUW TORPEX culminates with the submarine firing a MK-48 or a MK-48 Advanced Capability (ADCAP) torpedo against the surface target. Twice a year, submarine operations are conducted on PMRF as part of the Submarine Commander’s Course, which trains prospective submarine Commanding Officers (COs) and Executive Officers (XOs). These are integrated operations involving complex scenarios that will include a coordinated surface, air, and submarine force challenging the submarine CO and crew. During these events, submarines will be engaged in ASUW torpedo firings, as well as Antisubmarine Warfare (ASW) tracking exercises (TRACKEX) and ASW TORPEX operations.

Antisubmarine Warfare Tracking Exercises

Antisubmarine Warfare Tracking Exercises (ASW TRACKEX) train aircraft, ship, and submarine crews in tactics, techniques, and procedures for search, detection, localization, and tracking of submarines. No torpedoes are fired during a TRACKEX. As a unit-level exercise, the participants are typically an aircraft, ship, or submarine versus one target submarine or simulated target. The target may be non-evading while operating on a specified track or it may be fully evasive, depending on the state of training of the ASW unit.

Assets used in ASW TRACKEX events include ships, fixed wing aircraft, helicopters, torpedo targets, 1 to 10 submarines, and weapons recovery boats and/or helicopters. Sensors include sonars, sonobuoys, and non-acoustic sensors, such as airborne radars. ASW TRACKEX operations are conducted within PMRF Warning Area W-188, the Hawaii Offshore Areas and/or the open ocean.

Whenever aircraft use the ranges for ASW training, the range clearance procedures include a detailed visual range search for marine mammals and unauthorized boats and planes by the aircraft releasing the inert torpedoes, range safety boats/aircraft, and range controllers.

The use of sonobuoys is generally limited to areas greater than 100 fathoms, or 600 feet, in depth. Before dropping sonobuoys, the crew visually determines that the area is clear. When the sonobuoy is released, a small parachute (about 4 feet in diameter) retards its entry into the ocean. For operational reasons, the sonobuoy is designed to float on the surface and, after a controlled period of time (no longer than 8 hours), the complete package (with the parachute) will sink to the bottom.

Antisubmarine Warfare Torpedo Exercises

Antisubmarine Warfare Torpedo Exercises (ASW TORPEX) operations train crews in tracking and attack of submerged targets, using active or passive acoustic systems, and firing one or two Exercise Torpedoes (EXTORPs) or Recoverable Exercise Torpedoes (REXTORPs). TORPEX targets used in the Offshore Areas include live submarines, MK-30 ASW training targets, and MK-39 Expendable Mobile ASW Training Targets (EMATT). As a unit-level exercise, the participants are typically one ASW platform versus one target. The target may be non-evading while operating on a specified track, or it may be fully evasive, depending on the training requirements of the operation. Submarines periodically conduct torpedo firing training exercises within the Hawaii Offshore OPAREA. Typical duration of a submarine TORPEX operation is 22.7 hours, while air and surface ASW platform TORPEX operations are considerably shorter.

Major Integrated Antisubmarine Warfare Training Exercise

ASW training conducted during a major integrated ASW training exercise utilizes ships, submarines, aircraft, non-explosive exercise weapons, and other training systems and devices. These large scale ASW exercises occur as part of RIMPAC, USWEX, or any other exercise where one or more strike groups converge to train in the range complex. No new or unique operations would take place during an integrated event; it is merely the compilation of numerous ASW operations as conducted by multiple units over a period of time ranging from 3 to 30 days.

Air Combat Maneuver

Air Combat Maneuver (ACM) includes basic flight maneuvers where aircraft engage in offensive and defensive maneuvering against each other. These maneuvers typically involve supersonic flight and expenditure of chaff and flares. No Air-to-Air ordnance is released during this exercise. ACM operations within the range complex are primarily conducted within W-188, W-189, W-190, W-192, W-193, and W-194 under Fleet Area Control and Surveillance Facility (FACSFAC) Pearl Harbor's control. These operations typically involve from two to eight aircraft; however, based upon the training requirement, ACM exercises may involve over a dozen aircraft. Sorties can be as short as 30 minutes or as long as 2 hours, but the typical ACM mission has an average duration of 1.5 hours.

Air-to-Air Missile Exercise

In an Air-to-Air Missile Exercise (A-A MISSILEX), missiles are fired from aircraft against unmanned aerial target drones such as BQM -34s and BQM-74s. Additionally, weapons may be fired against flares or Tactical Air Launched Decoys (TALDs) dropped by supporting aircraft. Typically, about 85% of the missiles fired have live warheads and 15% have telemetry packages. The fired missiles and targets are not recovered, with the exception of the BQMs, which have parachutes and will float to the surface where they are recovered by boat.

Jet target drones are launched from PMRF Launch Complex or an aircraft controlled by PMRF. The targets are engaged by aircraft equipped with air-to-air missiles. The targets are tracked by the aircraft and then the air-to-air missiles are launched at the targets. Recoverable target drones and all recoverable elements are refurbished and reused.

Assets required for an A-A MISSILEX include 1 to 6 jet target drones, 2 to 20 aircraft, 2 to 20 missiles and a weapons recovery boat for target recovery.

A-A MISSILEX activities are conducted within PMRF Warning Area W-188 Targets are launched from an existing ground-based target launch site at PMRF Launch Complex, from a Mobile Aerial Target Support System (MATSS) located in the open ocean within the PMRF Warning Areas, or released from an aircraft.

Electronic Combat Operations

Electronic Combat (EC) operations consist of air-, land-, and sea-based emitters simulating enemy systems and stimulating air, surface and submarine electronic support measures (ESM) and electronic countermeasures (ECM) systems. Appropriately configured aircraft fly threat profiles against the ships so that crews can be trained to detect electronic signatures of various threat aircraft, or so that ship crews can be trained to detect counter jamming of their own electronic equipment by the simulated threat. EC operations can also consist of land-based emitters simulating enemy systems and stimulating air, surface, and submarine ESM and ECM systems.

Surface-to-Air Gunnery Exercise

A Surface-to-Air GUNEX requires air services to serve as a threat aircraft or missile that will fly from high or low altitude threat profiles at representative threat speeds. Commercial air services aircraft will also tow a target drone unit (TDU) that ships will track, target, and engage with their surface-to-air weapon systems, which include 5-inch, 76-mm, 20-mm, and 7.62-mm.

Gunnery training operations involve the use of highly automated guns against aerial targets. Crews respond to threats from air attack and surface-skimming missiles that require extremely fast reaction times and a heavy volume of fire.

The exercise involves 1 to 10 surface vessels, towed aerial targets, and/or jet aerial targets. Ship-deployed and air-deployed weapons systems are used, ranging from 20 mm to 5 inch caliber guns.

GUNEX activities are conducted within PMRF Warning Areas W-186 and W 188, Oahu Warning Areas W-187 (Kaula), W-194, and Restricted Airspace R-3107 (Kaula).

Surface-to-Air Missile Exercise

A Surface-to-Air MISSILEX involves surface combatants firing live missiles (RIM-7 Sea Sparrows, SM-1 or SM-2 Standard Missiles) at target drones. Future tests could include SM-3 missiles as they become operational. The surface ship must detect, track, and engage the target using its onboard weapon systems. The purpose of the exercise is to provide realistic training and evaluation of surface ships and their crews in defending against enemy aircraft and missiles.

Target drones representing enemy aircraft or missiles are flown or towed into the vicinity of the surface ship. The crew must identify the incoming object and respond with surface-to-air missiles as appropriate. There are two types of missiles. One type of missile is equipped with an instrumentation package, while the other type is equipped with a warhead. Recoverable target drones are refurbished and reused.

The exercise consists of one or more surface ships, one or more target drones, and a helicopter and weapons recovery boat for target recovery.

The surface-to-air missiles are launched from ships located within PMRF Warning Area W-188. Targets are launched from an existing ground-based target launch site at PMRF Launch Complex; from a MATSS located in the open ocean within the PMRF Warning Areas; or released from an aircraft.

Naval Surface Fire Support Exercise

Navy surface combatants conduct fire support exercise (FIREX) operations at PMRF on a virtual range against "Fake Island", located on BARSTUR) (Figure 1.2-1). Fake Island is unique in that it is a virtual landmass simulated in three dimensions. Ships conducting FIREX training against targets on the island are given the coordinates and elevation of targets. PMRF is capable of tracking fired rounds to an accuracy of 30 feet.

Flare Exercise

A flare exercise is an aircraft defensive operation in which the aircrew attempts to cause an infrared (IR) or radar energy source to break lock with the aircraft. During IR break-lock (flare) training, a shoulder-mounted IR surface-to-air missile simulator is trained on the aircraft by an operator attempting to lock onto the aircraft's IR signature. The aircraft maneuvers while expending flares. The scenario is captured on videotape for replay and debrief. No actual missiles are fired during this training operation. Radar break-lock training is similar except that the energy source is an electronic warfare (EW) simulator, and the aircraft expends chaff during its defensive maneuvering.

Chaff Exercise

A Chaff Exercise (CHAFFEX) trains aircraft and shipboard personnel in the use of chaff to counter antiship 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 CHAFFEX, the ship combines maneuvering with deployment of multiple rounds of MK-36 super rapid bloom offboard chaff (SRBOC) to confuse incoming missile threats, simulated by opposition force aircraft. In an integrated CHAFFEX scenario, helicopters will deploy air-launched, rapid-bloom offboard chaff (AIRBOC) in pre-established patterns designed to enhance antiship missile defense. Chaff exercises average 3.8 hours in duration.

Live Fire Exercise

Live Fire Exercise (LFX) provides ground troops with live-fire training and combined arms live-fire exercises training, including aerial gunnery and artillery firing. This benefits ground personnel by receiving semi-realistic training.

These exercises can include platoon troop movements through numerous target objectives with various weapons. Aerial gunnery exercises and artillery and mortar exercises are also conducted as part of combined and separate exercises. Live fire and blanks are used. Blanks are used outside of defined impact areas.

LFX typically consists of ground troops and special forces, including a sniper unit, of about 2 to 18 people, a helicopter, artillery, mortars, and miscellaneous small arms. In the future, up to a brigade of U.S. or foreign troops could receive LFX training during a major exercise.

LFX operations are conducted at PTA (Figure 2.1.1-2) and Makua Military Reservation (MMR) (Figure 2.1.1-3).

Salvage Operations

The purpose of Salvage Operations is to provide a realistic training environment for fire at sea, de-beaching of ships, and harbor clearance operations training by U.S. Navy diving and salvage units.

The U.S. Navy's Mobile Diving and Salvage Unit One (MDSU-1) (Figure 2.1.1-4) and divers from other countries would practice swift and mobile ship and barge salvage, towing, battle damage repair, deep ocean recovery, harbor clearance, removal of objects from navigable waters, and underwater ship repair capabilities.

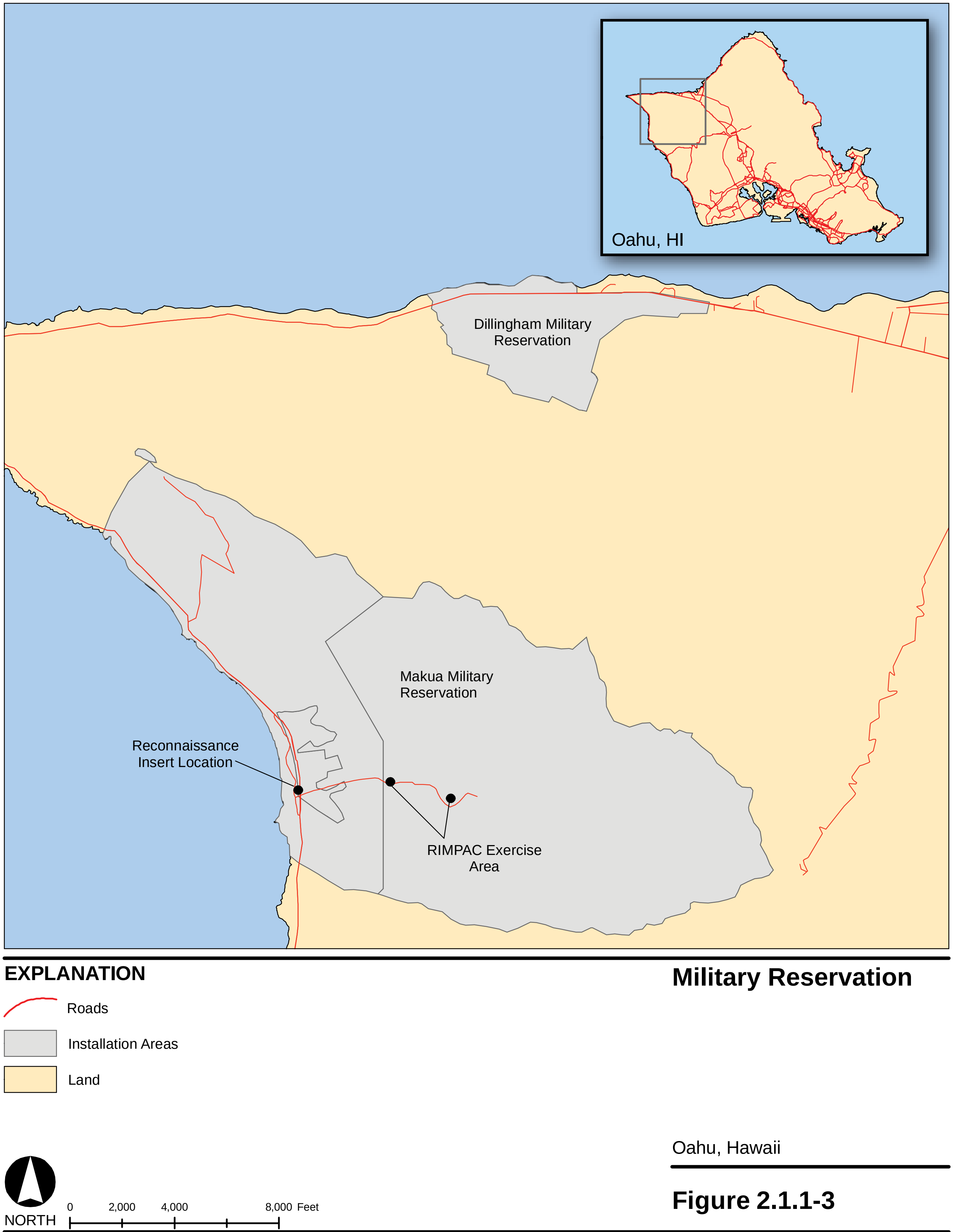
U.S. Naval and coalition diving and salvage forces exercise the following capabilities:

- SCUBA and surface supplied air and mixed gas (HeO_2) diving operations to depths of 300 feet of sea water
- Hyperbaric recompression chamber operations

Pohakuloa Training Area

Hawaii, Hawaii

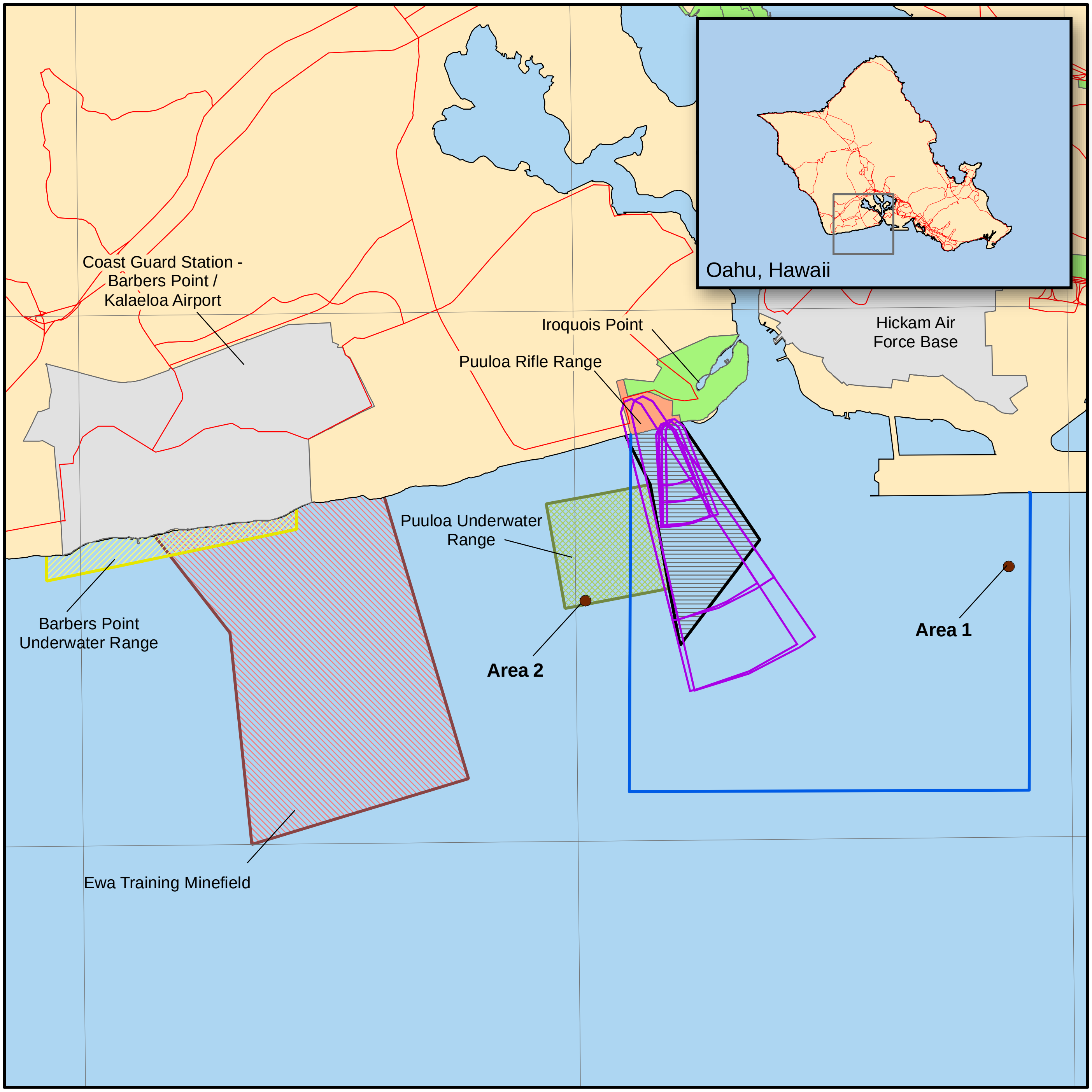
Figure 2.1.1-2



Military Reservation

Oahu, Hawaii

Figure 2.1.1-3



EXPLANATION

- Proposed Mobile Diving and Salvage Unit Training Area
- Road
- Pearl Harbor Naval Base Area
- Puuloa Underwater Range
- Barbers Point Underwater Range
- Ewa Training Minefield
- Puuloa Rifle Range
- Puuloa Rifle Range Surface Danger Zone
- Puuloa Rifle Range Small Arms Firing Area
- Naval Defensive Sea Area
- Installation Area
- Land

NORTH

0 0.5 1 2 Nautical Miles

Mobile Diving and Salvage Unit One

Oahu, Hawaii

Figure 2.1.1-4

- Underwater ship inspection, husbandry, and repair of coalition Naval ships and submarines
- Underwater search and recovery operations
- Underwater cutting employing hydraulic, pneumatic, and oxy-arc powered tools
- Underwater welding
- Removal of petroleum, oil, and lubricants (POL) exercising various POL offload techniques
- Restoring Buoyancy (Survey, Patch, De-water) to restore buoyancy to a grounded or sunken vessel or object of value
- Harbor clearance for clearance or removal of derelict vessels or other obstructions from navigable waterways and berthing
- Off-Ship fire fighting to simulate providing rescue and assistance at sea to condition Naval combatants battling fires

These activities may take place at Puuloa Underwater Range, Pearl Harbor, and Keehi Lagoon. Staging for these activities would be from the MDSU-1 Facility located on Bishop Point, an annex of Pearl Harbor, on the southwestern side of Hickam AFB, Oahu. To capitalize on real-world training opportunities and to provide mutual benefit for both the U.S. Naval and Coalition Salvage Force and for the State of Hawaii, salvage training and harbor clearance exercises may take place in any of the shoal waters, harbors, ports, and in-land waterways throughout the Hawaiian OPAREA.

Explosive Ordnance Disposal Ranges

EOD training operations include both underwater demolitions and land demolitions of ordnance items. 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 non-combatants. Both SEAL and EOD teams gain experience detonating underwater explosives. Underwater demolitions at the Puuloa range have a limit of 20 lb net explosive weight (NEW). The training areas are noted on navigation charts and listed in the CFR. Part of the Puuloa range is located within the Pearl Harbor Naval Defensive Sea Area. Training at Lima landing involves the use of no greater than 0.25 lb NEW. Approximately 5 to 8 personnel take part in each exercise and there are between 25 and 30 exercises per year.

2.1.1.3 Current Training operations within the Hawaii Onshore OPAREA

Expeditionary Assault

Expeditionary Assault (formerly known as amphibious exercise) consists of a seaborne force from over the horizon assaulting across a beach in a combination of helicopters, vertical takeoff and landing (VTOL) aircraft, landing craft air cushion (LCAC), amphibious assault vehicles (AAVs), expeditionary fighting vehicle (EFV) and landing craft. More robust expeditionary assault operations include support by Naval surface fire support (NSFS), close air support (CAS), and Marine artillery with the purpose of securing a lodgment.

A larger expeditionary assault exercise provides a realistic environment for amphibious training, reconnaissance training, hydrographic surveying, surf condition observance, and communication.

An ESG is normally a mix of three to five amphibious ships equipped with aircraft landing platforms for helicopter and fixed wing operations and well decks for carrying landing craft and AAVs. The ESG typically launches its aircraft, and landing craft up to 25 miles from a training beachhead. AAVs are typically launched approximately 2,000 yards from the beach. The aircraft provide support while the landing craft approach and move onto the beach. The troops disperse from the landing craft and would utilize existing vegetation for cover and concealment while attacking enemy positions. The landing craft and troops proceed to a designated area where they stay 1 to 4 days. The backload operation takes place when actions on the objective are completed. The backload will normally be accomplished over a 2- to 3-day period.

Expeditionary assault exercises involve the use of rubber boats, amphibious vehicles, landing craft, helicopters, and attack aircraft. Types of amphibious landing craft and vehicles include:

- LCAC, an air-cushioned vessel equipped with an open-bay craft with roll-on, roll-off ramps capable of carrying tank-sized vehicles or up to 185 troops. Approximately 88 feet by 47 feet
- Landing Craft, Utility (LCU), a displacement hull craft designed to land very heavy vehicles, equipment, and cargo or up to 400 troops on the beach. Approximately 135 feet by 29 feet
- AAV, a tracked, armored personnel carrier with a capacity of 21 troops. Approximately 24 feet by 13 feet
- CRRC, a lightweight, inflatable boat carrying up to 8 people used for raid and reconnaissance missions. Approximately 16 feet by 6 feet
- Rigid Hull, Inflatable Boat (RHIB), similar to the CRRC, but larger, carrying up to 15 people. Approximately 24 feet by 9 feet (EWTGLANT On-Line Resource Center, 1998).

The primary location for the amphibious landings is Majors Bay, PMRF, Kauai (Figure 2.1.1-5). Amphibious landings could also occur at the K-Pier boat ramp, Kawaihae, Hawaii, Marine Corps Base Hawaii (three beaches), and MCTAB, Oahu (Figure 2.1.1-6).

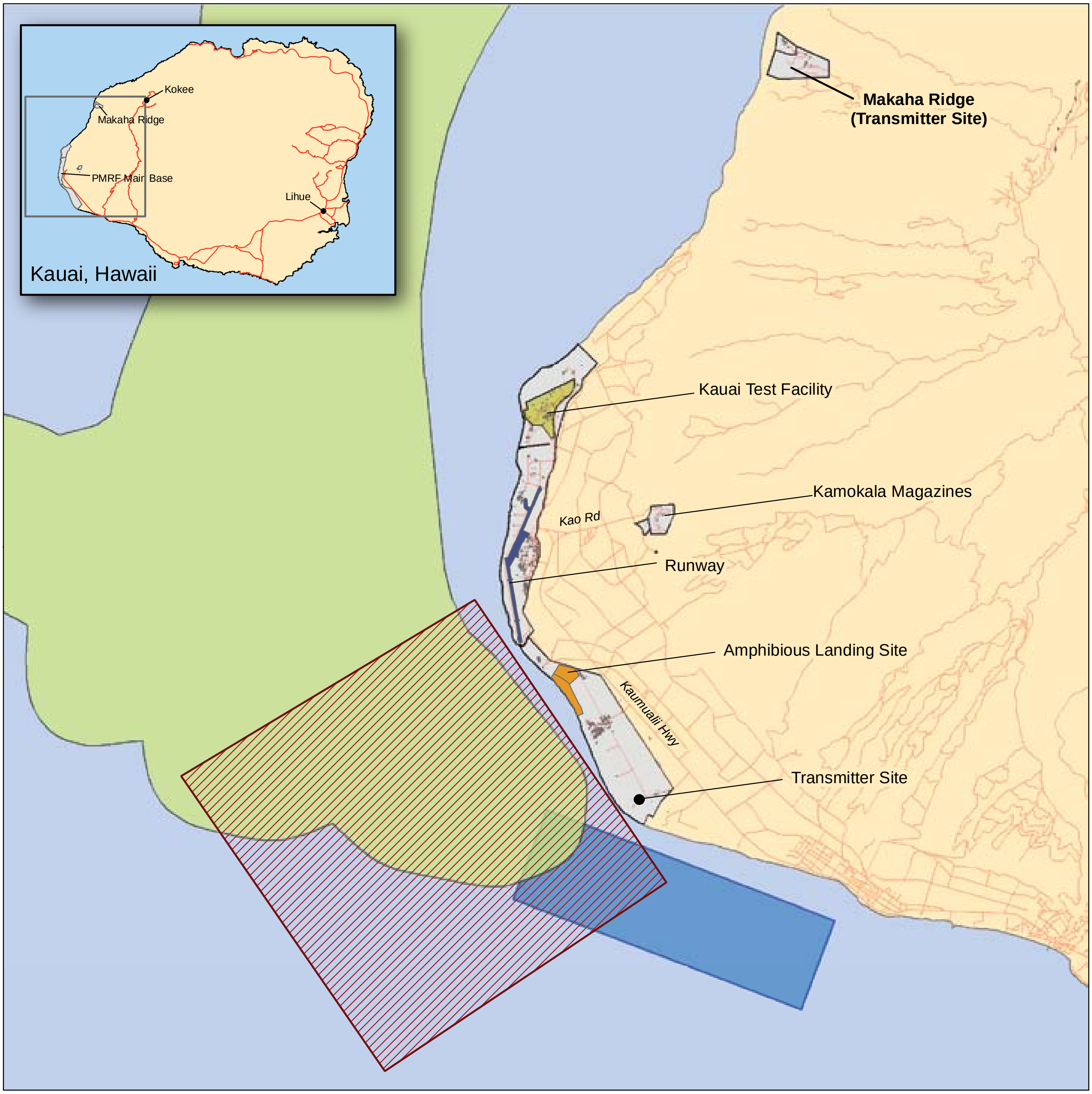
Amphibious landings are restricted to specific areas of designated beaches. Before each major amphibious landing exercise is conducted, a hydrographic survey will be performed to map out the precise transit routes through sandy bottom areas. During the landing, the crews follow established procedures, such as having a designated lookout watching for other vessels, obstructions to navigation, marine mammals (whales or monk seals), or sea turtles.

Bombing Exercise (Land)

Kaula Rock, a small island southwest of Kauai, is used for bomb exercise (BOMBEX) training. BOMBEX operations consist of air-to-ground delivery of small, 25-pound (lb), inert MK-76 (a type of training ordnance); or the MK-82, a 500-lb bomb. Bombing exercises can originate from an aircraft carrier or a land base. Transiting CSG fixed-wing aircraft account for all of the Navy BOMBEX operations at Kaula Rock. Only inert ordnance 500 pounds or less is authorized for use on Kaula Rock.

Air-to-Ground Gunnery Exercise

Kaula Rock is also used for air-to-ground gunnery (GUNEX [A-G]) training. GUNEX (A-G) includes live-fire gunnery training from fixed- or rotary-wing aircraft. 20mm and 30mm cannon fire is not allowed from November through May.



EXPLANATION

- Roads
- Existing Kingfisher Area
- Kauai Test Facility
- PMRF Shallow Water Training Range (SWTR)
- Amphibex / Demolition Area
- RIMPAC Amphibious Landing Site
- Airfield
- Existing Structures
- PMRF Installation Areas
- Land

NORTH

0 1 2 4 Miles

Majors Bay, PMRF, Kauai

Kauai, Hawaii

Figure 2.1.1-5

EXPLANATION

- Major Roads
- Airfield Runway
- Installation Areas
- Land

NORTH

0 0.5 1 2 Miles

K-Pier Boat Ramp, Kawaihae, Hawaii, Marine Corps Base Hawaii (three beaches), and MCTAB, Oahu

Oahu, Hawaii

Figure 2.1.1-6

Humanitarian Assistance Operation/Non-combatant Evacuation Operation

The purpose of Humanitarian Assistance Operation/Non-combatant Evacuation Operation (HAO/NEO) is to provide training in responding to a United Nations request for complex emergency support.

HA/DR training exercises involve approximately 125 to 250 troops and 125 to 200 refugees. An amphibious landing craft would off-load approximately 4 transport trucks, 3 support vehicles, 3 water supply vehicles, water and food supply, and 125 troops. They would travel along authorized highways to the HA/DR site. A safe haven camp would be established in existing facilities or temporary facilities (tents, etc.). There will be two sites for each exercise, a refugee camp and a Civil–Military Operations Center area. There will be roughly 30 five-person Red Cross tents within the refugee camp, with a few larger tents for various support functions including meals, showers, recreation, administration, and storage. The Civil–Military Operations Center section will contain more storage, communication links, staff housing, experimentation (including information management in an austere environment, high-bandwidth informatics support, interviewing of refugees for war-crimes documentation using digital transcription, and solar powered computer systems), and various public relations areas for visitors. Approximately 18 portable latrines would be at the sites. Buses and/or trucks would be needed to transport refugees. Military helicopters could also be used.

HA/DR exercises would include approximately four transport trucks, three support vehicles, three water supply vehicles, and seven buses. Additional requirements include:

A safe haven refugee camp would be established within the Marine Corps Base Hawaii (MCBH), MCTAB and/or Kahuku Training Area (KTA). An amphibious landing craft or trucks would offload equipment, vehicles, troops, and refugees. Airstrips at the above locations could be used to transport personnel.

The HA/DR exercise lasts for approximately 10 days. Future HA/DR exercises could range from 2 to 18 days. The camp would be established in 2 days. Approximately 125 to 250 refugee actors would be provided water, shelter, food, sanitation, and communications for 5 days. Takedown would last about 2 days.

The HA/DR exercise takes place near an existing training trail. The access road to the site would be graded before the exercise, if required. Grading would be within the existing roadway in accordance with standard procedures. Equipment and personnel would be transferred to the camp location via transport trucks and buses, respectively. Training overlays that identify the transit route, camp location, and any nearby restricted areas or sensitive biological and cultural resource areas would be used by participants.

2.1.2 HAWAII RANGE COMPLEX RDT&E ACTIVITIES

RDT&E activities occur primarily at one of two locations in Hawaii: PMRF and NUWC Detachment Pacific ranges. The current RDT&E activities conducted in the Hawaii Range Complex are described below and previously shown in Table 2.1-2.

Table 2.1-2. Baseline RDT&E Operations

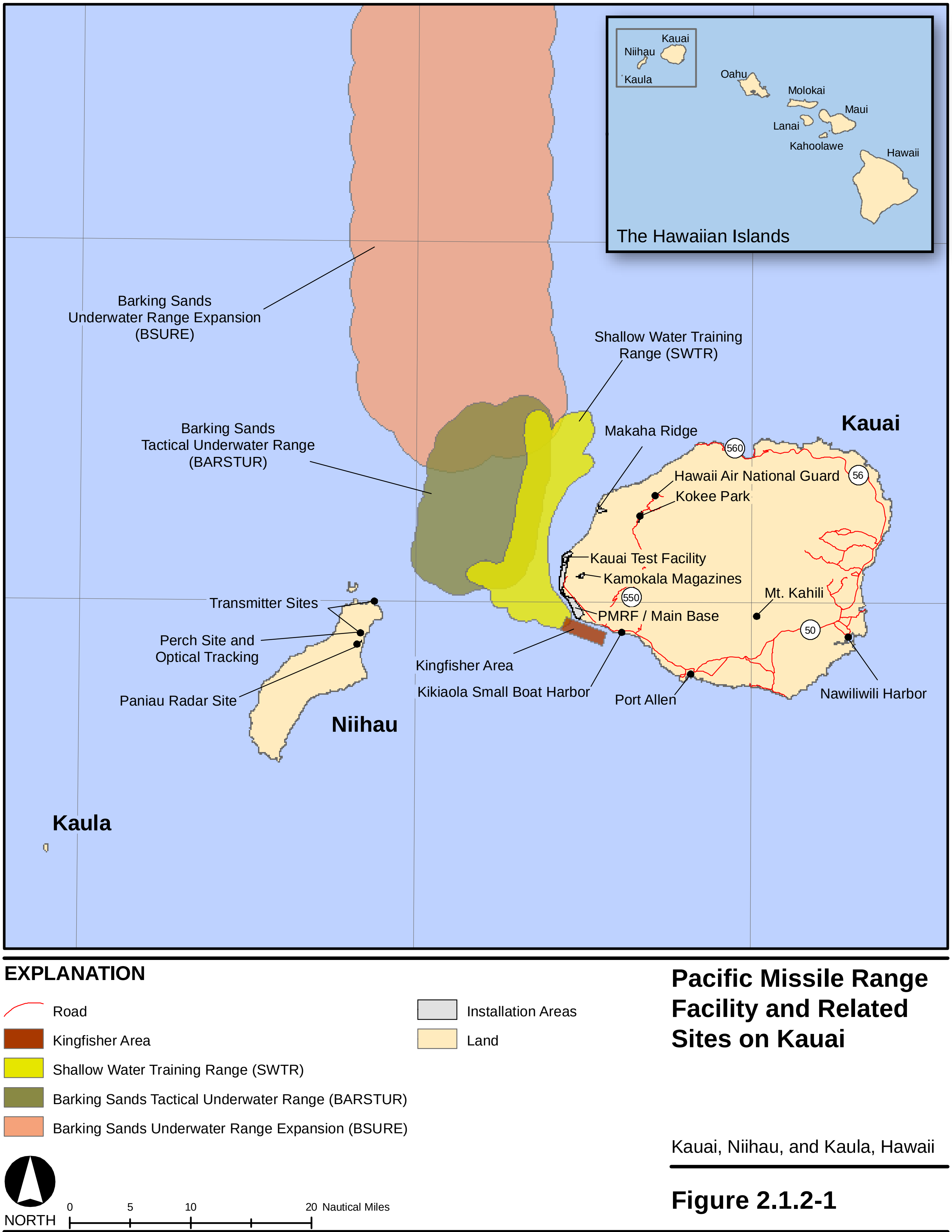
Mission Area	Operations / (NTA)	Area	Baseline (Operations/ Year)
Research, Development, Test, and Evaluation (RDT&E)	Anti-air Warfare Research, Development, Test, and Evaluation (RDT&E)	Pacific Missile Range Facility (PMRF)	35
	Antisubmarine Warfare	PMRF	19
	Combat System Ship Qualification Trial	PMRF	7
	Electronic Combat/Electronic Warfare	PMRF	65
	High Frequency	PMRF	9
	Joint Task Force Wide Area Relay Network	PMRF	2
	Missile Defense	PMRF	40
	Science & Technology / Other	PMRF	22
	Terminal High Altitude Area Defense	PMRF	6
	Fleet Operational Readiness Accuracy Check Site (FORACS) Tests	FORACS	5
	Shipboard Electronic Systems Evaluation Facility (SESEF) Quick Look Tests	SESEF / Pearl Harbor	3,842
	SESEF System Performance Tests	SESEF	67

2.1.2.1 Pacific Missile Range Facility

PMRF is the world's largest instrumented, multi-environment, military test range capable of supporting subsurface, surface, air, and space operations (Figure 2.1.2-1). PMRF consists of 1,000 nm^2 of instrumented underwater ranges, 42,000 nm^2 of controlled airspace, and a temporary operating area covering 2.1-million nm^2 of ocean area. PMRF provides major range services for training, tactics development, and evaluation of air, surface, and subsurface weapons systems for the U.S. Navy, other DoD agencies, foreign military forces, and private industry. It also maintains facilities and provides services to support naval operations, and other activities and units designated by the Chief of Naval Operations (CNO).

Planned Research and Development Activities

The Naval Sea Systems Command is currently preparing the Advanced Radar Detection Laboratory (ARDEL) Environmental Assessment (EA), which is scheduled for completion in Fall 2007. Because this EA is scheduled for completion prior to the Final EIS/OEIS, the ARDEL is considered part of the No-action Alternative. The ARDEL would serve to mitigate development risk on the Air and Missile Defense Radar for the next generation cruiser, referred to as the CG(X). The laboratory would house radar equipment, including active phased array radar antenna(s), signal detection processing equipment, power conversion and conditioning equipment, operator consoles, and recording equipment. The ARDEL would be located



Pacific Missile Range Facility and Related Sites on Kauai

Kauai, Niihau, and Kaula, Hawaii

Figure 2.1.2-1

approximately 100 feet (ft) from shore in the open area near the Calibration Laboratory (Building 515), south of Nohili Ditch (Figure 2.1.2-2). The approximate 17,000 square foot building would be elevated above the tsunami inundation flood elevation (approximately 5-7 ft). The building structure height would be 30 ft above this elevation. An additional 30-ft tall radar turret on top of the building would reach approximately 65 ft above ground level. Construction of the ARDEL is expected to last from March 2009 to March 2011.

As part of the ARDEL, the S-Band Advanced Radar would operate in the 2.0 to 4.0 gigahertz frequency range. It is designed to detect ballistic missile defense targets in a harsh electromagnetic interference environment. This phased-array radar would also be tested on the Mobile Aerial Target Support System to determine operational mobility in a shipboard environment. Other sensors would be tested on the Mobile Aerial Target Support System as they are developed.

Beginning around Fiscal Year 2011, the ARDEL would support the Air and Missile Defense Radar Engineering Development Model for System Design and Development program testing. Testing of advanced radar technologies at ARDEL is expected to continue through at least Fiscal Year 2018. Additional opportunities in areas of fleet training and advanced technology testing exist beyond this timeframe.

Testing and Evaluation Activities

PMRF's additional mission is supporting RDT&E projects. Current ongoing programs at PMRF include torpedo, torpedo defense, submarine and periscope detection, submarine systems, anti-submarine warfare, ship-defense systems, land sensor, missile defense, and other miscellaneous programs. These programs involve the testing and evaluation of enhancements on systems already used in exercises conducted at PMRF. These are described briefly below.

- CNO projects are usually related to test and evaluation research. In some, tactical variables are studied against underwater, surface, airborne, and ballistic missile threats. Other CNO projects study proposed or new hardware and software designs.
- Torpedo RDT&E programs include a torpedo development testing program involving deep and shallow-water testing of aircraft, helicopter, and surface ship-launched anti-submarine torpedo sensors to increase their operational performance.
- Torpedo defense RDT&E programs include a surface-ship torpedo-defense program, involving the testing of new systems to counter incoming torpedoes.
- Submarine detection RDT&E programs include an advanced sensor application program for locating submarines. Periscope detection programs include: radar, optical, and laser testing from airborne, ground, and surface ship platforms.
- Ship defense system RDT&E programs include chaff and flare countermeasures testing.
- Missile defense RDT&E programs include missile launches from PMRF and offshore platforms and ships, with intercepts over the broad ocean area within PMRF's Temporary Operating Area.

Gunnery/special weapons tests include the usually one-of-a-kind adaptation of an existing weapon to meet a unique threat situation. The weapon is either mounted to or fired from a boat offshore of PMRF/Main Base or set up west of the PMRF launch facility. Targets include

EXPLANATION

- Roads
- PMRF Installation Boundary
- Kauai Test Facility
- Existing Structures
- Proposed Advanced Radar Detection Laboratory (ARDEL) Site
- Land

Note: PMRF = Pacific Missile Range Facility

Advanced Radar Detection Laboratory (ARDEL)

Kauai, Hawaii

Figure 2.1.2-2

surface targets and small radio-controlled planes. Appendix E lists the existing weapon systems used at PMRF.

Anti-air Warfare RDT&E

Anti-air Warfare (AAW) RDT&E operations include post construction test and training, which is performed on Aegis capable ships after refurbishment or overhaul. Aegis Ballistic Missile Defense (BMD) operations involve testing and evaluating the ship's missile system and associated hardware in support of the ship's missile defense mission. An additional operation for Aegis ships is the waterfront integration test (WIT). WIT provides pier side testing, simulating events that take place during the on range Aegis BMD operations. WIT ensures that all shipboard systems are operable.

Antisubmarine Warfare Test and Evaluation

ASW Test and Evaluation (T&E) operations at PMRF include sensor, fire control, and weapon testing. The use of PMRF Submarine Tracking Systems (STS) involves using this system to evaluate MK-30 system upgrades. Submarine system evaluation operations conducted in the submarine training areas near Maui are also part of ASW T&E operations.

Combat System Ship Qualification Trial

Combat System Ship Qualification Trial (CSSQT) operations are performed at PMRF and are categorized as T&E events. CSSQT is conducted for new ships and for ships that have undergone modification and/or overhaul of their combat systems. Although CSSQT can vary from ship to ship as requirements dictate, the primary goals are to ensure that the ship's equipment and combat systems are in top operational condition, and that the ship's crew is proficient at operating these systems. Therefore, CSSQT can include operating any or all of a ship's combat systems.

Electronic Combat/Electronic Warfare

Electronic Combat/Electronic Warfare (EC/EW) operations include events designed to assess how well EC/EW exercises.

High Frequency

High frequency T&E operations include those events where high frequency radio signals are evaluated.

Joint Task Force Wide Area Relay Network

Joint Task Force Wide Area Relay Network (JTF WARNET) is a demonstration of advanced Command, Control and Communications (C3) technologies in a highly mobile, wireless, wide-area relay network in support of tactical forces. JTF WARNET testing evaluates joint and coalition C3 decision making, distributive collaborative planning and execution, and tactical capability across the Joint Task Force.

Missile Operations

Missile training exercises conducted at PMRF include general air-to-air, air-to-surface, surface-to-air, and surface-to-surface missile exercises; specific anti-surface missile exercises; AAW exercises. Each missile training operation must obtain PMRF safety approval before proceeding, covering the type of weapon, type of target, speed, altitude, debris corridor, ground hazard area, and water surface and undersea hazard areas. Figure 2.1.2-3 shows existing relative heights of missiles launched as part of PMRF activities. Appendix E of the EIS lists the existing missile defense systems at PMRF. These systems use both solid and liquid propellants. Defensive missile payloads may be equipped with divert and attitude control propulsion systems that control the payload after separation from the launch vehicle. Divert and attitude control systems may use small liquid hypergolic propellant systems or consist of miniature solid-propellant rocket motors.

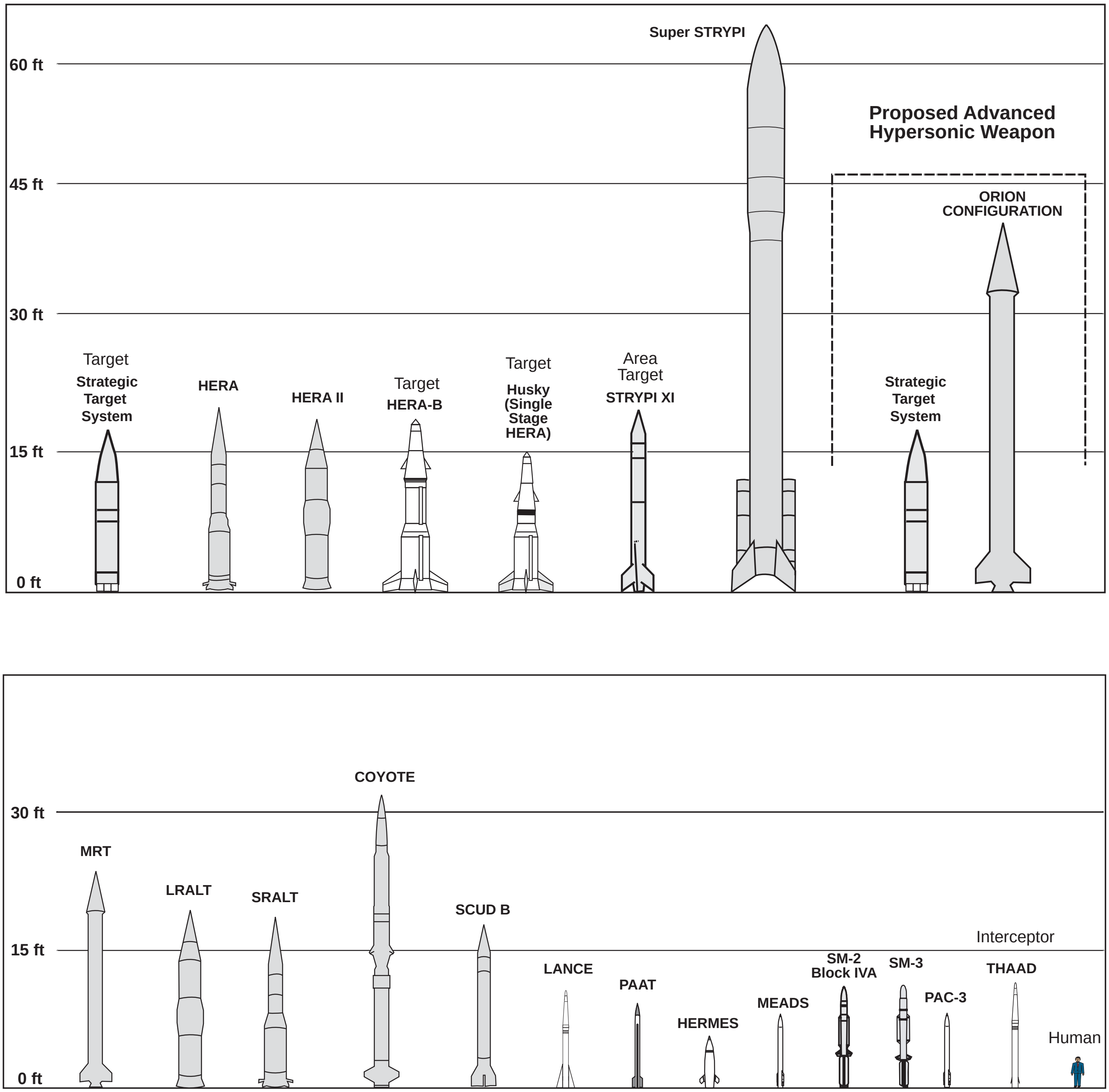
Missile Defense

Figure 2.1.2-4 shows the existing launch facilities at PMRF and the Kauai Test Facility (KTF). Figure 2.1.2-5 shows the existing missile flight corridors. Aerial targets are launched from PMRF, mobile sea-based platforms, or military cargo aircraft. During missile defense RDT&E events, a ballistic missile target vehicle is launched from PMRF and intercepted by a ship-launched missile. The operations can include:

- Aegis ships
- Use of the Mobile Range Safety System
- On-load and off-load of aircraft
- Long-Range Air Launch Target
- Smart Test Vehicle
- Light Detection and Ranging
- Mobile At-Sea Sensor System
- Utilization of the Battle Management Interoperability Center
- Transportation of liquid propellants to PMRF
- Flight Termination System preparations for an operation
- Dress rehearsals and dry runs for specific missile defense events

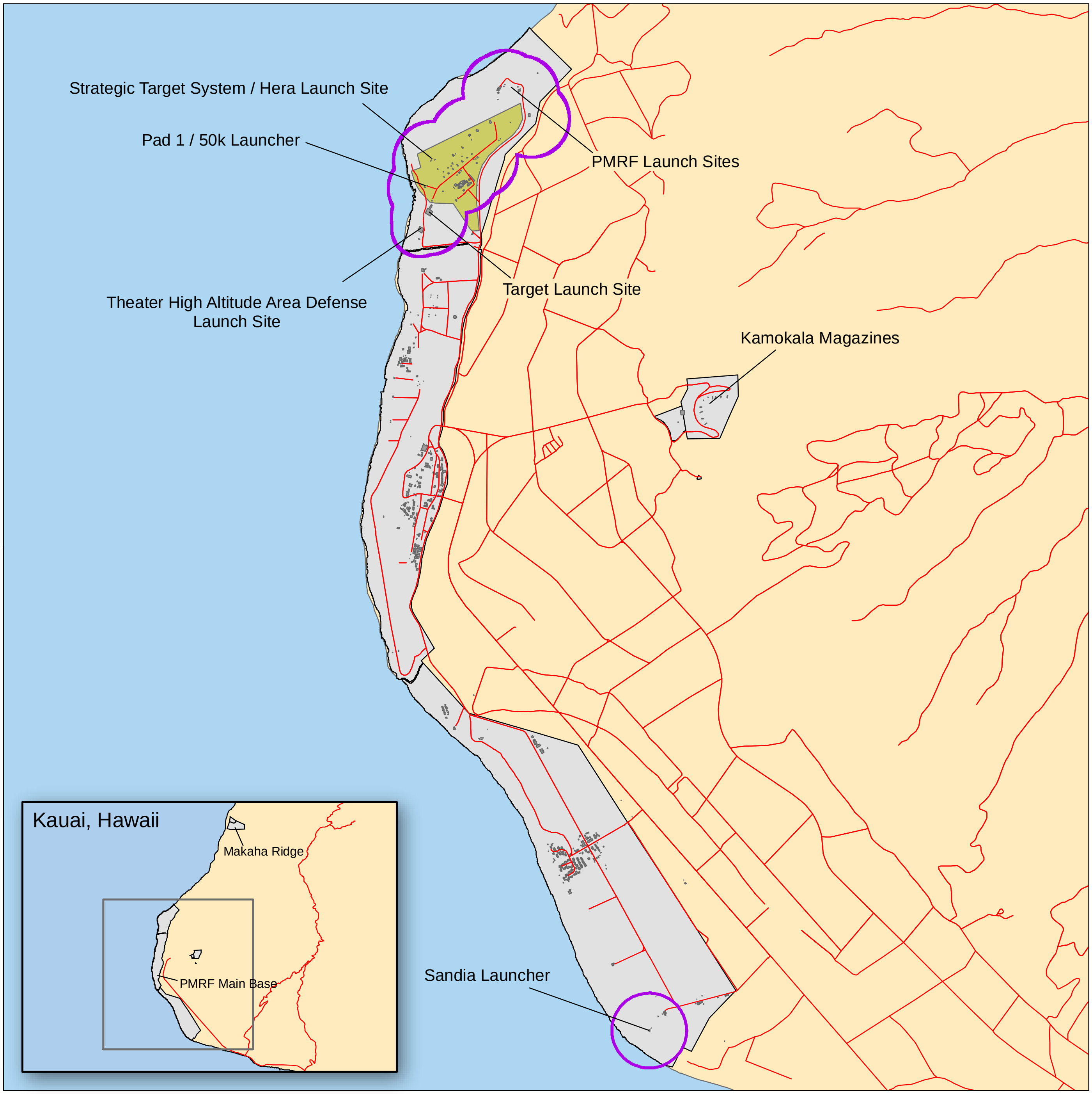
The U.S. Army's Terminal High Altitude Area Defense (THAAD) is part of the Department of Defense Ballistic Missile Defense System. THAAD is the antimissile system designed to intercept and destroy missiles in the final phase of their trajectories. THAAD PMRF operations include midcourse tracking of ballistic missiles using the Coherent Signal Processing radar, telemetry, C-Band precision radars, and Mobile Aerial Target Support System. THAAD differs from other missile defense testing in that THAAD scenarios involve the target vehicle being launched outside of PMRF, with the THAAD interceptor launched from an existing launch pad at PMRF. The intercept occurs in the Temporary Operating Area.

Other RDT&E associated missile defense activities include preparing security, range instrumentation and communications checks, radar calibrations, and range clearance.



Relative Heights of Missiles Launched as part of PMRF activities

Figure 2.1.2-3



EXPLANATION

- Road
- Kauai Test Facility
- Existing Explosive Safety Quantity Distance (ESQD) Arc
- Existing Structure
- Pacific Missile Range Facility (PMRF) Installation Area
- Land

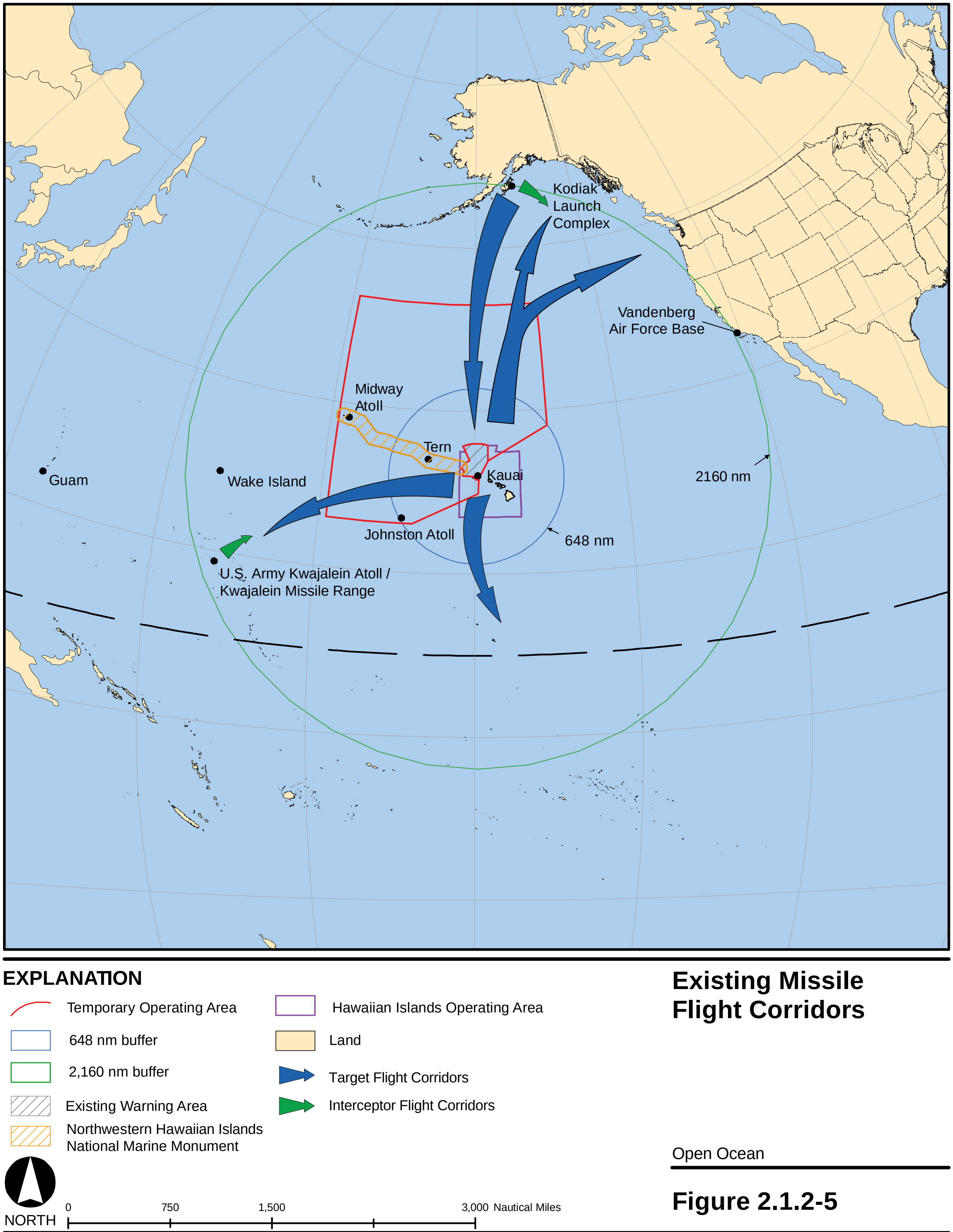
NORTH

0 2,500 5,000 10,000 Feet

Launch Facilities at PMRF and the Kauai Test Facility

Kauai, Hawaii

Figure 2.1.2-4



Existing Missile Flight Corridors

Open Ocean

Figure 2.1.2-5

As part of the required clearance before an exercise, the target area must be inspected visually and determined to be clear. Range Control is charged with hazard area surveillance and clearance and the control of all range operational areas. The PMRF Range Control Officer is solely responsible for determining range status and setting RED (no firing) and GREEN (range is clear and support units are ready to begin the event) range firing conditions. The Range Control Officer coordinates the control of PMRF airspace with the FAA and other military users, often on a real-time basis.

The Range Control Officer communicates with the operations conductors and all participants entering and leaving the range areas. The Range Control Officer also communicates with other agencies such as the FAA Air Route Traffic Control Center (ARTCC) in Honolulu, the PMRF/Main Base airfield control tower, the 154th Air Control Squadron at Kokee, and the Fleet Area Control and Surveillance Facility (FACSFAC) at Ford Island, Pearl Harbor.

Science and Technology/Other

PMRF operations include one-of-a-kind or short duration RDT&E events conducted for both government and commercial customers. Examples of these include Acoustic Data Acquisition System, Littoral Airborne Sensor Hyper-spectral evaluations, Ultra High Frequency Electronically Scanned Array, Maritime Synthetic Range, ROVs, Autonomous Underwater Vehicles (AUVs) such as REMUS and sea-glider, numerous System Integration Checkout operations, and electromagnetic interference/electronic countermeasures.

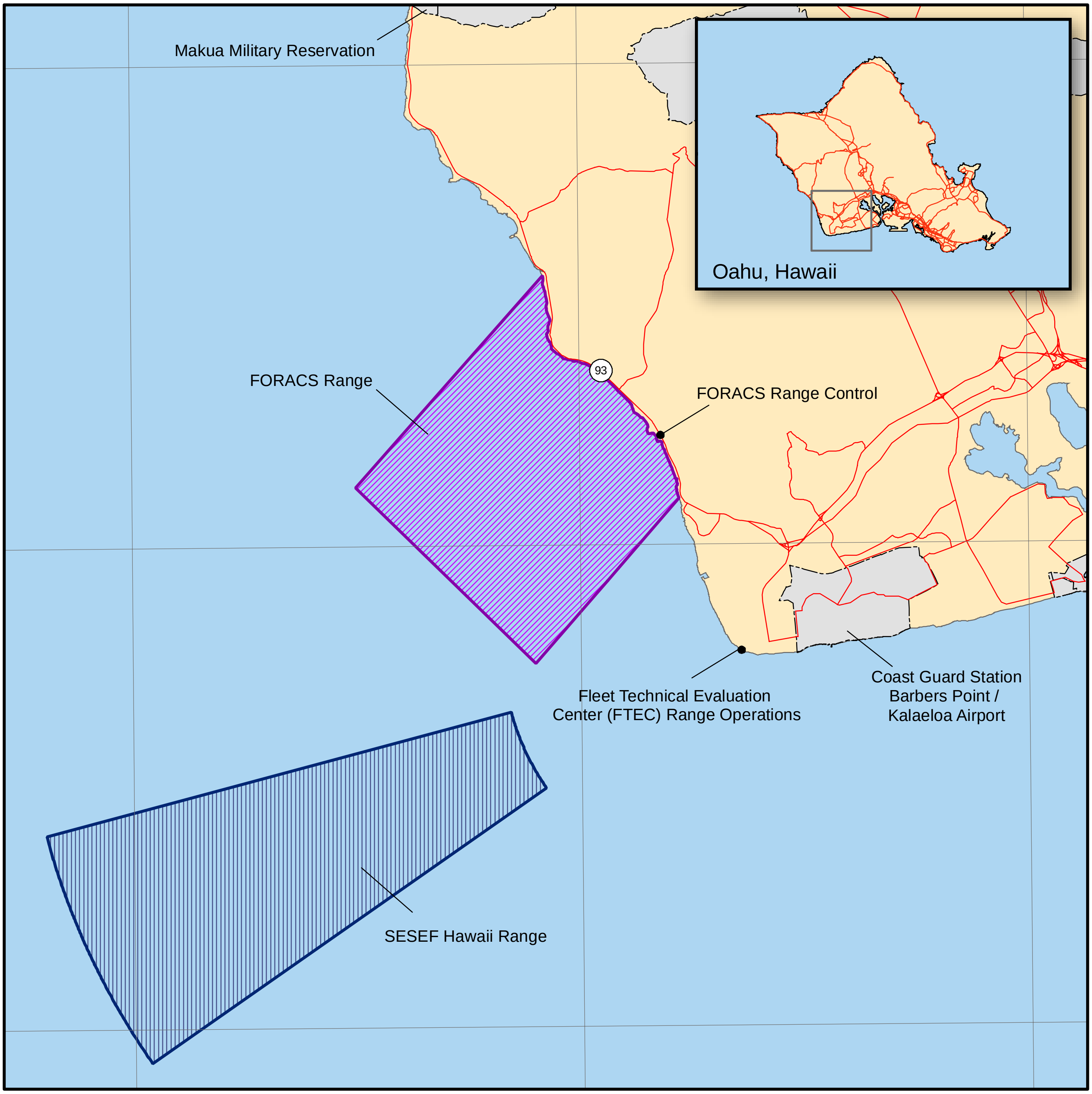
2.1.2.2 Naval Undersea Warfare Center Ranges

RDT&E operations take place at the NUWC ranges in Hawaii (Figure 2.1.2-6). The Shipboard Electronic Systems Evaluation Facilities (SESEF) range, located off Barbers Point on Oahu, provides state-of-the-art T&E of combat systems that radiate or receive electromagnetic (EM) energy. The SESEF range includes land based test facilities established to provide electromagnetic system T&E services to afloat and shore commands. SESEF services can be used for the development of new and upgraded systems, and provide a real-time evaluation of a system in an operational environment. SESEF provides for two-party testing, analysis, and troubleshooting of shipboard EM systems. Emphasis is placed on providing real-time data analysis while minimizing test time. The SESEF offers a wide variety of tests that fall into two basic categories: quick-look operability testing and system performance testing.

Fleet Operational Readiness Accuracy Check Site Tests

The purpose of the FORACS range is to provide accuracy checks of ship and submarine sonar, both in active and passive modes. The range can also evaluate the accuracy of a ship's radar. The ship will conduct a series of "runs" on the range, each taking approximately 1.5 hours. Both active and passive sonar can be checked on a single run. During a run, the ship will approach the target, a stationary underwater acoustic transducer located near shore, making a slow turn to eventually track outbound from the target, establishing a bearing to the target in use. This information is compared with the known bearing by FORACS range technicians stationed onboard the ship. During active sonar testing, range-to-target information is also evaluated. Examples of specific FORACS tests are:

- Surface Weapons System Accuracy Trial (SURFSAT)—is both an acoustic (as described above) and an RF accuracy evaluation for a surface ship's radar.
- At Sea Bearing Accuracy Test—is a test of a ship's radar alone.



EXPLANATION

- Road
- Fleet Operational Readiness Accuracy Check Site (FORACS)
- Shipboard Electronic Systems Evaluation Facility (SESEF) Hawaii Range
- Installation Area
- Land

NORTH

0 1 2 4 Nautical Miles

Naval Undersea Warfare Center Ranges

Oahu, Hawaii

Figure 2.1.2-6

- Submarine Warfare System Assessment (SWSA)—is an assessment of a submarine's radar and sonar. The SWSA is similar to the SURFSAT, but is only for submarines.
- Undersea Warfare Readiness Evaluation Facility (USWREF)—is a test of a ship's radar and sonar. The USWREF is similar to, but less involved than, the SURFSAT or SWSA.

SESEF Tests

SESEF tests are conducted to evaluate ship, shore, and aircraft systems that emit or detect electronic emissions. These systems include those used for radio communications, data transfer, navigation, radar, and identification of friend and foe. Depending on the system being evaluated, either the tested site, the SESEF, or both will transmit electronic signals in or near the radio frequency band of the electromagnetic spectrum. Specific frequencies and power settings are dependent on the type of test being conducted. The test equipment operated by SESEF allows for a performance evaluation of the ship, shore, or aircraft system. Tests conducted by SESEF fall into one of two broad categories; Quicklook (Q/L) and System Performance tests.

Quicklook tests are generally conducted during transit to and from port, or while pier side at Pearl Harbor. These tests provide the ship a quick operational evaluation of the system(s) being tested with a simple "SAT or UNSAT" grade along with any detected system anomalies or problems. An example is a radio check that confirms that a ship's radio can both transmit and receive voice communications. Q/L tests have the following characteristics:

- Generally short in duration
- Require little or no advance scheduling
- Require little or no shipboard maneuvering
- May be accomplished pier side (Communications, LINK-4A and LINK-11 only)
- Require minimal internal shipboard coordination

System performance testing provides the ship with a more detailed analysis and evaluation of the system(s) under test. The testing requirements and the desired measurement precision dictate a higher degree of control on the ship and coordination of its personnel. System performance tests are characterized as tests which:

- Generally require longer periods of dedicated testing
- Require advance scheduling and coordination with SESEF
- Require the ship to maneuver in pre-defined geometries within a certain geographic area; and
- Require internal shipboard coordination

2.1.3 MAJOR FLEET EXERCISES

Types of major exercises that occur within the HRC are the RIMPAC Exercise and Undersea Warfare Exercise (USWEX). Figure 2.1.3-1 shows the areas used by these exercises. Table 2.1.3-1 shows the matrix of events. Each of these exercises has at its center, one of two types of strike group. A strike group is a naval force comprised of one or more capital ships; several surface combatant ships such as cruisers, frigates, and destroyers; and one or more attack submarines. In a Carrier Strike Group (CSG), the aircraft carrier is the capital ship. The other type of strike group is an Expeditionary Strike Group (ESG). The ESG capital ships are two to three amphibious assault ships.

2.1.3.1 Rim of the Pacific

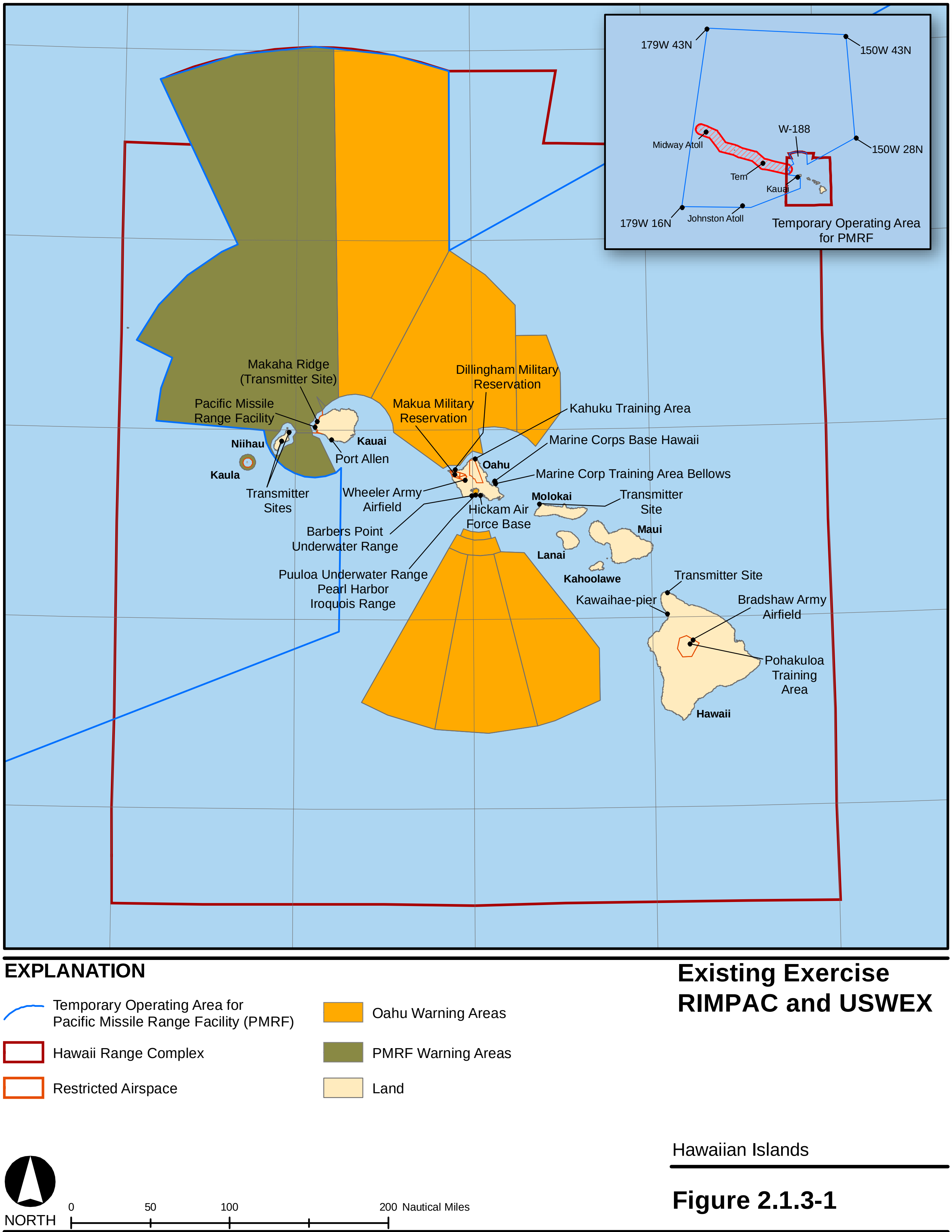
The Commander, U.S. Third Fleet, conducts RIMPAC within the HRC every other year. The biennial RIMPAC is a multinational, sea control and power projection fleet exercise that consists of various phases of activity by U.S. Army, U.S. Marine Corps, U.S. Navy, and U.S. Air Force forces, as well as the military forces of several Pacific Rim nations. During the month-long exercise, each phase of activity includes individual training operations in open ocean, nearshore, and onshore ranges. These individual operations consist of those operations normally conducted on the ranges, but which are now conducted in the context of a larger multinational campaign.

Much of the RIMPAC exercise takes place on existing U.S. Army, U.S. Marine Corps, and PMRF ranges. RIMPAC operations will be analyzed in the cumulative impacts section of this EIS/OEIS. A Programmatic EA for RIMPAC was completed in 2002, and supplemental EAs were prepared in 2004 and 2006.

The 2004 Supplement to the RIMPAC Programmatic EA was prepared to evaluate the additional RIMPAC activities proposed for 2004 not covered by the RIMPAC Programmatic EA. The 2004 Supplement examined whether new installations or facilities were proposed for use, whether significantly different training levels or types of equipment were proposed, and whether environmental sensitivities had changed. The following exercises were evaluated in the 2004 Supplement:

- GUNEX at PMRF Barking Sands Tactical Underwater Range (BARSTUR)
- MCM at Marine Corps Training Area/Bellows (MCTAB), Oahu; Open Ocean Areas, Hawaiian Islands between Molokai, Lanai, and Maui, (including Penguin Bank and the U.S. Navy's shallow water training area south of Maui
- Demolition (DEMO) at Land/Underwater Demolition Range, Naval Magazine Pearl Harbor, West Loch Branch, Oahu; Naval Inactive Ship Maintenance Facility, Middle Loch, Pearl Harbor, Oahu (NISM PH)

The 2006 Supplement to the RIMPAC Programmatic EA also included an assessment of a NEO training event at PMRF and on Niihau and additional analysis related to mid-frequency active sonar. The training events analyzed were the same as previously analyzed and had taken place with not significant changes over the previous 19 RIMPAC exercises. Table 2.1.3-2 shows the matrix of events used during previous RIMPAC exercises by location.



Existing Exercise RIMPAC and USWEX

Hawaiian Islands

Figure 2.1.3-1

2.1.3.2 Undersea Warfare Exercises

USWEX includes a single CSG or expeditionary strike group (ESG) training in the HRC for up to 4 days, four times per year. The total sonar usage is twice that of RIMPAC. [Editor's Note: The environmental documentation for this exercise is underway and will be completed prior to release of this EIS/OEIS. Additional information will be provided in the next version.] Table 2.1.3-1 shows the matrix of events generally used during a USWEX exercise by location.

Table 2.1.3-1. Current Activities Included in Major Range Events

			Training Events																							
											MIW															
					AAW				ASUW / ASW			MCM			ASUW											
Service	Location	Island	IN-PORT/ SUPPORTEX	C2	AIROPS	S-A MISSILEX	A-A MISSILEX/ ACM	A-S MISSILEX	S-S MISSILEX	ASW	MINEX	SMWEX	Air MIWEX	UMWEX	STW, CASEX	GUNEX	SINKEX	LFX	HAO/NEO	HA/DR	SPECWAROPS	DEMO	SALVAGE OPS	Expeditionary Assault	SUBOPS	OTHER
U.S. Navy	Pacific Missile Range Facility*	Kauai																	■		■	■		■		
	Niihau	Niihau																	■		■					
	Kaula	Kaula													■											
	Pearl Harbor**	Oahu	■	■	■																■	■	■			
	Iroquois Land/Underwater Range	Oahu																			■	■				
	Puuloa Underwater Range – Pearl Harbor	Oahu																			■	■	■			
	Barbers Point Underwater Range	Oahu																			■	■				
	Coast Guard AS Barbers Point/ Kalaeloa Airport	Oahu			■																■					
	PMRF Warning Areas#	Ocean Areas				■	■	■	■	■	■				■	■	■				■	■			■	
	Oahu Warning Areas#	Ocean Areas				■	■			■						■					■	■			■	
	Open Ocean Areas#	Ocean Areas								■		■	■	■							■	■			■	■
	U.S. Command Ship	Ocean Areas		■																						
U.S. Marines	Marine Corps Base Hawaii	Oahu		■	■									■					■	■	■			■		
	Marine Corps Training Area Bellows	Oahu																	■	■	■			■		
U.S. Air Force	Hickam Air Force Base	Oahu		■	■																■					
U.S. Army	Kahuku Training Area	Oahu																	■	■	■					
	Makua Military Reservation	Oahu																■			■					
	Dillingham Military Reservation	Oahu																			■					
	Wheeler Army Airfield	Oahu		■	■																■					
	K-Pier, Kawaihae	Hawaii																			■			■		
	Bradshaw Army Airfield	Hawaii		■	■																■					
	Pohakuloa Training Area	Hawaii													■			■			■					
State	Keehi Lagoon	Oahu																					■			

* Includes Port Allen and Makaha Ridge

** Includes Ford Island and all other areas within the harbor.

These areas are included in the HRC. The HRC is now used to define the outer limits of the ocean areas used during major range events.

■ Locations where events can occur

Training Events:

A-A MISSILEX	Air-to-Air Missile Exercise (formerly AAMEX)
AAW[1]	Anti-Air Warfare
AIROPS	Aircraft Operations
AMPHIBEX	Amphibious Landing Exercise (now Expeditionary Assault)
Air MIWEX	Air Mine Warfare Exercise (formerly AMWEX)
A-S MISSILEX	Air-to-Surface Missile Exercise (formerly ASMEX)
ASUW[2]/ASW[3]	Anti-Surface Warfare/ Anti-Submarine Warfare Exercise
ASW	Anti-Submarine Warfare Exercise (formerly ASWEX)
CASEX	Close Air Support
C2	Command and Control
DEMO	Demolition Exercise
GUNEX	Gunnery Exercise
HA/DR	Humanitarian Assistance/Disaster Relief
HAO/NEO	Humanitarian Assistance Operation/ Non-Combatant Evacuation Operation
IN-PORT	In-port Briefings and Activities
LFX	Live Fire Exercise
MCM	Mine Countermeasures
MINEX	Mine Exercise
MIW[4]	Mine Warfare
SALVAGE OPS	Salvage Operations
S-A MISSILEX	Surface-to-Air Missile Exercise (formerly SAMEX)
SINKEX	Sink Exercise
SMWEX	Ship Mine Warfare Exercise
SPECWAROPS	Special Warfare Operations (NSW Operations?)
S-S MISSILEX	Surface-to-Surface Missile (formerly SSMEX)
STW	Strike Warfare Exercise (formerly STWEX)
SUBOPS	Submarine Operations
SUPPORTEX	In-Port Support Exercise
UMWEX	Underwater Mine Warfare Exercise

Note: Since the publication of the RIMPAC PEA, new terminology and/or categories of exercises have come into use. They are as follows:

[1] AAW includes AIROPS, S-A MISSILEX, A-A MISSILEX, and A-S MISSILEX

[2] ASUW includes GUNEX, S-S MISSILEX, and ASW

[3] ASW includes S-S MISSILEX and ASW

[4] MIW encompasses two subsets, MINEX and MCM. MINEX is the act of laying mines. MCM is the act of locating and countering mining by others and includes SMWEX, AMWEX, and UMWEX.

Table 2.1.3-2. RIMPAC 06 Exercise Matrix

			Training Events																							
					AAW				ASUW / ASW		MIW				ASUW											
												MCM														
Service	Location	Island	IN-PORT/ SUPPORTEX	C2	AIROPS	S-A MISSILEX	A-A MISSILEX/ ACM	A-S MISSILEX	S-S MISSILEX	ASW	MINEX	SMWEX	Air MIWEX	UMWEX	STW, CASEX	GUNEX	SINKEX	LFX	HAO/NEO	HA/DR	SPECWAROPS	DEMO	SALVAGE OPS	Expeditionary Assault	SUBOPS	OTHER
U.S. Navy	Pacific Missile Range Facility*	Kauai																	blue		gray	gray		gray		
	Niihau	Niihau																	blue		gray					
	Kaula	Kaula													gray											
	Pearl Harbor**	Oahu	gray	gray	gray																gray	yellow	gray			
	Iroquois Land/Underwater Range	Oahu																			gray	gray				
	Puuloa Underwater Range – Pearl Harbor	Oahu																			gray	gray	gray			
	Barbers Point Underwater Range	Oahu																			gray	gray				
	Coast Guard AS Barbers Point/ Kalaeloa Airport	Oahu			gray																gray					
	PMRF Warning Areas#	Ocean Areas				gray	gray	gray	gray	gray	gray				gray	gray	gray				gray	gray			gray	
	Oahu Warning Areas#	Ocean Areas				gray	gray			gray						gray					gray	gray			gray	
	Open Ocean Areas#	Ocean Areas								gray		yellow	yellow	yellow							gray	gray			gray	yellow
	U.S. Command Ship	Ocean Areas		gray																						
U.S. Marines	Marine Corps Base Hawaii	Oahu		gray	gray									yellow					gray	gray	gray			gray		
	Marine Corps Training Area Bellows	Oahu																	gray	gray	gray			gray		
U.S. Air Force	Hickam Air Force Base	Oahu		gray	gray																gray					
U.S. Army	Kahuku Training Area	Oahu																	gray	gray	gray					
	Makua Military Reservation	Oahu																gray			gray					
	Dillingham Military Reservation	Oahu																			gray					
	Wheeler Army Airfield	Oahu		gray	gray																gray					
	K-Pier, Kawaihae	Hawaii																			gray			gray		
	Bradshaw Army Airfield	Hawaii		gray	gray																gray					
	Pohakuloa Training Area	Hawaii																gray			gray					
State	Keehi Lagoon	Oahu																					gray			

* Includes Port Allen and Makaha Ridge

** Includes Ford Island and all other areas within the harbor.

These areas are included in the HRC. The HRC is now used to define the outer limits of the ocean areas used during major range events.

(gray) Locations where events can occur — (yellow) Added RIMPAC 04 Supplement — (blue) Added RIMPAC 06 Supplement

Training Events:

A-A MISSILEX	Air-to-Air Missile Exercise (formerly AAMEX)	C2	Command and Control
AAW[1]	Anti-Air Warfare	DEMO	Demolition Exercise
AIROPS	Aircraft Operations	GUNEX	Gunnery Exercise
AMPHIBEX	Amphibious Landing Exercise (now Expeditionary Assault)	HA/DR	Humanitarian Assistance/Disaster Relief
Air MIWEX	Air Mine Warfare Exercise (formerly AMWEX)	HAO/NEO	Humanitarian Assistance Operation/ Non-Combatant Evacuation Operation
A-S MISSILEX	Air-to-Surface Missile Exercise (formerly ASMEX)	IN-PORT	In-port Briefings and Activities
ASUW[2]/ASW[3]	Anti-Surface Warfare/ Anti-Submarine Warfare Exercise	LFX	Live Fire Exercise
ASW	Anti-Submarine Warfare Exercise (formerly ASWEX)	MCM	Mine Countermeasures
CASEX	Close Air Support	MINEX	Mine Exercise
		MIW[4]	Mine Warfare
SALVAGE OPS	Salvage Operations		
S-A MISSILEX	Surface-to-Air Missile Exercise (formerly SAMEX)		
SINKEX	Sink Exercise		
SMWEX	Ship Mine Warfare Exercise		
SPECWAROPS	Special Warfare Operations (NSW Operations?)		
S-S MISSILEX	Surface-to-Surface Missile (formerly SSMEX)		
STW	Strike Warfare Exercise (formerly STWEX)		
SUBOPS	Submarine Operations		
SUPPORTEX	In-Port Support Exercise		
UMWEX	Underwater Mine Warfare Exercise		

Note: Since the publication of the RIMPAC PEA, new terminology and/or categories of exercises have come into use. They are as follows:

[1] AAW includes AIROPS, S-A MISSILEX, A-A MISSILEX, and A-S MISSILEX

[2] ASUW includes GUNEX, S-S MISSILEX, and ASW

[3] ASW includes S-S MISSILEX and ASW

[4] MIW encompasses two subsets, MINEX and MCM. MINEX is the act of laying mines. MCM is the act of locating and countering mining by others and includes SMWEX, AMWEX, and UMWEX.

Table 2.1.3-3. Example USWEX Matrix

Training Events

					AAW/ACM				ASUW / ASW		MIW	MIW – MCM			ASUW											
Service	Location	Island	IN-PORT/ SUPPORTEX	C2	AIROPS	S-A MISSILEX	A-A MISSILEX/ ACM	A-S MISSILEX	S-S MISSILEX	ASW	MINEX	SMWEX	Air MIWEX	UMWEX	STW, CASEX	GUNEX	SINKEX	LFX	HAO/NEO	HA/DR	SPECWAROPS	DEMO	SALVAGE OPS	Expeditionary Assault	SUBOPS	OTHER
U.S. Navy	Pacific Missile Range Facility*	Kauai																								
	Niihau	Niihau																								
	Kaula	Kaula																								
	Pearl Harbor**	Oahu																								
	Iroquois Land/Underwater Range	Oahu																								
	Puuloa Underwater Range – Pearl Harbor	Oahu																								
	Barbers Point Underwater Range	Oahu																								
	Coast Guard AS Barbers Point/ Kalaeloa Airport	Oahu																								
	PMRF Warning Areas#	Ocean Areas																								
	Oahu Warning Areas#	Ocean Areas																								
	Open Ocean Areas#	Ocean Areas																								
	U.S. Command Ship	Ocean Areas																								
U.S. Marines	Marine Corps Base Hawaii	Oahu																								
	Marine Corps Training Area Bellows	Oahu																								
U.S. Air Force	Hickam Air Force Base	Oahu																								
U.S. Army	Kahuku Training Area	Oahu																								
	Makua Military Reservation	Oahu																								
	Dillingham Military Reservation	Oahu																								
	Wheeler Army Airfield	Oahu																								
	K-Pier, Kawaihae	Hawaii																								
	Bradshaw Army Airfield	Hawaii																								
	Pohakuloa Training Area	Hawaii																								
State	Keehi Lagoon	Oahu																								

* Includes Port Allen and Makaha Ridge

** Includes Ford Island and all other areas within the harbor.

[#] These areas are included in the HRC. The HRC is now used to define the outer limits of the ocean areas used during major range events.

Locations where events can occur

USWEX

Training Events:

A-A MISSILEX	Air-to-Air Missile Exercise (formerly AAMEX)	C2	Command and Control	SALVAGE OPS	Salvage Operations
AAW[1]	Anti-Air Warfare	DEMO	Demolition Exercise	S-A MISSILEX	Surface-to-Air Missile Exercise (formerly SAMEX)
AIROPS	Aircraft Operations	GUNEX	Gunnery Exercise	SINKEX	Sink Exercise
AMPHIBEX	Amphibious Landing Exercise (now Expeditionary Assault)	HA/DR	Humanitarian Assistance/Disaster Relief	SMWEX	Ship Mine Warfare Exercise
Air MIWEX	Air Mine Warfare Exercise (formerly AMWEX)	HAO/NEO	Humanitarian Assistance Operation/ Non-Combatant Evacuation Operation	SPECWAROPS	Special Warfare Operations (NSW Operations?)
A-S MISSILEX	Air-to-Surface Missile Exercise (formerly ASMEX)			S-S MISSILEX	Surface-to-Surface Missile (formerly SSMEX)
ASUW[2]/ASW[3]	Anti-Surface Warfare/ Anti-Submarine Warfare Exercise	IN-PORT	In-port Briefings and Activities	STW	Strike Warfare Exercise (formerly STWEX)
		LFX	Live Fire Exercise	SUBOPS	Submarine Operations
ASW	Anti-Submarine Warfare Exercise (formerly ASWEX)	MCM	Mine Countermeasures	SUPPORTEX	In-Port Support Exercise
CASEX	Close Air Support	MINEX	Mining Exercise	UMWEX	Underwater Mine Warfare Exercise
		MIW[4]	Mine Warfare		

Note: Since the publication of the RIMPAC PEA, new terminology and/or categories of exercises have come into use. They are as follows:

[1] AAW includes AIROPS, S-A MISSILEX, A-A MISSILEX, and A-S MISSILEX

[2] ASUW includes GUNEX, S-S MISSILEX, and ASW

[3] ASW includes S-S MISSILEX and ASW

[4] MIW encompasses two subsets, MINEX and MCM. MINEX is the act of laying mines. MCM is the act of locating and countering mining by others and includes SMWEX, AMWEX, and UMWEX.

2.2 ALTERNATIVE 1

2.2.1 ONGOING ACTIVITIES ASSOCIATED WITH THE NO-ACTION ALTERNATIVE

Under Alternative 1, all activities in the No-action Alternative would continue. In addition, Alternative 1 activities would include increased training operations, planned RDT&E programs, new activities resulting from force structure changes and range complex investments, and major range exercises not previously considered.

Table 2.2.1-1 indicates the operations associated with the baseline and proposed actions under Alternative 1.

Table 2.2.1-1. Baseline and Alternative 1 Proposed Operations

Mission Area	Events	Area	Baseline (Events/ Year)	Alt. 1 (Events/ Year)
OFFSHORE ACTIVITIES				
Anti-Air Warfare (AAW)	Air Combat Maneuver	W-188, 189, 190, 192, 193, 194	738	774
	Air-to-Air Missile Exercise	W-188	36	41
	Surface-to-Air Gunnery Exercise	W-188, 192, Mela South	86	108
	Surface-to-Air Missile Exercise	W-188	17	26
	Chaff Exercise	Hawaii Offshore	34	34
Amphibious Warfare (AMW)	Naval Surface Fire Support Exercise	W-188	22	28
Anti-Surface Warfare (ASUW)	Visit, Board, Search, and Seizure	Hawaii Offshore	60	60
	Surface-to-Surface Gunnery Exercise	W-191, 192, 193, 194, 196, Mela South, Pacific Missile Range Facility (PMRF)	69	91
	Surface-to-Surface Missile Exercise	PMRF (W-188)	7	12
	Air-to-Surface Gunnery Exercise	Hawaii Offshore, PMRF	128	152
	Air-to-Surface Missile Exercise	PMRF	36	50
	Bombing Exercise (Sea)	Hawaii Offshore, PMRF	35	35
	Sink Exercise	Hawaii Offshore, PMRF	6	6
	Antisurface Warfare Torpedo Exercise (Submarine-Surface)	Hawaii Offshore, PMRF	35	35
Anti-Submarine Warfare (ASW)	Antisubmarine Warfare Tracking Exercise	Hawaii Offshore, PMRF	372	372
	Antisubmarine Warfare Torpedo Exercise	Hawaii Offshore, PMRF	397	397
	Major Integrated ASW Training Exercise	Hawaii Offshore, PMRF	5	7

Table 2.2.1-1. Baseline and Alternative 1 Proposed Operations (Continued)

Mission Area	Events	Area	Baseline (Events/ Year)	Alt. 1 (Events/ Year)
OFFSHORE ACTIVITIES (Continued)				
Electronic Combat (EC)	Electronic Combat Operations	Hawaii Offshore, PMRF	50	50
Mine Warfare (MIW)	Mine Countermeasures Exercise	PMRF, Submarine Operating Area	32	62
Naval Special Warfare (NSW)	Swimmer Insertion/Extraction	Hawaii Offshore, Marine Corps Training Area–Bellows (MCTAB), PMRF	80	80
Strike Warfare (STW)	Bombing Exercise (Land)	Kaula Rock, Pohakuloa Training Area (PTA)	97	139
	Air-to-ground Gunnery Exercise)	Kaula Rock	16	18
Other	Command and Control (C2)	U.S. Command Ship at sea	1	1
NEARSHORE ACTIVITIES				
AMW	Expeditionary Assault	PMRF, MCTAB	11	11
ASUW	Flare Exercise	W-188	6	6
MIW	Mine Neutralization	Puuloa Underwater Range	62	62
	Mine Laying	PMRF	22	32
NSW	Swimmer Insertion/Extraction	Hawaii Offshore, MCTAB, PMRF	52	52
Other	Salvage Operations	Pearl Harbor, Puuloa Underwater Range, Keehi Lagoon, Eastern Naval Defense Sea Area	1	1
	In Port Ship Support Operations	Pearl Harbor	1	1
ONSHORE ACTIVITIES				
MIW	Land Demolitions	Explosive Ordnance Disposal Land Range	85	85
Other	Command and Control (C2)	Pearl Harbor, Marine Corps Base Hawaii (MCBH), Hickam Air Force Base (AFB), Wheeler Army Airfield (AAF), Bradshaw AAF	1	1
	Aircraft Support Operations	PH, Kalaeloa Airport, MCBH, Hickam AFB, Wheeler AAF, Bradshaw AAF, PMRF	1	1
	Personnel Support Operations	Oahu, Kauai	1	1
	Air Operations	Pearl Harbor, Kalaeloa Airport, MCBH, Hickam AFB, Wheeler AAF, Bradshaw AAF, PMRF, Kona International Airport	2,600	2,600
	Field Carrier Landing Practice (FCLP)	Kalaeloa Airport, MCBH, Barking Sands, Kona International Airport	0	160
	Live Fire Exercise	Makua, PTA	3	3
	Humanitarian Assistance / Non-combatant Evacuation Operations (HAO/NEO)	PMRF, Niihau, MCBH, MCTAB, Kahuku	1	1
	Humanitarian Assistance / Disaster Relief Operations (HA/DR)	MCBH, MCTAB, Kahuku	1	1

2.2.2 INCREASED TRAINING OPERATIONS TO SUPPORT FLEET RESPONSE TRAINING PLAN

The U.S. Navy proposes to increase training operations from current levels as necessary in support of the FRTP as shown in Table 2.2.2-1.

Table 2.2.2-1. Baseline and Alternative 1 RDT&E Operations

Warfare Area	Events / (NTA)	Area	Baseline (Events/ Year)	Alt. 1 (Events/ Year)
Research, Development, Test, and Evaluation (RDT&E)	Anti-air Warfare RDT&E	Pacific Missile Range Facility (PMRF)	35	40
	Antisubmarine Warfare	PMRF	19	21
	Combat System Ship Qualification Trial	PMRF	7	8
	Electronic Combat/Electronic Warfare	PMRF	65	72
	High Frequency	PMRF	9	10
	Joint Task Force Wide Area Relay Network	PMRF	2	3
	Missile Defense	PMRF	40	40
	Science & Technology / Other	PMRF	22	24
	Terminal High Altitude Area Defense	PMRF	6	6
	Fleet Operational Readiness Accuracy Check Site (FORACS) Tests	FORACS	5	5
	Shipboard Electronic Systems Evaluation Facility (SESEF) Quick Look Tests	SESEF / Pearl Harbor	3,842	4,225
	SESEF System Performance Tests	SESEF	67	74

2.2.3 PLANNED TEST AND EVALUATION ACTIVITIES

Additional Chemical Simulant

The purpose of using chemical simulants in target launch vehicles is to assess the effectiveness of defensive missiles against threat missiles carrying chemical agents as payloads. To adequately emulate this threat in testing, it is necessary to use materials that are similar to the physical characteristics of actual chemical agents, but without the toxic effects. Use of actual chemical agents in testing would present the potential for unacceptable hazards, thus the need for simulants.

Tributyl phosphate, for example, is used as a representative threat that, when thickened, has physical and aerodynamic response properties similar to a chemical agent. Up to 120 gal of the thickened tributyl phosphate would be loaded into a payload vehicle and installed on the target missile. The thickener, 3.8 percent by weight, is polybutylmethacrylate polymer, an inert plastic.

Target launches from PMRF would incorporate additional chemical simulants to include larger quantities of tributyl phosphate (TBP) and various glycols. Approximately 120 gallons (gal) of simulant would be used in target vehicles launched from PMRF. The simulant would be transported from the Continental United States (CONUS) to PMRF with the target vehicle and would be loaded into the target vehicle payload as part of the payload processing activities.

Approximately 120 gallons (gal) of simulant would be used in target vehicles launched from PMRF. The simulant would be transported from the Continental United States (CONUS) to PMRF with the target vehicle and would be loaded into the target vehicle payload as part of the payload processing activities.

Intercept Targets Launched Into PMRF Controlled Area

Launches from Wake Island, the Reagan Test Site at U.S. Army Kwajalein Atoll (USAKA), and Vandenberg AFB towards the vicinity of PMRF are proposed and depicted in Figure 2.2.3-1. Launches from those sites would be from existing launch facilities, and no new boosters from these sites are proposed. The intercept areas would be in the Broad Ocean Area and Temporary Operating Area of the PMRF Range. Targets would also continue to be launched from sea-based and air-based platforms as analyzed in previous environmental documents.

Launch SM-6 from Sea-Based Platform

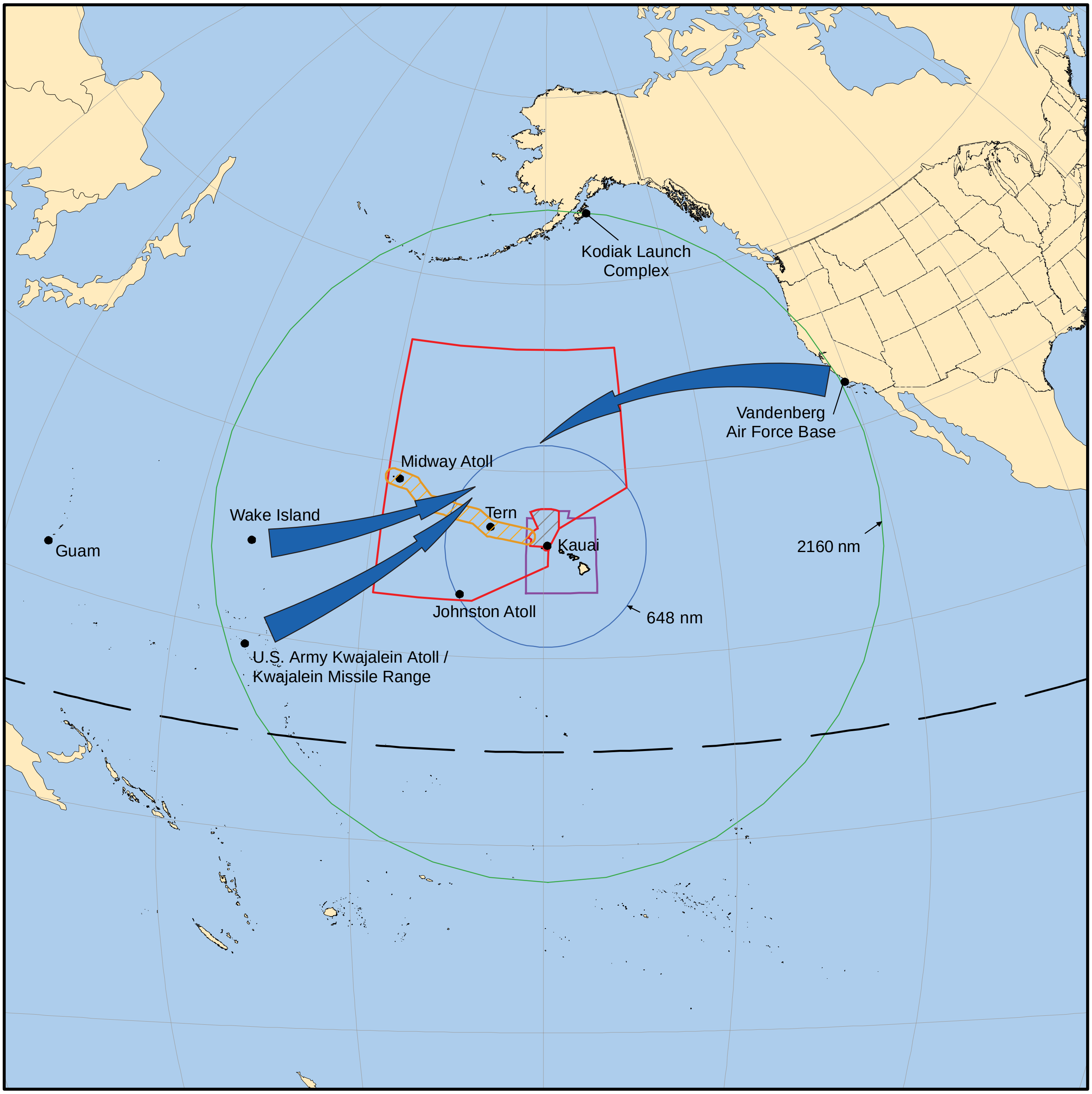
PMRF would also develop as part of Alternative 1 the capability to launch the Extended Range Active Missile, tentatively designated SM-6, from a sea-based platform. This testing would be similar to ongoing launches of the current version of the Standard Missile from Aegis ships. For testing purposes the SM-6 could also be launched from the Mobile Aerial Target Support System or other mobile launch platform. The SM-6 would consist of the SM-2 Block IV booster system and an active Advanced Medium Range Air-to-Air Missile seeker to provide enhanced capabilities. Testing would occur in the Temporary Operating Area.

Testing High-Speed and Unmanned Surface Vehicles

Future testing of Unmanned Surface Vehicles (USVs) is proposed to occur within the HRC. These remote-controlled boats could be equipped with modular packages to potentially support surveillance and reconnaissance activities, mine warfare, anti-terrorism/force protection, port protection, Special Forces operations, and possibly anti-submarine warfare.

USVs generally represent small boats up to approximately 40 ft in length, with either rigid hulls and/or inflatable pontoons. Inboard or outboard diesel or gasoline engines up to several hundred horsepower would likely be used for propulsion. Test packages carried on the USVs may include radars; sonar; multi-functional camera suites; autonomous equipment packages; and required communications, testing, and support equipment. Onboard electrical power for equipment operations and engine starting would come from a series of batteries (lead-acid, lithium, etc.), and possibly an electrical generator run off the main engine.

For testing just off the coast of PMRF, the USV would be launched from either Port Allen or the Kikiaola Small Boat Harbor. For safety purposes, the USV would be towed by a manned vessel out of the harbor and up the coast to PMRF before operating remotely under its own power. Testing would only occur in areas cleared of non-mission essential vessels. Using computers, personnel would remotely operate the USV from a transportable command post in a trailer or located within an existing building at PMRF. The types of tests may include low-speed surveillance activities using cameras, radar, and/or sonar; maneuvering through obstacles; and high-speed runs in excess of 40 knots. Individual test events could occur day or night and last for up to 24 hours, depending on test requirements. Following each test, the USV would be towed back to harbor. Depending on test schedules, the USV might be temporary docked, or taken out of the water on a trailer for storage at the harbor or at PMRF. No new storage or docking facilities would be required.



EXPLANATION

Temporary Operating Area

648 nm buffer

2,160 nm buffer

Existing Warning Area

Northwestern Hawaiian Islands
Marine National Monument

Hawaiian Islands Operating Area

Land

Proposed Flight Corridors

NORTH

0 750 1,500 3,000 Nautical Miles

Intercept Targets Launched into PMRF Controlled Area

Open Ocean

Figure 2.2.3-1

The testing of USVs could also occur in open waters within the Temporary Operating Area. In this case, the USV would be towed out to sea or launched directly from a surface ship. Remote control of the USV would occur from a command center on a vessel. Again, testing would only occur in areas cleared of non-mission essential vessels

Testing High-Speed and Unmanned Aerial Vehicles

A variety of Unmanned Aerial Vehicles (UAVs) may also be tested in the future at PMRF. UAVs are remotely piloted or self-piloted aircraft that include fixed-wing, rotary-wing, and other vertical takeoff vehicles. They can carry cameras, sensors, communications equipment, weapons, or other payloads. At PMRF, UAV testing could support one or more of the following mission areas: intelligence, surveillance, and reconnaissance; suppression of enemy air defenses; electronic attack; anti-surface ship and anti-submarine warfare; mine warfare; communications relay; and derivations of these themes.

UAVs can vary in size up to approximately 45 ft in length, with gross vehicle weights ranging from several hundred pounds (lb) to approximately 45,000 lb. Forms of propulsion for UAVs can range from traditional turbofans, turboprops, and piston engine-driven propellers; to electric motor-driven propellers powered by rechargeable batteries (lead-acid, nickel-cadmium, lithium Ion), photovoltaic cells, and/or hydrogen fuel cells.

Prior to testing at PMRF, each UAV would be ground checked at existing facilities to ensure proper system operations. Depending on engine propulsion, the vehicle would be fueled most likely with gasoline or diesel fuel (approximately 50 to 700 lb); or jet fuel (approximately 50 to 17,000 lb of JP-5 or JP-8). Takeoff procedures would vary by UAV system, using a traditional runway takeoff, small solid rocket-assisted takeoff, or a portable catapult launcher. Personnel would use computers to remotely operate the UAV from a transportable command post in a trailer or located within an existing building at PMRF.

Depending on the UAV system being tested, individual flights could extend just a few nautical miles off the PMRF coast, or well over 100 nm into the Temporary Operating Area. Maximum altitudes for flights could range from a few thousand feet for the smallest UAVs to over 30,000 ft for the largest jet-powered vehicles. Maximum velocities attained would range from approximately 100 to 500 knots. Testing would only occur in areas cleared of non-mission essential aircraft and away from populated areas. The types of tests conducted could include demonstration of aircraft flight worthiness and endurance, surveillance activities using onboard cameras and other sensors, and over-the-horizon targeting. Individual test flights could last from a few hours to more than a day. At the completion of each flight test, vehicle landing would occur via traditional runway landing or using retrieval nets for smaller UAVs. The storage and ground-support for UAVs would occur within existing facilities at PMRF. No new facilities are planned.

In some cases, UAV flight tests, including takeoff and landing procedures, may be conducted from surface ships in the Temporary Operating Area. Remote control of the UAV would occur from a command center on a vessel. Again, testing would only occur in areas cleared of non-mission essential aircraft.

Test Hypersonic Vehicles

The U.S. Navy and the Department of Defense are working towards development of air-breathing hypersonic vehicles that are capable of maximum sustainable cruising speeds in excess of Mach 4. As potential ordnance delivery systems, such vehicles could significantly decrease the launch to target engagement timeline.

Hypersonic vehicles, such as those being developed under the Hypersonic Flight Demonstration program, could be flight tested at PMRF from within and beyond the Temporary Operating Area. The missile-like test vehicle would be fueled at PMRF using JP-10 (exo-tetrahydrocyclo-pentadiene) or a similar turbine liquid fuel. On-board fuel weights are currently undetermined, but are expected to not exceed 500 lb. Because the hypersonic vehicles use a scramjet technology, engine operation requires a high-speed boost on a rocket or from a jet aircraft.

Rocket launching a hypersonic test vehicle could occur from the Vandal launch site at PMRF and follow a similar flight trajectory as other missiles launched from PMRF. For example, a two-stage Terrier-Orion sounding rocket could be used to boost the hypersonic vehicle. Following launch and booster motor separation, the spent motor casings would impact in the open ocean. Upon reaching hypersonic velocities at altitudes in excess of 50,000 ft, the test vehicle would continue on a pre-designated flight trajectory under its own scramjet power, before making a controlled splashdown into the open ocean.

For flight insertion using a jet aircraft, such as an F-15, the test vehicle would be attached under the aircraft at PMRF. Following takeoff, and upon reaching an appropriate altitude and velocity over the Temporary Operating Area, the test vehicle would be released from the aircraft. With engine ignition, the hypersonic test vehicle would climb to an appropriate cruising altitude before making a controlled splashdown into the open ocean. The hypersonic vehicle flight tests would serve to demonstrate flight performance and flight worthiness. Testing would only occur in areas cleared of non-mission essential aircraft and vessels, and away from populated areas. In support of test activities at PMRF, no new facilities would be needed.

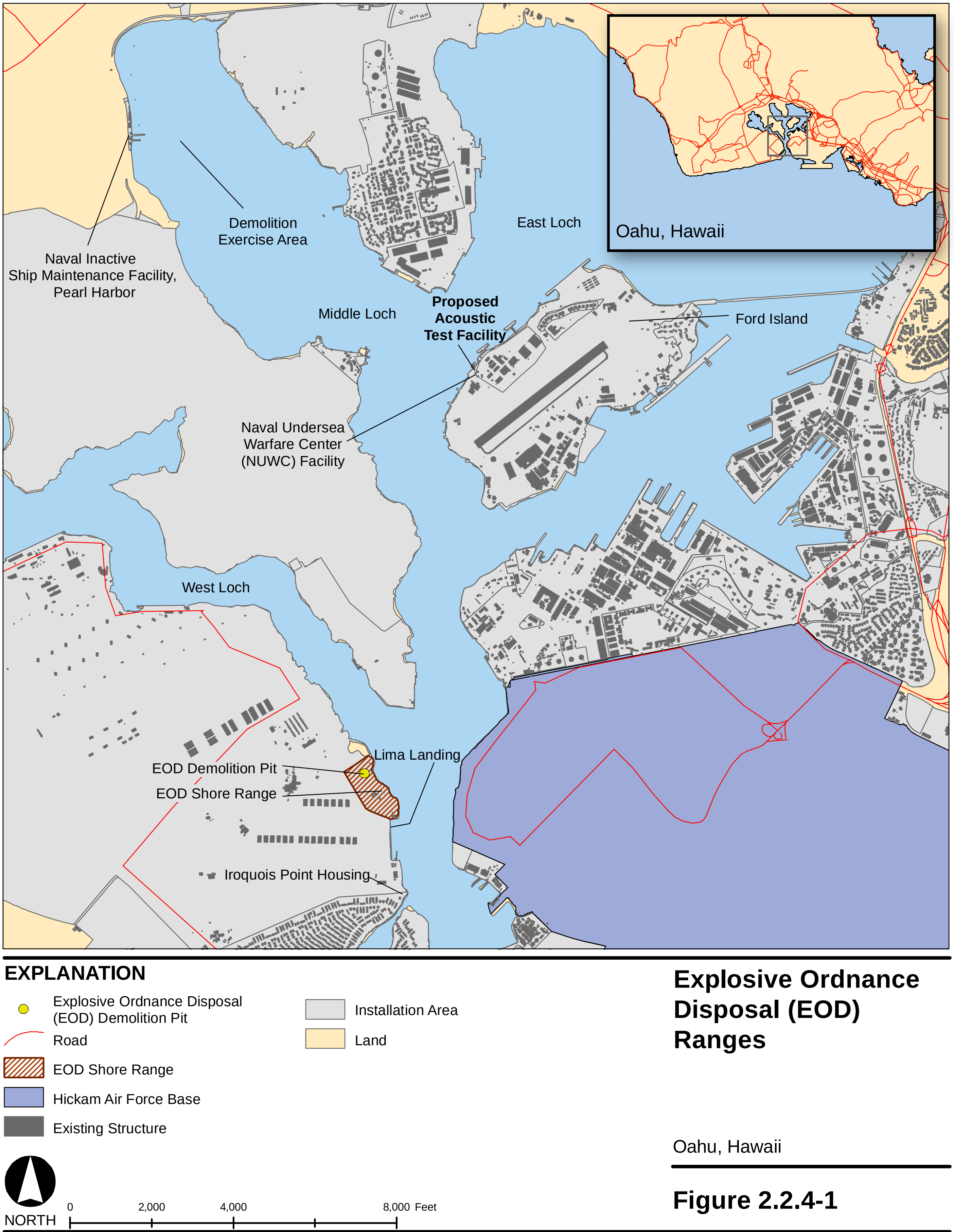
2.2.4 HAWAII RANGE COMPLEX ENHANCEMENTS

The Hawaii Range Complex Management Plan presented specific enhancements and recommendations to optimize range capabilities required to adequately support training for all missions and roles assigned to the HRC.

2.2.4.1 EOD Range Enhancements

Naval Special Warfare and EOD Targets

Hawaii based Sea, Air, ad Land (SEAL) and EOD forces have target requirements not currently met in Hawaii. The U.S. Navy proposes to develop targets and support target maintenance for exposed beach obstacles and fortified beach or nearshore defenses, at least some of which must be cleared for live Naval Special Warfare weapons and explosives. Targets are steel frames and shapes that can be lowered into the water to simulate hulls of ships, or amphibious obstacles. The hull frames would be removed following the exercise. Obstacles would be destroyed in place and are not recoverable. The targets would be used at the EOD Land Range or the Puuloa EOD Range (Figure 2.2.4-1).



Explosive Ordnance Disposal (EOD) Ranges

Oahu, Hawaii

Figure 2.2.4-1

Large Area Tracking Range (LATR) provides high fidelity time, space, and position information capability at PMRF. This capability is proposed to be upgraded with ground relay stations to cover training operations throughout much of the HRC. This upgrade would include Pohakuloa Training Area (PTA) and the Warning Areas south of Oahu to provide seamless tracking within all warning areas, the Island of Hawaii, and throughout every island's offshore area (out to 150 nm). The upgrade of the LATR would expand the fleet training exercise capability by enlarging the training area and involving greater numbers of participants. The proposed ground relay stations would be modifications to existing facilities and no new construction is expected.

2.2.4.2 Pearl Harbor Enhancements

MK-84/MK-72 Pinger Acoustic Test Facility

MK-84 and MK-72 acoustic pingers are critical to the underwater tracking of targets on ASW ranges throughout the HRC. Each of these two models of pingers is a small acoustic transmitter that emits acoustic energy at regular intervals at a specific frequency. The pinger is attached internally or externally to submarines, simulated submarine targets, and exercise torpedoes. Undersea tracking ranges, such as the Barking Sands Tactical Underwater Range (BARSTUR) and Barking Sands Underwater Range Expansion (BSURE) at PMRF rely on this signal to track these underwater objects during training on the range. MK-84 and MK-72 pingers are serviced and tested in an in-ground tank at NUWC Detachment Pacific's Acoustic Test Facility at their Lualualei location. However, NUWC is vacating their Lualualei location, and there are no plans to move or rebuild the testing tank at the Acoustic Test Facility. Without a tank to test pingers, ASW target tracking capability will decline, as will ASW TRACKEX and TORPEX monitoring and reconstruction.

The U.S. Navy proposes to develop a new open-water Acoustic Test Facility capability near NUWC's Ford Island facility in Pearl Harbor, shown in Figure 2.2.4-2. Testing would take place in the water adjacent to pier S291 on Ford Island. Pinger operations typically run for an 8-hour period once a week. Development of the Acoustic Test Facility would require minor modification to the pier to provide electrical cabling and pinger attach points.

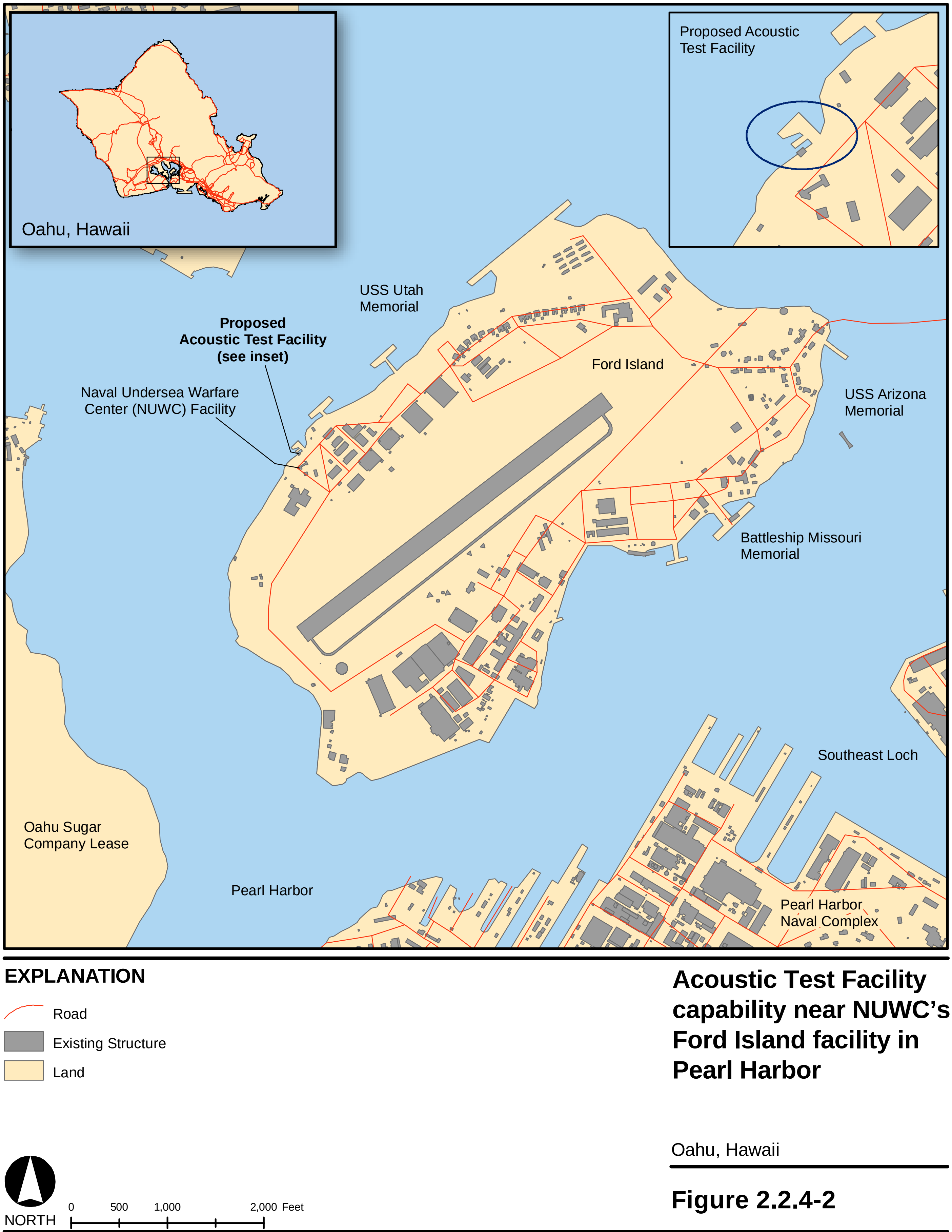
Mobile Diving and Salvage Unit Training Area

The U.S. Navy would establish an underwater training area in which Mobile Diving and Salvage Unit ONE can conduct military diving and salvage training, including submerging a 100-ft by 50-ft barge. Figure 2.2.4-3 shows the proposed location and an alternative site, as Area 1 and Area 2, respectively. The vessel would be placed within a 328- by 328-ft area centered at Area 1. The type of training to be conducted would consist of various underwater projects designed to develop mission critical skills, such as hot tapping, welding, cutting, patching, plugging, drilling, tapping, and grinding.

2.2.4.3 Onshore Enhancements (Hawaii, Oahu, Kauai)

Field Carrier Landing Practice

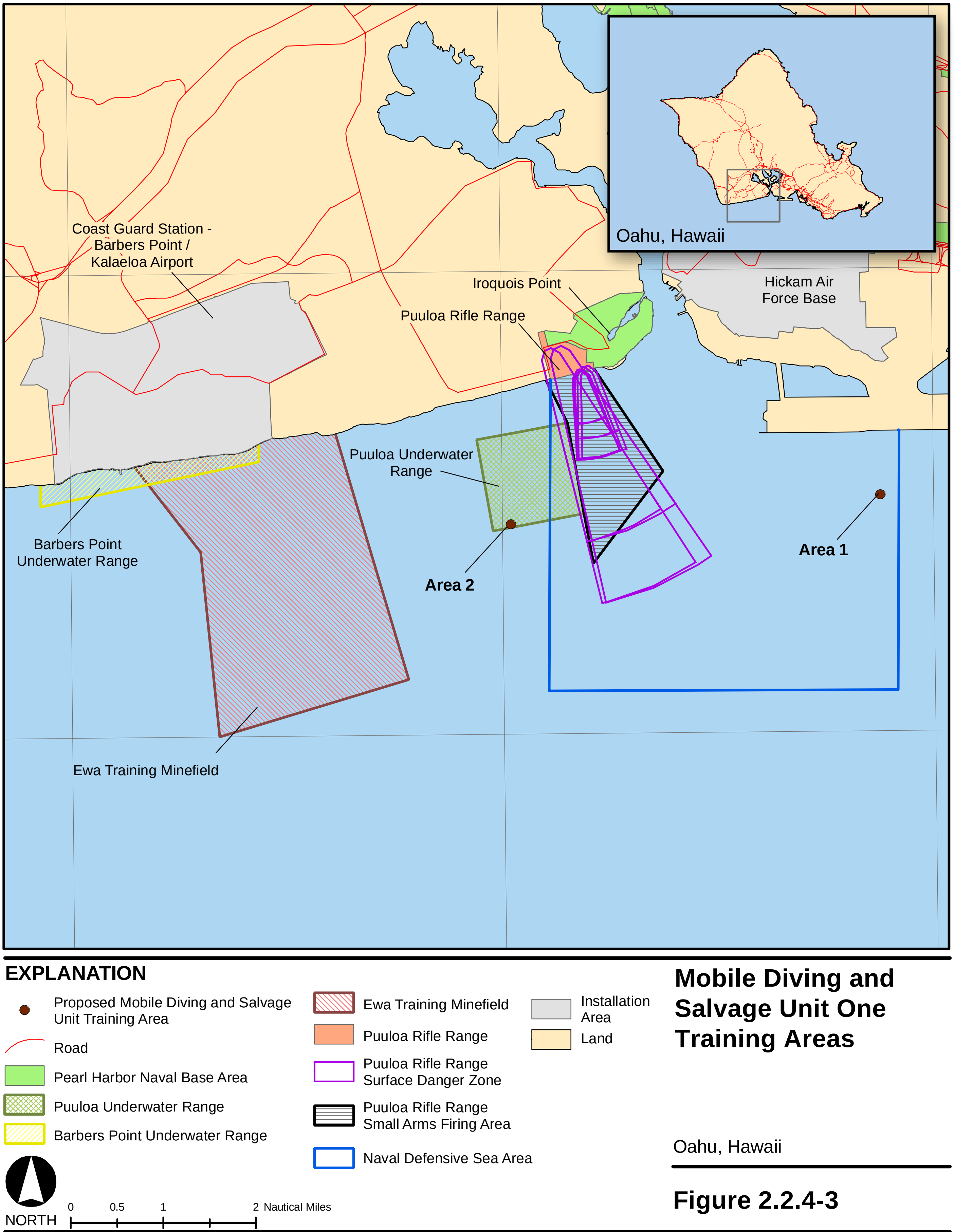
The Navy proposes conducting Field Carrier Landing Practice (FCLP) for half of an air wing's pilots, once per year in Hawaii. An FCLP is a series of touch-and-go landings conducted to prepare pilots for aircraft carrier landings. Only carrier-based, fixed-wing aircraft (both jet and propeller aircraft) are required to conduct FCLPs. FCLPs would be conducted during day or night periods, each consisting of six to eight touch-and-go landings per pilot. The landings



Acoustic Test Facility capability near NUWC's Ford Island facility in Pearl Harbor

Oahu, Hawaii

Figure 2.2.4-2



Mobile Diving and Salvage Unit One Training Areas

Oahu, Hawaii

Figure 2.2.4-3

would take place on an airport runway, preferably one marked and lighted to simulate the deck of an aircraft carrier.

The requirement for FCLP refresher training is dictated by the length of time since a pilot's last carrier landing. The number of FCLP periods and total number of FCLP landings required to prepare a pilot for carrier landings varies with individual pilot skills, experience, and currency in aircraft type. In addition, these requirements may be adjusted during FCLP refresher training according to individual performance.

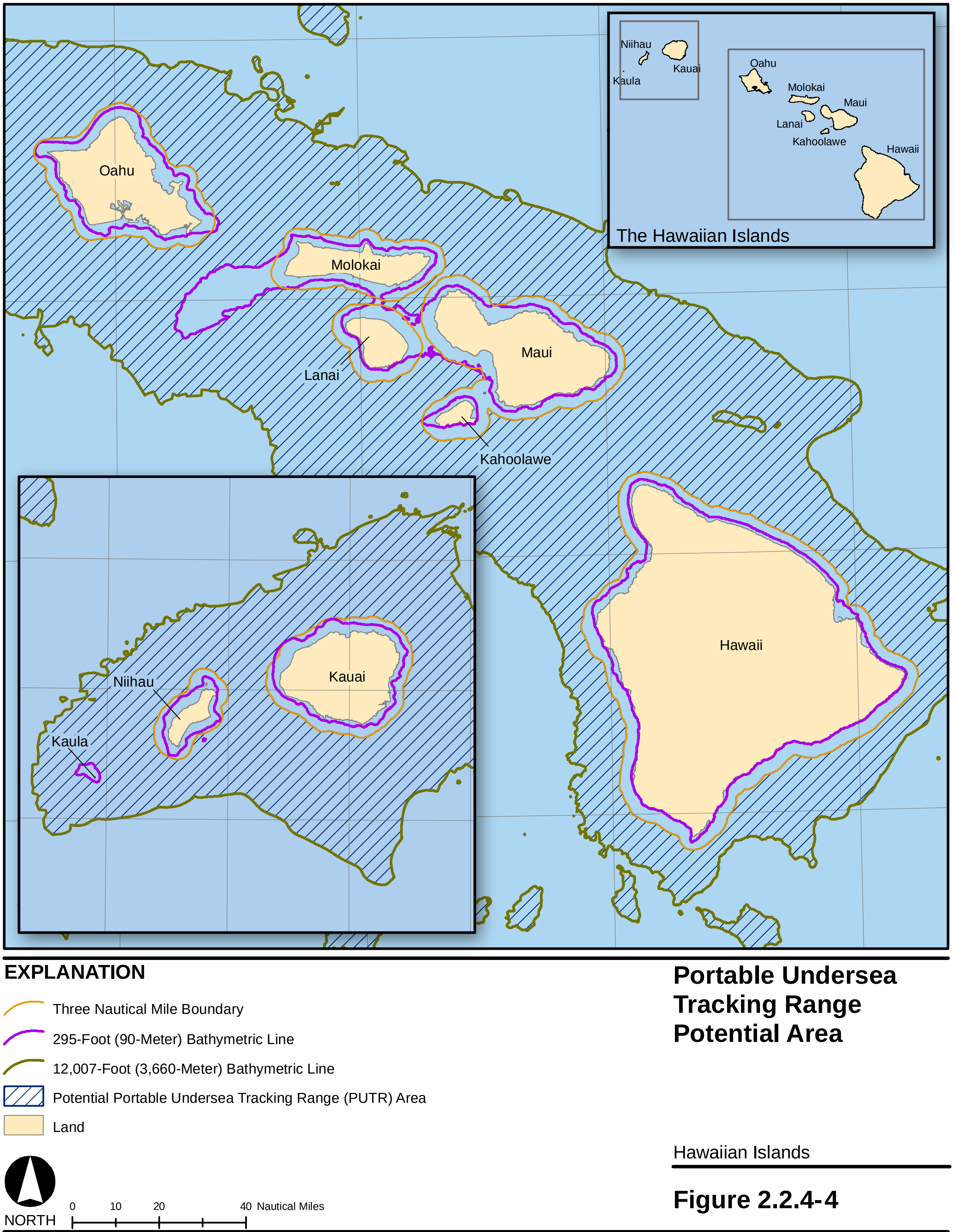
In general, the longer since a pilot's last carrier landing, and the less experience the pilot has, the greater the number of FCLP periods required. Nominally, four FCLP periods would be required per pilot (2 day, 2 night). To accommodate an air wing with half of its pilots not carrier qualified, 160 FCLP periods would be required. This practice would be conducted at Coast Guard Air Station Barbers Point/Kalaeloa Airport, Marine Corps Base Hawaii on Oahu, PMRF Barking Sands airfield on Kauai, and Kona International Airport on Hawaii.

2.2.4.4 Offshore Enhancements

Portable Undersea Tracking Range

The Portable Undersea Tracking Range would be developed to provide submarine training in areas where the ocean depth is between 300 ft and 12,000 ft and at least 3 nm from land. This proposed project would temporarily instrument 25-mi^2 or smaller areas on the seafloor within the area depicted on Figure 2.2.4-4. When training is complete, the Portable Undersea Tracking Range equipment could be recovered to be moved to another location. This tracking system is a modification of the previously used Portable Acoustic Range system. All of these areas have been used for submarine training since World War II. This project allows for better crew feedback and scoring of crew performance during the time allocated for training.

No on-shore construction would take place. Seven electronics packages, each approximately 3 ft long by 2 ft in diameter, would be temporarily installed on the seafloor by a range boat, in water depths greater than 600 ft. The anchors used to keep the electronics packages on the seafloor would be either concrete or sand bags. Operation of this range requires that underwater participants transmit their locations via pingers. Each package consists of a hydrophone that receives pinger signals, and a transducer that sends an acoustic "uplink" of locating data to the range boat. The uplink signal is transmitted at 8.8 kHz, 17 kHz, or 40 kHz, at a source level of 190 dB. The PUTR system also incorporates an underwater voice capability that transmits at 8-11 kHz and a source level of 190 dB. Each of these packages is powered by a D cell alkaline battery. After the end of the battery life, the electronic packages would be recovered and the anchors would remain on the seafloor. The U.S. Navy proposes to use this portable instrumentation system for only 2 days per month in an area beyond 3 mi from shore. Fishermen would not be denied use of this area. Prior to activities in the area, the Coast Guard would be notified and a Notice to Mariners would be issued. If fishermen, boaters, or whales are observed in the area, operations involving weapons training would be stopped or moved to another area.



Portable Undersea Tracking Range Potential Area

Hawaiian Islands

Figure 2.2.4-4

2.2.4.5 PMRF Enhancements

Large Area Tracking Range Upgrade

The Large Area Tracking Range (LATR) provides high fidelity time, space, and position information capability at PMRF. Ground radar and antenna stations detect participating ships and aircraft, relaying this information to PMRF. Currently, only a small portion of the HRC is within range of the existing system. This capability is proposed to be upgraded with ground relay stations to cover training operations throughout much of the HRC. This upgrade would include Pohakuloa Training Area and the Warning Areas south of Oahu to provide seamless tracking within all warning areas, the Island of Hawaii, and throughout every island's offshore area (out to 150 nm). The upgrade of the LATR would expand the fleet training exercise capability by enlarging the training area and involving greater numbers of participants. The proposed ground relay stations would be modifications to existing facilities, and no new construction is expected.

Kingfisher Underwater Training Area

PMRF would also move the simulated underwater minefield used to exercise the Kingfisher mine detection system closer to Niihau (Figure 2.2.4-5). This underwater training area would be approximately 2 mi off the southeast coast of Niihau at a depth of between 300 and 400 ft. This training area had previously been located off the southwest coast of Kauai.

The Kingfisher system would consist of fewer than 20 steel sphere-shaped buoys that are approximately 37 inches in diameter. The buoys would be anchored to the ocean floor by a clump of chain weighing approximately 2,000 lb. A wire rope would be woven through the chain to attach to each buoy, suspending it between 60 and 120 ft from the ocean surface. The clump of chain would occupy an area of approximately 3 ft by 3 ft. The chain may eventually bury itself, depending on the current and the softness of the ocean floor.

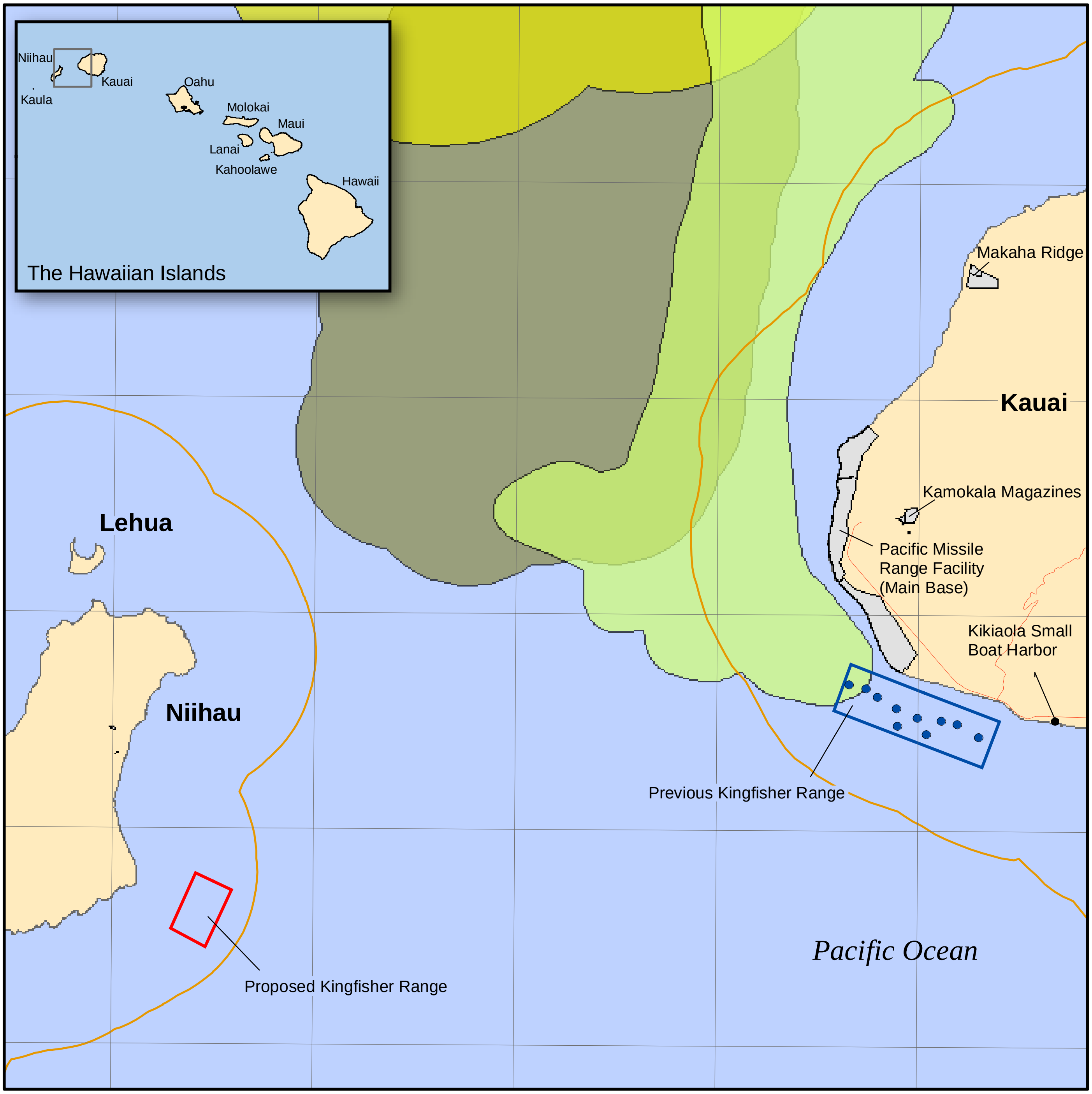
Each buoy would be deployed from a ship in a grid determined by the U.S. Navy. There would be no electronics and no emitters on the buoys.

FORCEnet Antenna

A site would be chosen at Makaha Ridge (Figure 2.2.4-6) or Kokee (Figure 2.2.4-7) to be the location of a FORCEnet integration laboratory. FORCEnet is an effort to integrate military personnel, sensors, networks, command and control, platforms, and weapons into a fully netted, combat force. The site chosen would be an existing building or a portable trailer. This new laboratory would bring a Cooperative Engagement Capability to PMRF. The purpose of the laboratory would be to demonstrate, experiment with, and evaluate emerging hardware and software technologies that support the FORCEnet architecture and standards as part of the U.S. Navy's SEA POWER 21, enhancing the United States' ability to project offensive power, defensive assurance, and operational independence around the globe.

Enhanced Electronic Warfare Training

The PMRF capability for EW training would be enhanced to include sites on other islands (e.g., Maui and Hawaii). EW training is accomplished when EW emitters transmit signals that replicate hostile radars and weapon systems. Ship and aircraft crews attempt to identify the



EXPLANATION

- Kingfisher Mineshape
- Road
- 3-Nautical Mile Boundary
- Previous Kingfisher Range
- Proposed Kingfisher Range
- Barking Sands Tactical Underwater Range (BARSTUR)
- Barking Sands Underwater Range Expansion (BSURE)
- PMRF Shallow Water Training Range (SWTR)
- Installation Area
- Land

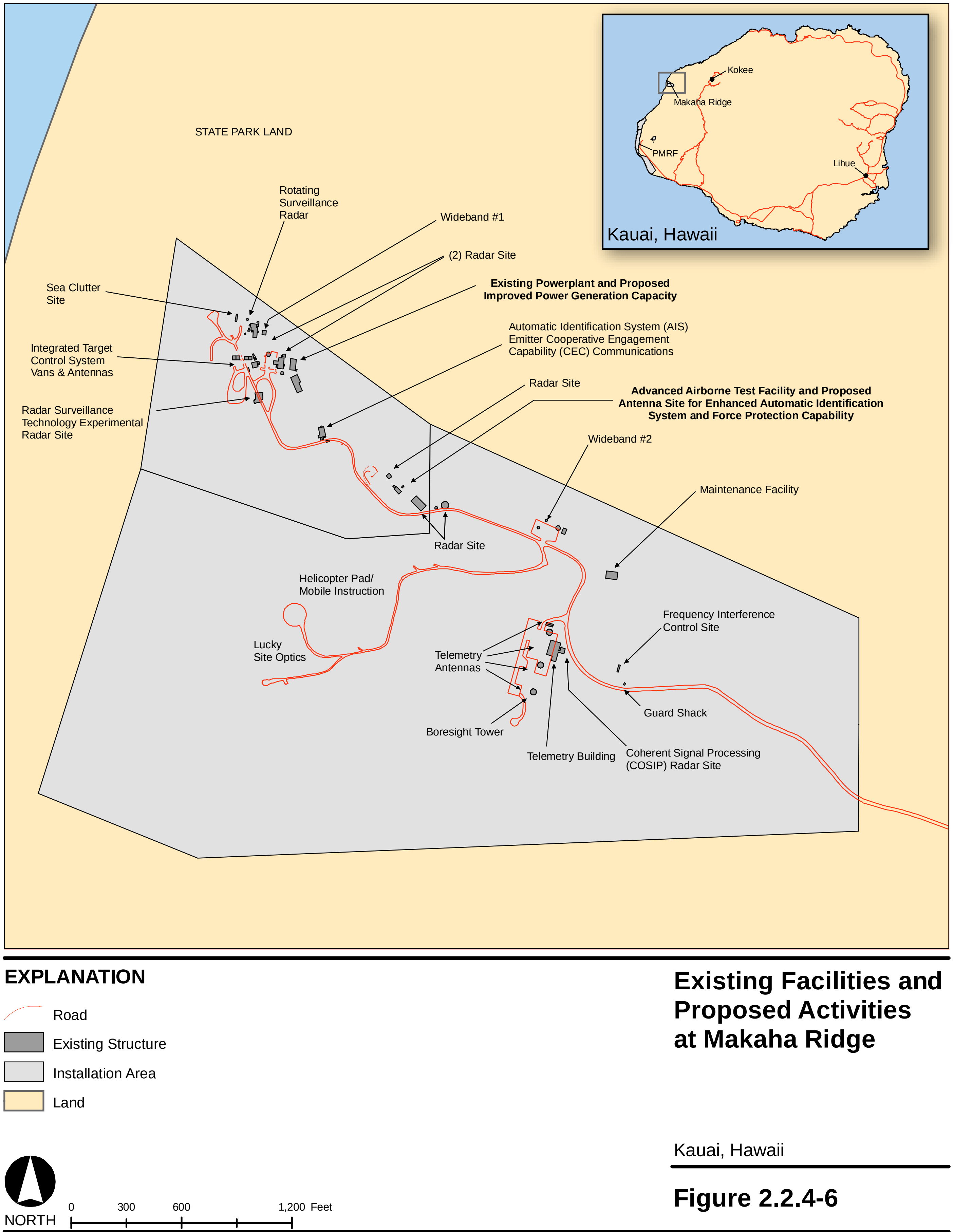
NORTH

0 1 2 4 Nautical Miles

Kingfisher Range

Hawaiian Islands

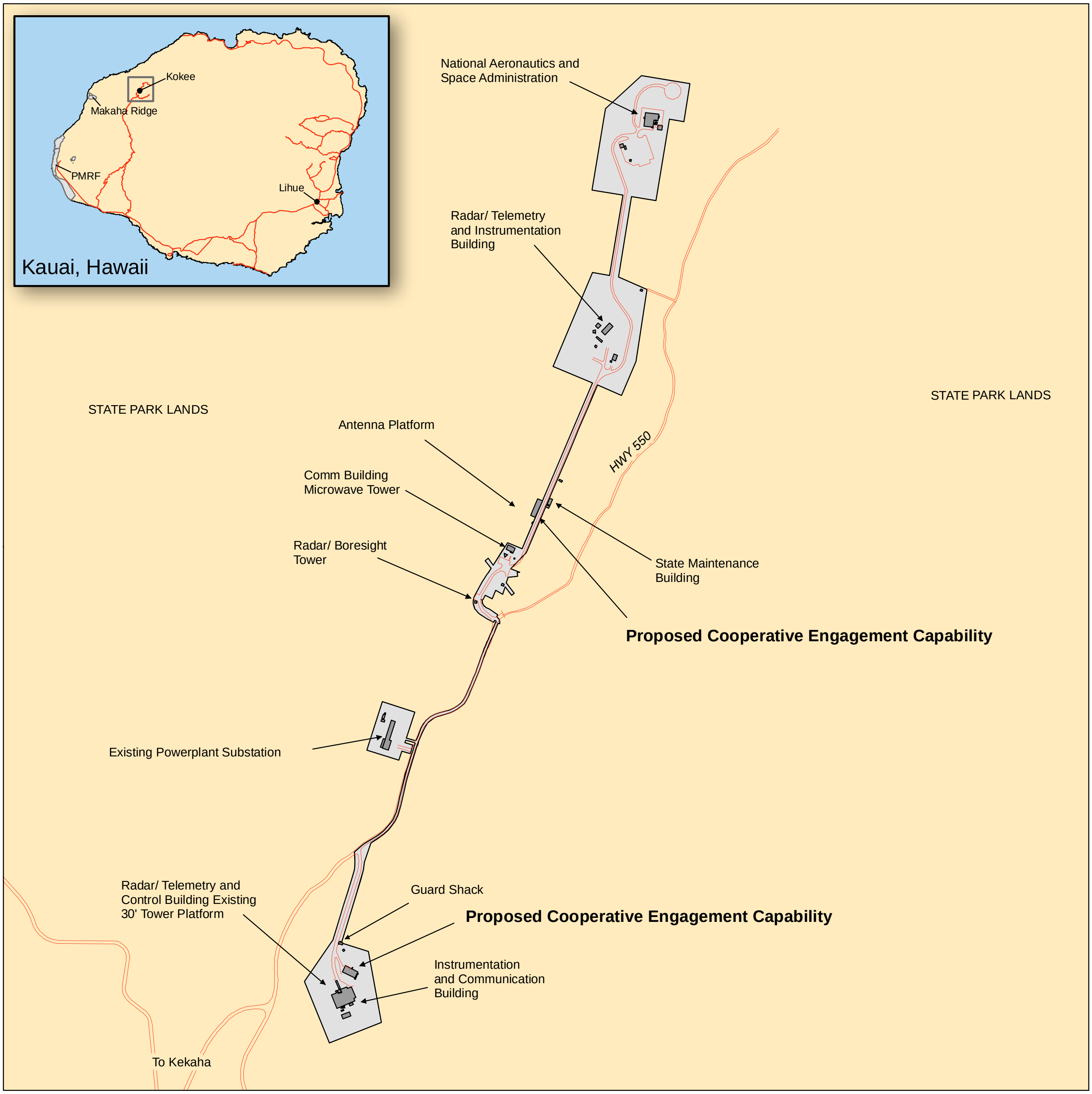
Figure 2.2.4-5



Existing Facilities and Proposed Activities at Makaha Ridge

Kauai, Hawaii

Figure 2.2.4-6



EXPLANATION

Road

Existing Structure

Installation Area

Land

NORTH

0 500 1,000 2,000 Feet

Existing Facilities and Proposed Activities at Kokee Park Radar Facility

Kauai, Hawaii

Figure 2.2.4-7

electronic signals, and react defensively if appropriate. Transmitters could be towers, antennae, or mobile vehicles. Where possible, existing towers would be chosen to incorporate new equipment with minimal modifications needed. If new towers were to be built and operated, follow-on environmental analyses beyond this EIS/OEIS would be required before such activities could occur.

Expanded Training Capability for Transient Air Wings

As part of the Joint National Training Capability, PMRF would provide dedicated equipment to enable Mid-Pacific and transiting strike groups, such as those deployed in Japan, as they go to/from San Diego, California, to participate in either live or virtual exercises. This capability would allow links between Third Fleet and Seventh Fleet to Mid-Pacific to demonstrate group level U.S. Navy Continuous Training Environment. PMRF would be able to participate in major in-port exercises with at-sea assets. No construction would be required.

Enhanced Automatic Identification System and Force Protection Capability

The Automatic Identification System (AIS), (recommended by the Navy in 2001 for Homeland Security) is similar to Identification Friend or Foe (IFF) that aircraft use, except that AIS is designed for use on commercial vessels for Force Protection purposes. These systems automatically report ID, origin, destination, current location, course and speed, intermediate stops, and cargo. AIS equipment would be installed on each island so each ship would have sensor connectivity and communication connections. Antennas would be added to building 720 on Makaha Ridge and to building 282 on PMRF Main Base as part of Alternative 1.

Construct Range Operations Control Building

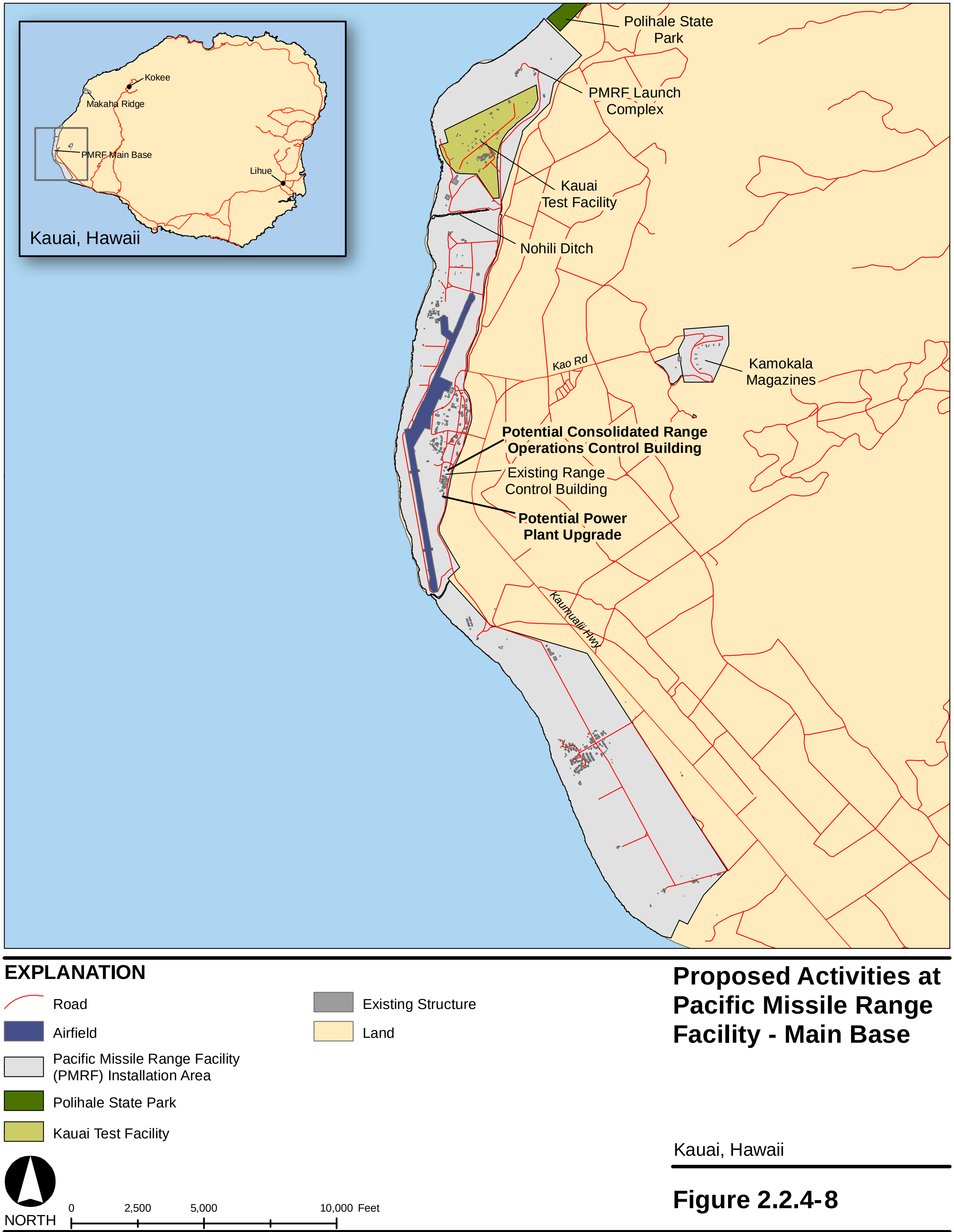
PMRF would build a new range operations building to consolidate the activities currently in 13 buildings. The facility would be almost 90,000 ft^2, and its proposed location on PMRF Main Base is shown in Figure 2.2.4-8.

The project also would include the following:

- Construction of a 4,200 ft^2 dehumidified warehouse to replace building 106, which would be displaced by the proposed Range Operations building
- Construction of a new bore site tower for the Q-1 radar
- Conversion of building 105 annex into an electrical and electronic system laboratory
- Demolition of 13 buildings with a combined floor area of over 45,000 ft^2, as shown in Figure 2.2.4-8
- Construction of antenna supports
- Installation of utilities and parking lots

Improve Fiber Optic Infrastructure

To improve communications and data transmission, PMRF would install fiber optic cable between the Main Base and the sites at Kokee, shown in Figure 2.2.4-7. This project would involve the installation of approximately 23 mi of fiber optic cable, which would be hung on existing Kauai Island Utility Cooperative poles between PMRF/Main Base and Kokee. The



Proposed Activities at Pacific Missile Range Facility - Main Base

Kauai, Hawaii

Figure 2.2.4-8

existing poles run from Kekaha Mill, up a ridge, and intersect Kokee Highway at an existing substation. If exceptionally long spans are encountered, additional poles might need to be installed in some areas. It is expected that all equipment and installation activities would occur along existing public and Kauai Island Utility Cooperative access roads. Prior to implementation, PMRF would coordinate with Kauai Island Utility Cooperative and the local Department of Transportation for approvals.

2.2.4.6 Mobile Diving and Salvage Unit Training Area

The U.S. Navy would establish an underwater training area in which MDSU ONE can conduct military diving and salvage training, including submerging a 100-ft by 50-ft barge. Ultimately, the barge would be placed within a 328- by 328-ft box having the center coordinate of the box centered at the coordinate provided above. The type of training to be conducted would consist of various underwater projects designed to develop mission critical skills, such as, hot tapping, welding, cutting, patching, plugging, drilling, tapping, and grinding. Figure 2.2.4-3 shows the proposed location and an alternative site.

2.2.4.7 Enhanced Cooperative Engagement Capability

A site would be chosen at Makaha Ridge (Figure 2.2.4-6) or Kokee (Figure 2.2.4-7) to be the location of a FORCEnet (an overarching effort to integrate warriors, sensors, networks, command and control, platforms, and weapons into a fully netted, combat force) integration laboratory. The site chosen would be an existing building or a portable trailer. This new laboratory would bring a Cooperative Engagement Capability to PMRF. The purpose of the laboratory would be to demonstrate, experiment with, and evaluate emerging hardware and software technologies that support the FORCEnet architecture and standards as part of the U.S. Navy's SEA POWER 21. SEA POWER 21 defines a U.S. Navy with three fundamental concepts: SEA SHIELD, SEA STRIKE, and the SEA BASE, enabled by FORCEnet. Respectively, they enhance the United States' ability to project offensive power, defensive assurance, and operational independence around the globe.

2.2.4.8 Enhanced Electronic Warfare Training

The PMRF capability for EW training would be enhanced to include sites on other islands (e.g., Molokai, Lanai, Maui, and Hawaii). Towers would hold EW and communication devices that would be used to maintain battlespace awareness. Where possible, existing towers would be chosen to incorporate new equipment. If a new tower should need to be built, coordination with the State Historic Preservation Officer would be initiated if initial surveys indicate potential cultural resources. If remains or artifacts should be discovered during ground-disturbing activities, all activity would be halted until an archaeologist can inspect the site and begin notifications of proper agencies and organizations.

2.2.4.9 Expanded Training Capability for Transient Air Wings

As part of the Joint National Training Capability, PMRF would provide dedicated equipment to enable MIDPAC and transiting CSGs, such as those deployed in Japan, as they go to/from San Diego, California, to participate in either live or virtual exercises. This capability would allow links between Third Fleet and Seventh Fleet to MIDPAC to demonstrate group level U.S. Navy Continuous Training Environment. PMRF would be able to participate in major in-port exercises with at-sea assets. No construction would be required.

2.2.4.10 Field Carrier Landing Practice

Field Carrier Landing Practice (FCLP) would be a series of touch-and-go landings conducted to prepare pilots for aircraft carrier landings. FCLPs would be conducted as day or night periods, each consisting of six to eight touch-and-go landings per pilot. The landings would take place on an airport runway, preferably one marked and lighted to simulated the deck of an aircraft carrier.

2.2.5 MAJOR FLEET EXERCISES

The U.S. Navy proposes to continue RIMPAC and USWEX exercises as described in the No-action Alternative. Under Alternative 1, USWEX frequency would increase from four to six times per year, two strike groups would operate simultaneously such as during a RIMPAC exercise, and FCLPs would occur in association with transiting CSGs. Table 2.2.5-1 shows the matrix of events generally used during a USWEX exercise by location. The activities associated with the exercises would be chosen from the list of training operations in Appendix D of the EIS.

Table 2.2.5-1. Proposed Future RIMPAC Exercise Matrix

Training Events

Service	Location	Island	IN-PORT/ SUPPORTEX	C2	AAW: AIROPS	AAW: S-A MISSILEX	AAW: A-A MISSILEX/ ACM	AAW: A-S MISSILEX	ASUW / ASW: S-S MISSILEX	ASUW / ASW: ASW	MIW: MINEX	MIW: MCM: SMWEX	MIW: MCM: Air MIWEX	MIW: MCM: UMWEX	ASUW: STW, CASEX	ASUW: GUNEX	ASUW: SINKEX	LFX	HAO/NEO	HA/DR	SPECWAROPS	DEMO	SALVAGE OPS	Expeditionary Assault	SUBOPS	OTHER	FCLP
U.S. Navy	Pacific Missile Range Facility*	Kauai																	X		X	X		X			Y
	Niihau	Niihau																	X		X						
	Kaula	Kaula													X												
	Pearl Harbor**	Oahu	X	X	X																X	X	X				
	Iroquois Land/Underwater Range	Oahu																			X	X					
	Puuloa Underwater Range – Pearl Harbor	Oahu																			X	X	X				
	Barbers Point Underwater Range	Oahu																			X	X					
	Coast Guard AS Barbers Point/ Kalaeloa Airport	Oahu			X																X						Y
	PMRF Warning Areas[#]	Ocean Areas				X	X	X	X	X	X				X	X	X				X	X			X		
	Oahu Warning Areas[#]	Ocean Areas				X	X			X						X					X	X			X		
	Open Ocean Areas[#]	Ocean Areas								X		X	X	X							X	X			X	X	X
	U.S. Command Ship	Ocean Areas		X																							
U.S. Marines	Marine Corps Base Hawaii	Oahu		X	X									X					X	X	X			X			Y
	Marine Corps Training Area Bellows	Oahu																	X	X	X			X			
U.S. Air Force	Hickam Air Force Base	Oahu		X	X																X						
U.S. Army	Kahuku Training Area	Oahu																	X	X	X						
	Makua Military Reservation	Oahu																X			X						
	Dillingham Military Reservation	Oahu																			X						
	Wheeler Army Airfield	Oahu		X	X																X						
	K-Pier, Kawaihae	Hawaii																			X			X			
	Bradshaw Army Airfield	Hawaii		X	X																X						
	Pohakuloa Training Area	Hawaii													X			X			X						
State	Keehi Lagoon	Oahu																					X				
	Kona International Airport	Hawaii																									Y

* Includes Port Allen and Makaha Ridge ** Includes Ford Island and all other areas within the harbor.

[#] These areas are included in the HRC. The HRC is now used to define the outer limits of the ocean areas used during major range events.

(X = gray) Locations where events can occur (Y = yellow) Future RIMPAC (Additional Exercises TBD)

Training Events:

A-A MISSILEX	Air-to-Air Missile Exercise (formerly AAMEX)	C2	Command and Control
AAW[1]	Anti-Air Warfare	DEMO	Demolition Exercise
AIROPS	Aircraft Operations	FCLP	Field Carrier Landing Practice
AMPHIBEX	Amphibious Landing Exercise (now Expeditionary Assault)	GUNEX	Gunnery Exercise
Air MIWEX	Air Mine Warfare Exercise (formerly AMWEX)	HA/DR	Humanitarian Assistance/Disaster Relief
A-S MISSILEX	Air-to-Surface Missile Exercise (formerly ASMEX)	HAO/NEO	Humanitarian Assistance Operation/Non-Combatant Evacuation Operation
ASUW[2]/ASW[3]	Anti-Surface Warfare/ Anti-Submarine Warfare Exercise	IN-PORT	In-port Briefings and Activities
		LFX	Live Fire Exercise
ASW	Anti-Submarine Warfare Exercise (formerly ASWEX)	MCM	Mine Countermeasures
CASEX	Close Air Support	MINEX	Mine Exercise
		MIW[4]	Mine Warfare
SALVAGE OPS	Salvage Operations		
S-A MISSILEX	Surface-to-Air Missile Exercise (formerly SAMEX)		
SINKEX	Sink Exercise		
SMWEX	Ship Mine Warfare Exercise		
SPECWAROPS	Special Warfare Operations (NSW Operations?)		
S-S MISSILEX	Surface-to-Surface Missile (formerly SSMEX)		
STW	Strike Warfare Exercise (formerly STWEX)		
SUBOPS	Submarine Operations		
SUPPORTEX	In-Port Support Exercise		
UMWEX	Underwater Mine Warfare Exercise		

Note: Since the publication of the RIMPAC PEA, new terminology and/or categories of exercises have come into use. They are as follows:

[1] **AAW** includes AIROPS, S-A MISSILEX, A-A MISSILEX, and A-S MISSILEX [2] **ASUW** includes GUNEX, S-S MISSILEX, and ASW [3] **ASW** includes S-S MISSILEX and ASW

[4] **MIW** encompasses two subsets, MINEX and MCM. MINEX is the act of laying mines. MCM is the act of locating and countering mining by others and includes SMWEX, AMWEX, and UMWEX.

2.3 ALTERNATIVE 2

2.3.1 ACTIVITIES ASSOCIATED WITH ALTERNATIVE 1

Alternative 2 would include all the activities of Alternative 1 plus an increase in training exercises and RDT&E activities, new RDT&E activities, and additional major range events, as described below. Table 2.3.2-1 shows the number of events proposed for Alternative 2, compared to the baseline and the number of events proposed for Alternative 1.

2.3.2 INCREASED TEMPO AND FREQUENCY OF TRAINING EXERCISES

Under Alternative 2, the Navy proposes to compress the tempo of training exercises in the HRC. For example, instead of an exercise lasting 5 days, the same activities would be completed in 3 days. The frequency of exercises would also be increased.

2.3.3 INCREASED TRAINING OPERATIONS TO SUPPORT FLEET READINESS TRAINING PLAN

The U.S. Navy proposed to increase training events from current levels as necessary in support of the FRTP as shown in Table 2.3.3-1.

Table 2.3.2-1. Baseline, Alternative 1, and Alternative 2 Proposed Training Activities

Mission Area	Events	Area	Baseline (Events/ Year)	Alt. 1 (Events/ Year)	Alt. 2 (Events/ Year)
OFFSHORE ACTIVITIES					
Anti-Air Warfare (AAW)	Air Combat Maneuver	W-188, 189, 190, 192, 193, 194	738	774	814
	Air-to-Air Missile Exercise	W-188	36	41	41
	Surface-to-Air Gunnery Exercise	W-188, 192, Mela South	86	108	108
	Surface-to-Air Missile Exercise	W-188	17	26	26
	Chaff Exercise	Hawaii Offshore	34	34	37
Amphibious Warfare) (AMW)	Naval Surface Fire Support Exercise	W-188	22	28	28
Anti-Surface Warfare (ASUW)	Visit, Board, Search, and Seizure	Hawaii Offshore	60	60	66
	Surface-to-Surface Gunnery Exercise	W-191, 192, 193, 194, 196, Mela South, Pacific Missile Range Facility (PMRF)	69	91	91
	Surface-to-Surface Missile Exercise	PMRF (W-188)	7	12	12
	Air-to-Surface Gunnery Exercise	Hawaii Offshore, PMRF	128	152	152
	Air-to-Surface Missile Exercise	PMRF	36	50	50
	Bombing Exercise (Sea)	Hawaii Offshore, PMRF	35	35	38
	Sink Exercise	Hawaii Offshore, PMRF	6	6	6
	Antisurface Warfare Torpedo Exercise (Submarine-Surface)	Hawaii Offshore, PMRF	35	35	38

Table 2.3.2-1. Baseline, Alternative 1, and Alternative 2 Proposed Training Activities (Continued)

Mission Area	Event	Area	Baseline (Events/ Year)	Alt. 1 (Events/ Year)	Alt. 2 (Events/ Year)
Anti-Submarine Warfare (ASW)	Antisubmarine Warfare Tracking Exercise	Hawaii Offshore, PMRF	372	372	414
	Antisubmarine Warfare Torpedo Exercise	Hawaii Offshore, PMRF	397	397	440
	Major Integrated ASW Training Exercise	Hawaii Offshore, PMRF	5	7	8
Electronic Combat (EC)	Electronic Combat Operations	Hawaii Offshore, PMRF	50	50	55
Mine Warfare (MIW)	Mine Countermeasures Exercise	PMRF, Submarine Operating Area	32	62	62
Naval Special Warfare (NSW)	Swimmer Insertion/Extraction	Hawaii Offshore, Marine Corps Training Area–Bellows (MCTAB), PMRF	80	80	88
Strike Warfare (STW)	Bombing Exercise (Land)	Kaula Rock	97	139	139
	Air-to-ground Gunnery Exercise	Kaula Rock	16	18	18
Other	Command and Control (C2)	U.S. Command Ship at sea	1	1	2
NEARSHORE ACTIVITIES					
AMW	Expeditionary Assault	PMRF, MCTAB	11	11	12
ASUW	Flare Exercise	W-188	6	6	7
MIW	Mine Neutralization	Puuloa Underwater Range	62	62	68
	Mine Laying	PMRF	22	32	32
NSW	Swimmer Insertion/Extraction	Hawaii Offshore, MCTAB, PMRF	52	52	57
Other	Salvage Operations	Pearl Harbor, Puuloa Underwater Range, Keehi Lagoon, Eastern Naval Defense Sea Area	1	1	1
	In Port Ship Support Operations	Pearl Harbor	1	1	1

Table 2.3.3-2. Baseline, Alternative 1, and Alternative 2 Proposed RDT&E Activities

Mission Area	Event	Area	Baseline (Events/ Year)	Alt. 1 (Events/ Year)	Alt. 2 (Events/ Year)
RDT&E	Anti-air Warfare Research, development, Test and Evaluation (RDT&E)	Pacific Missile Range Facility (PMRF)	35	40	44
	Antisubmarine Warfare	PMRF	19	21	23
	Combat System Ship Qualification Trial	PMRF	7	8	9
	Electronic Combat/Electronic Warfare	PMRF	65	72	80
	High Frequency	PMRF	9	10	11
	Joint Task Force Wide Area Relay Network	PMRF	2	3	4
	Missile Defense	PMRF	40	40	44
	Science & Technology / Other	PMRF	22	24	26
	Terminal High Altitude Area Defense	PMRF	6	6	6
	Fleet Operational Readiness Accuracy Check Site (FORACS) Tests	FORACS	5	5	6
	Shipboard Electronic Systems Evaluation Facility (SESEF) Quick Look Tests	SESEF / Pearl Harbor	3,842	4,225	4,225
	SESEF System Performance Tests	SESEF	67	74	74

Sources: FACSFAC Pearl Harbor Annual Report FY 2003, SESEF FY03 Test Data Summary, FORACS BRAC Data Call, EODMU-3 Det MIDPAC OIC

2.3.4 ADDITIONAL RDT&E ACTIVITIES

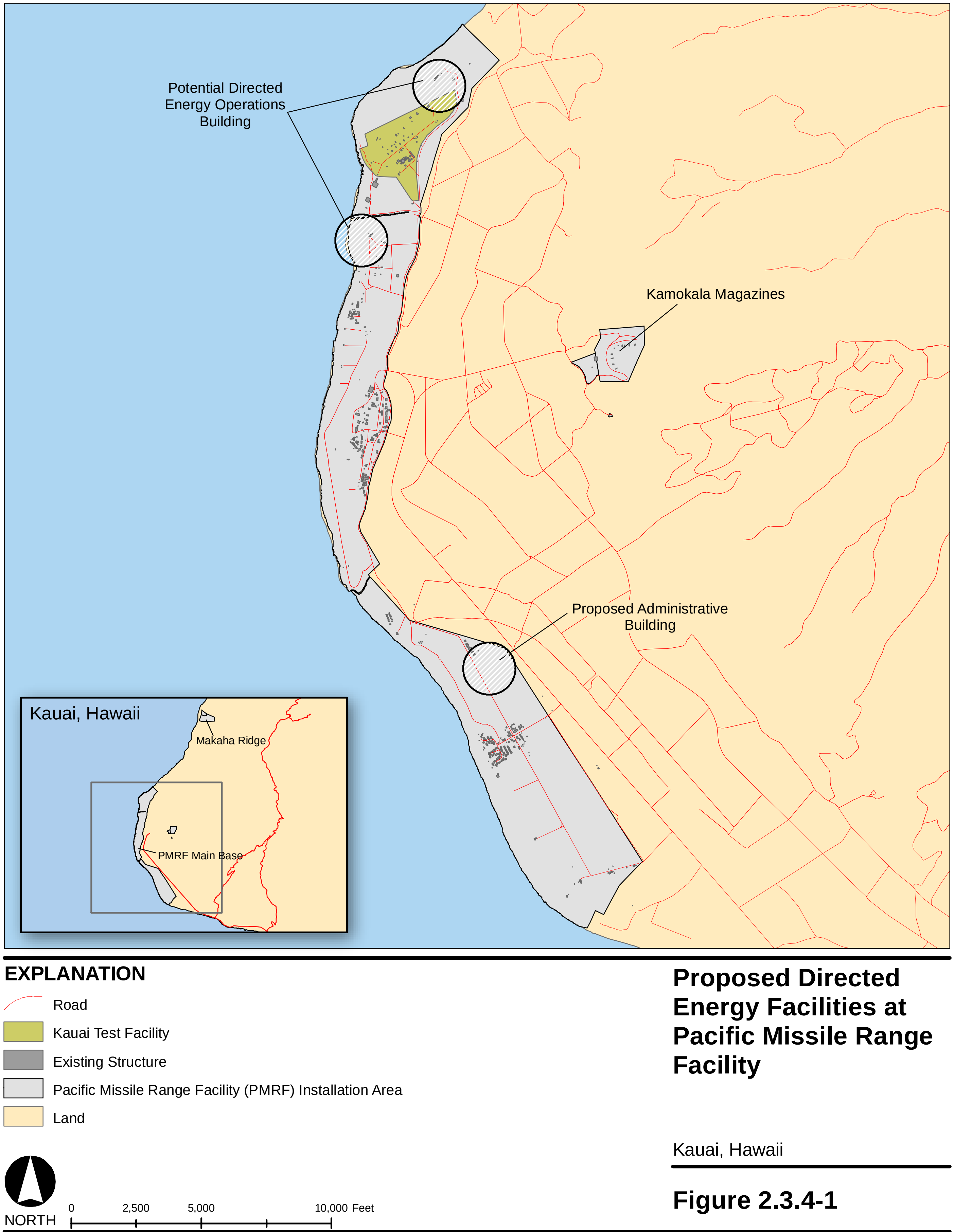
PMRF would develop the capability to support the following programs.

Directed Energy

Naval Sea Systems Command (NAVSEA) could establish a long-term support facility, the Maritime Directed Energy Test Center, at PMRF for directed energy programs, such as the High Energy Laser.

The high energy laser would require a permanent operations building with approximately 25,000 ft^2. Figure 2.3.4-1 shows the proposed location. During testing, the range would need to be cleared. Up to four air targets and up to four surface targets would be needed for testing. The laser would require 30 megawatts of power. Up to 100 personnel would support this program. Should NAVSEA decide to build and operate the Maritime Directed Energy Test Center, separate environmental documentation would be required to analyze the specific location and operational requirements.

PMRF would add the capability to test non-eye-safe lasers. These types of lasers are associated with the Hellfire system and the GQM-163 Coyote. The range could also be used to support Airborne Laser program testing. The Airborne Laser aircraft would stage out of Hickam AFB on Oahu. The chemicals for operating the laser onboard the aircraft would be transported to Oahu by ship and would be stored at Hickam AFB. Should the Airborne Laser program decide to perform testing at PMRF, separate environmental documentation would be required to analyze the specific operational requirements.



Proposed Directed Energy Facilities at Pacific Missile Range Facility

Kauai, Hawaii

Figure 2.3.4-1

The following PMRF assets would be available to support any future laser testing:

- Numerous tracking sensors at Makaha Ridge
- Fleet assets (air, surface, subsurface, strategic) for open range testing
- Hawaiian Surveillance Network programs on Kauai, Maui, Hawaii, and Niihau
- Supercomputer center at Kihei, Maui, to support operational analyses

Advanced Hypervelocity Weapon

The Advanced Hypervelocity Weapon is a U.S. Army Space and Missile Defense Command RDT&E program that would eventually involve launches of long range (greater than 3,400 mi) missiles deploying an unpowered payload. This is proposed to be a four-missile launch program, with the first two tests using a Strategic Target System booster launched from the KTF at PMRF (Figure 2.1.2-4). The payload would travel a distance of approximately 2,500 mi from PMRF to Illeginni Island in USAKA. The first test is scheduled in the spring of 2008, and the second test would occur between 6 and 12 months later, again using a Strategic Target System following the same flight path. The third test would be approximately 1 year later and would use a Orion 50S XLG first stage and Orion 50 XL second stage launched from the same pad, with the payload that would fly to Farallon de Medinilla in the Marianas Islands, approximately 3,700 mi away. The fourth test from the same launch site would again use Orion 50S XLG and Orion 50 XL boosters. Launches would average one per year. There are no fuels or hypergolics on the payloads, and they would all impact on land.

The Orion 50S XLG contains 33,105 lb of propellant, and the Orion 50 XL contains 8,655 lb of propellant. The composition of the propellant is similar to that of the Strategic Target System. The modified 10,000-ft ground hazard area would be used for both systems. The explosive safety quantity-distance (ESQD) for the Orion system would be smaller than the current Strategic Target System because the Strategic Target System second stage is Class 1.1 propellant and the Orion system is all Class 1.3 propellant.

2.3.5 ADDITIONAL MAJOR RANGE EVENTS – MULTIPLE CARRIER STRIKE GROUP TRAINING

Up to three CSGs would be allowed to conduct training exercises simultaneously in the HRC (Figure 1.2-1). The CSGs would not be home ported in Hawaii, but would stop in Hawaii enroute to a final destination. The CSGs would be in Hawaii for up to 30 days per exercise.

The exercise would involve U.S. Navy assets engaging in a free play battle scenario, with U.S. forces pitted against an opposition force. The exercise provides realistic training on in-theater operations utilizing previous training skill sets and thus maintains and improves upon the level of proficiency needed for a deployment-ready unit. Proposed exercise activities would be similar to current exercise activities currently used for RIMPAC and USWEX exercises. Also included in the training activities would be field carrier landing practice to be conducted at the following airfields: These exercises could have as many as 260 aircraft, supported at Hickam AFB, Coast Guard Air Station Barbers Point/Kalaeloa Airport, Marine Corps Base Hawaii, Wheeler Army Airfield on Oahu, Bradshaw Army Airfield, Kona International Airport on Hawaii, and PMRF Barking Sands airfield on Kauai.

The proposed exercise would provide U.S. Navy personnel realistic maritime training in a complex three CSG scenario in a Joint environment that replicates the types of challenges that could be faced during real-world operations. Training would be provided to submarine, ship, and aircraft crews in tactics, techniques, and procedures for ASW, Defensive Counter Air, Maritime Interdiction, and operational level C2 of maritime forces. Table 2.3.5-1 shows the matrix of events proposed for multiple CSG training.

Table 2.3.5-1. Proposed Multiple Carrier Strike Group Matrix

Training Events

Service	Location	Island	IN-PORT/ SUPPORTEX	C2	AAW				ASUW / ASW		MIW				ASUW			LFX	HAO/NEO	HA/DR	SPECWAROPS	DEMO	SALVAGE OPS	Expeditionary Assault	SUBOPS	OTHER
					AIROPS	S-A MISSILEX	A-A MISSILEX/ ACM	A-S MISSILEX	S-S MISSILEX	ASW	MINEX	MCM			STW, CASEX	GUNEX	SINKEX									
												SMWEX	Air MIWEX	UMWEX												
U.S. Navy	Pacific Missile Range Facility*	Kauai																								
	Niihau	Niihau																								
	Kaula	Kaula																								
	Pearl Harbor**	Oahu																								
	Iroquois Land/Underwater Range	Oahu																								
	Puuloa Underwater Range – Pearl Harbor	Oahu																								
	Barbers Point Underwater Range	Oahu																								
	Coast Guard AS Barbers Point/Kalaeloa Airport	Oahu																								
	PMRF Warning Areas[#]	Ocean Areas																								
	Oahu Warning Areas[#]	Ocean Areas																								
	Open Ocean Areas[#]	Ocean Areas																								
	U.S. Command Ship	Ocean Areas																								
U.S. Marines	Marine Corps Base Hawaii	Oahu																								
	Marine Corps Training Area Bellows	Oahu																								
U.S. Air Force	Hickam Air Force Base	Oahu																								
U.S. Army	Kahuku Training Area	Oahu																								
	Makua Military Reservation	Oahu																								
	Dillingham Military Reservation	Oahu																								
	Wheeler Army Airfield	Oahu																								
	K-Pier, Kawaihae	Hawaii																								
	Bradshaw Army Airfield	Hawaii																								
	Pohakuloa Training Area	Hawaii																								
State	Keehi Lagoon	Oahu																								

* Includes Port Allen and Makaha Ridge

** Includes Ford Island and all other areas within the harbor.

[#] These areas are included in the HRC. The HRC is now used to define the outer limits of the ocean areas used during major range events.

Locations where events can occur

Multiple Carrier Strike Group

Training Events:

A-A MISSILEX	Air-to-Air Missile Exercise (formerly AAMEX)
AAW[1]	Anti-Air Warfare
AIROPS	Aircraft Operations
AMPHIBEX	Amphibious Landing Exercise (now Expeditionary Assault)
Air MIWEX	Air Mine Warfare Exercise (formerly AMWEX)
A-S MISSILEX	Air-to-Surface Missile Exercise (formerly ASMEX)
ASUW[2]/ASW[3]	Anti-Surface Warfare/ Anti-Submarine Warfare Exercise
ASW	Anti-Submarine Warfare Exercise (formerly ASWEX)
CASEX	Close Air Support
C2	Command and Control
DEMO	Demolition Exercise
GUNEX	Gunnery Exercise
HA/DR	Humanitarian Assistance/Disaster Relief
HAO/NEO	Humanitarian Assistance Operation/ Non-Combatant Evacuation Operation
IN-PORT	In-port Briefings and Activities
LFX	Live Fire Exercise
MCM	Mine Countermeasures
MINEX	Mine Exercise
MIW[4]	Mine Warfare
SALVAGE OPS	Salvage Operations
SAMEX	Surface-to-Air Missile Exercise (now S-A MISSILEX)
SINKEX	Sinking Exercise
SMWEX	Ship Mine Warfare Exercise
SPECWAROPS	Special Warfare Operations (NSW Operations?)
SSMEX	Surface-to-Surface Missile (now S-S MISSILEX)
STWEX	Strike Warfare Exercise
SUBOPS	Submarine Operations
SUPPORTEX	In-Port Support Exercise
UMWEX	Underwater Mine Warfare Exercise

Note: Since the publication of the RIMPAC PEA, new terminology and/or categories of exercises have come into use. They are as follows:

[1] AAW includes AIROPS, S-A MISSILEX, A-A MISSILEX, and A-S MISSILEX

[2] ASUW includes GUNEX, S-S MISSILEX, and ASW

[3] ASW includes S-S MISSILEX and ASW

[4] MIW encompasses two subsets, MINEX and MCM. MINEX is the act of laying mines. MCM is the act of locating and countering mining by others and includes SMWEX, AMWEX, and UMWEX.

3.0 EXISTING HABITAT CONDITIONS

The existing habitat information and citations provided below comes from the *Marine Resources Assessment for the Hawaiian Islands Operating Area* (Navy 2005), with additional technical information and changes incorporated throughout this section.

Marine ecosystems in Hawaiian waters are diverse and extensive; they extend offshore to a depth of 5,000 m and inland to include coastal marine anchialine ponds (Maragos 1998). The Hawaiian Islands have three distinct types of volcanic islands: young (the largest), mature, and drowned (atolls and seamounts). The distribution of marine ecosystems is determined by island age, reef growth, wave exposure, depth (which affects light and temperature), and latitude. This dynamic geology yields a diverse array of habitats; most harbor large communities of macroflora, corals, invertebrates, and pelagic life. Anchialine ponds and tidepools occur on rocky shorelines; small beaches occur around bays and coves (Maragos 1998). Mature volcanic islands have undergone extensive weathering and erosion and typically have eroded slopes, broad, gently sloping coastal plains, numerous streams and estuaries, sandy beaches, fringing reefs, and, occasionally, barrier reefs. Lagoons provide protected environments for the development of unique coral “patch” and “pinnacle” reefs (Maragos 1998). Rocky beaches are also present, especially along the north and south coasts that experience heavy wave exposure; seagrasses, mangroves (introduced flora), and coral reef flats are common in the nearshore waters of protected shorelines. Eventually the Hawaiian Islands will subside and in some cases an atoll will form from surrounding corals that grow fast enough to compensate for the rate of sinking. An atoll reef, the coastal perimeter of a drowned volcanic island, encloses protected waters to form a lagoon that is connected to the open ocean by passes cut through the reef. Sometimes benches are present and reef flats are very common. Guyots (sunken atolls that become flat-topped seamounts) and other seamounts provide important habitat for fisheries and precious corals (Maragos 1998). As these ancient islands moved to the northwest, the spores of marine plants and larvae of corals, fishes, and other marine animals drifted to colonize the younger islands. This process fostered the evolution of marine species in the region over millions of years. The Hawaiian Islands has the highest reported endemism among marine ecosystems from any tropical archipelago in the Pacific and perhaps in the world (Maragos 1998).

3.1 MARINE AND ESTUARINE WETLANDS

Wetlands can be subdivided into five major systems: marine, estuarine, riverine, lacustrine (lake), and palustrine (freshwater marsh) (Cowardin et al. 1979). Of these five major categories, only the marine and estuarine systems are relevant to the Hawaiian Islands OPAREA. These areas are subject to tidal influence, characterized by strong salinity gradients, and include tidal salt marshes, mudflats, salt flats, mangroves, seagrass beds, and coastal lagoons (MMS 2001). For all marine and estuarine wetlands, salinity varies with season, time, precipitation, location, and water depth. The USFWS defines wetlands as having one or more of three attributes: 1) the area supports predominantly hydrophytes, at least periodically; 2) the substrate is predominantly undrained hydric soil; and 3) the substrate is nonsoil and is saturated with water or submerged by shallow water at some time during the growing season of each year (Cowardin et al. 1979).

Wetlands form the transition zone between terrestrial and marine systems; because of this, they help to prevent shoreline erosion, reduce flood damage, and improve water quality (Carlisle et al. 2002). For example, pollutants from terrestrial runoff are filtered through wetlands where 1) particulates settle to the substrate; 2) excessive nutrients (i.e., the nitrogen and phosphorous found in fertilizers) are taken-up by vegetation and microorganisms (Bertness 1999); 3) contaminants are bound and broken down; 4) excess carbon from the burning of fossil fuels is absorbed; and 5) nitrogen and sulfur are re-cycled (Mendelssohn 1979). In addition, estuarine and marine wetlands are among the most productive natural systems on earth, capable of producing more food per acre than the richest farmland (RAE/ERF 1999). They support essential habitat for 80% of the world's fish and shellfish species and provide feeding, nesting, shelter, high tide refuge, spawning grounds, nursery habitat, and other benefits for thousands of commercially and recreationally important fish, birds, mammals, and invertebrates. Per unit surface area, wetlands are more diverse than any other marine habitat (Bertness 1999).

The tidal range in the Hawaiian Islands is less than 1 m (Maragos 1998) creating a narrow nearshore environment in most areas. However, due to the variability within the habitats, biodiversity is high throughout the nearshore zone (Thurman 1997). Three types of marine and estuarine wetlands occur in the main Hawaiian Islands (MHI): a large embayment at Pearl Harbor, Oahu; stream mouths on all major islands; and locations of coastal groundwater discharge such as those surrounding Hawaii (Maragos 1998). Wetlands are generally confined to portions of the higher islands with floodplains or coastal plains (Meier et al. 1993). The floors of embayments and stream-mouth estuaries are sediment covered; groundwater estuaries are sometimes rocky. Over 450 significant wetlands have been identified throughout the islands (Meier et al. 1993). Marine and estuarine wetland environments located within the Hawaiian Islands OPAREA and vicinity include fishpond and harbor, lagoon, seagrass, mangrove, mudflat, and rocky and sandy intertidal habitats (Figure 3-1). Within the Hawaiian Islands OPAREA, there are two areas of important marine and estuarine wetlands, mangrove, and mudflat habitats: Mamala Bay and Pearl Harbor on the south coast of Oahu and Kaneohe Bay on the northern coast of Oahu. Further discussion of these habitats can be found within this section.

Prior to human intervention in the Hawaiian Islands, marine and estuarine wetlands had few species of vascular plants. Seagrasses, *Ruppia maritima* and *Halophilia hawaiiana*, could be found subtidally and herbaceous plants such as *Susuvium portulacastrum*, *Heliotropium curassacvicum*, and *Lycium sandwicense* occurred in the upper intertidal zone; the bulk of the intertidal zone was primarily inhabited by algal and fungi flora. These historic marine and estuarine wetlands have since been heavily modified (Allen 1998). Presently, common animals that occur in the Hawaiian Islands marine and estuarine wetland habitats include crabs, shrimps, mollusks, mullets (Mugil), endemic flagtails, āhelehole (*Kuhlia sandwichensis*), anchovies, small jacks, barracudas, and eels (Maragos 1998). Some juvenile jacks, *Caranx ignobilis* and *Caranax melampygus* (which supported a fishery value of $14,400 in 1998), occupy estuarine wetlands opportunistically before moving to nearshore marine wetlands (Smith and Parrish 2002). Five endemic and endangered species of waterbirds including the Hawaiian Stilt or āeʻo (*Himantopus mexicanus knudseni*), Hawaiian duck or koloa (*Anas wyvilliana*), Laysan duck (*Anas laysanensis*), Hawaiian Gallinule (*Gallinula chloropus sandvicensis*), and Hawaiian Coot (*Fulica americana alai*) rely heavily on marine and estuarine wetlands for foraging, nesting, and resting (Maragos 1998, 2000).

In the Hawaiian Islands, wetland loss has occurred via many different means. Many low-lying coastal marshes were walled and modified to create ponds called loʻi for taro cultivation (Meier et al. 1993). During the previous century, sugar cane and pineapple agriculture caused many coastal ponds and marshes to be buried or drained. Coastal wetlands were filled for ranching and livestock that in turn increased soil erosion (Meier et al. 1993). In addition, rice farming, harbor and port construction, housing and civil works projects, and stream diversion has resulted in a major loss or modification of wetland habitat (Meier et al. 1993).

In the State of Hawaii, wetlands are managed by one federal, several state, and two county agencies. The USFWS is responsible for National Wildlife Refuges (NWR) while the Department of Land and Natural Resources is responsible for state refuges including wetlands and Natural Area Reserves (Meier et al. 1993). For additional information regarding marine and coastal protected areas in the Hawaiian Islands OPAREA refer to Section 3.11.

Mamala Bay—Mamala Bay is a coastal indentation extending a distance of approximately 30 km along the southern shoreline of Oahu in the Hawaiian Islands, from Diamond Head in the east to Barbers Point in the west (Laws et al. 1999). Maintenance of high water quality is a particularly sensitive issue in an area such as Mamala Bay, with currently receives wastewater in the form of primary treated sewage from a population of roughly 750,000 persons (Laws et al. 1999). Mamala Bay and its tributaries receive 100 to 300 x 10^6 cubic meters per year (m^3/yr) of land runoff/groundwater seepage and 150 x 106 m^3/yr of treated sewage effluent (Laws et al. 1999). However, water quality in the bay is good because nonpoint source discharge enters either estuaries or harbors which function as buffer zones. Also, the principal point source discharges are located in deep water and the coastal current system has a strong exchange with the offshore ocean (Laws et al. 1999).

Kaneohe Bay—Kaneohe Bay is located on windward Oahu; ten major named stream systems empty into the bay encompassing a watershed approximately 10,300 hectare (ha) in size (Englund et al. 2003). The Kaneohe Bay ecosystem consists of the watershed, the bay itself, the protecting barrier reef, and the nearshore oceanic environment. The three major physiographic marine zones of Kaneohe Bay are the inshore, inner bay, and outer bay. The inshore zone consists of the intertidal zone along the shoreline and the fringing reef. The inner bay zone consists of the lagoon and patch reefs; the lagoon is generally divided into southeast, central, and northwest sectors. The outer bay consists primarily of the barrier reef complex and the two channels bisecting the reef. The offshore portion comprises 34% of the total bay area. It consists almost entirely of an extensive shallow coral and sand reef 0.3 to 1.2 m in depth. In the central section, live coral, small-sized coral rubble, coarse coral sand, and volcanic rock are found (Englund et al. 2003).

Kaneohe Bay offers a diverse array of habitats for marine organisms, ranging from inter-tidal to deep-sea within only a few kilometers. Although natural shoreline areas consisting of beaches, stream mouth deltas, and promontories are still found along Kaneohe Bay, much of the bay's shoreline has been heavily modified. Agriculture, urbanization, and streambed channels have increased freshwater runoff rates causing sedimentation and pollution; the introduction of mangroves has also modified the shoreline environment.

Benthic habitats in Kaneohe Bay are found in upper, middle, and lower intertidal zones along the coast. Shorelines have small sandy beaches, rocky shores, mud flats, and mangrove swamps, and many of these areas are affected by estuarine conditions (Englund et al. 2003). In the subtidal regions of the bay, organisms live on live coral reefs as well as in dead coral and coral rubble areas. Sandy and muddy areas of the lagoon floor along with hardbottom areas of limestone and lithified sand dunes in the bay also provide habitats with

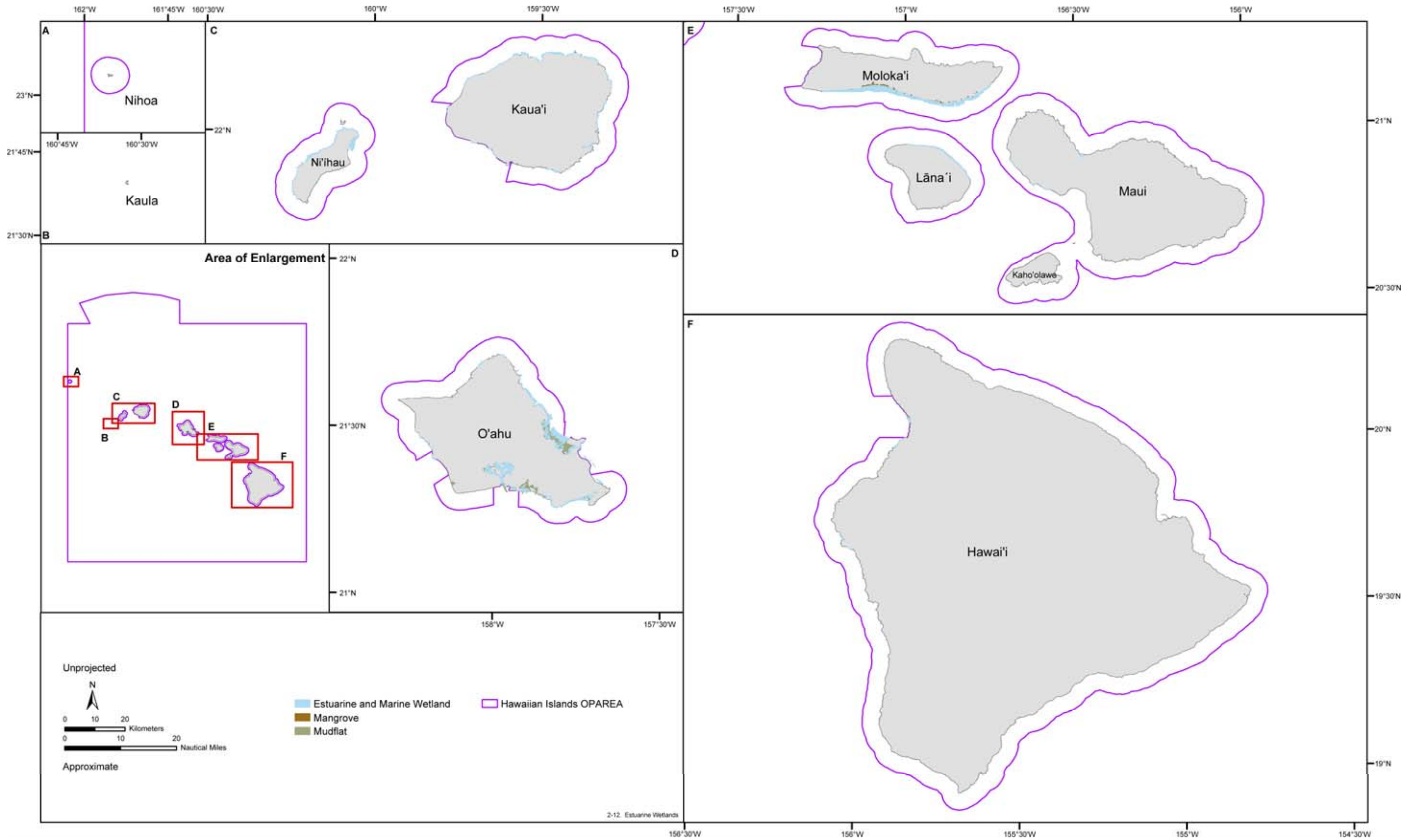


Figure 3-1. Estuarine and marine wetland, mangrove, and mudflat habitat distribution in the Hawaiian Islands OPAREA and vicinity. Source data: NOS (2001), NOAA (2003), State of Hawaii, Office of Planning (2005), and USFWS (2005).

organisms living both in as well as on top of the bottom substrates. Sand dwellers (e.g., acorn worms, auger shells, box crabs, alpheid shrimp, the lampshell, and clams) frequently burrow into the substrate (Englund et al. 2003). *Halophila* or turtle grass is also found growing in sandy areas, especially on parts of the sand bar. The commercially valuable black-lipped pearl oyster (*Pinctada margaritifera*), once abundant in Kaneohe Bay, is now protected from harvest (Englund et al. 2003). *Lingula reevii*, a brachiopod endemic to the Hawaiian Islands, is literally a living fossil remaining essentially unmodified for 350 to 400 million years (Emig 1987). *Eucheuma spinosum* or tambalang, a red alga, and *Opheodesoma spectabilis*, a giant non-burrowing sea cucumber, are found almost exclusively in Kaneohe Bay (Englund et al. 2003).

The interrelated influences of tides, circulation, bathymetry, wave action, and water quality produce an infinitely varied set of vertically and horizontally arranged habitats. Vertical and horizontal distribution of marine organisms reflects corresponding changes in the environment. Pelagic organisms in Kaneohe Bay include large fish such as ulua and papio, aku, hammerhead sharks, halfbeak and needlenose fish, Hawaiian green sea turtles, and occasionally Pacific bottlenose dolphins. Kaneohe Bay is also a pupping ground for the scalloped hammerhead shark, *Sphyrna zygaena* or mano kihikihi (Clarke 1971).

Offshore and oceanic waters outside of Kaneohe Bay support large schools of aku and mahi mahi; occasionally humpback whales are seen during winter months. The first specimen of a previously unknown shark, "Megamouth", was also captured offshore of Kaneohe Bay at a depth of approximately 150 m (Englund et al. 2003).

3.1.1 FISHPONDS AND HARBORS

Fishponds are ancient structures that still exist along many of the island shorelines (Figure 3-2). These structures were typically built in embayments, on reef flats, or over submarine springs. Fishponds allow fish to become trapped while at the same time tidal flows replenish nutrients through gates in fishpond walls (Maragos 1998). Fishponds are significant natural resources that provide nurseries for fish stocks and foraging areas for endangered waterbirds. Fishponds are currently being overgrown by invasive mangroves; their root systems are gradually destroying the walls of the ancient structures (DoN 2001c). Similar to fishponds, harbors are generally constructed in areas sheltered from strong waves. Harbors attract fish, sediment-adapted biota, and rocky intertidal organisms (Maragos 1998). Plants commonly found in fishpond and harbor habitats include rock-dwelling algae and *limu* (seaweeds); animals commonly found in fishpond and harbor habitats include mullet, *moi*, anchovies, crabs, shrimps, clams, and oysters (Maragos 1998). Within the Hawaiian Islands OPAREA there are numerous fishponds located in Mamala Bay and Pearl Harbor on the southern coast of Oahu, five on the northern coast of Oahu in and around Kaneohe Bay, and three on the southwestern coast of Kauai (Figure 3-2).

Pearl Harbor—Pearl Harbor is a type C estuary, with an area of 20.1 km^2 and a mean tidal range of 0.37 m (Laws et al. 1999). There are a total of 187.7 ha of wetlands in the Pearl Harbor area (DoN 2001b). The wetlands provide a variety of vital functions in the natural environment, including endangered waterbird habitat, juvenile fish habitat, natural treatment/purification of upland runoff, wetland agriculture, and important cultural and aesthetic value (DoN 2001b). Pearl Harbor encompasses approximately 2,024 ha of permanently submerged soft sea floor habitat (e.g., mud and sand) that acts as a sink or repository for chemicals entering the harbor (DoN 2001b). As an estuary, Pearl Harbor has received pollutant inputs from many sources over the years, including industrial, urban, and agricultural activities in surrounding lands, thermal, and sewage discharges. Most of the pollutants are sequestered in the bottom sediments, which are also the natural habitat for many types of marine life. Among the many fishponds in the Hawaiian Islands, there are four significant Hawaiian fishponds located within the Pearl Harbor region: Loko Laulaunui, Loko Paʻaiau, Loko Okiʻokiolepe, and Loko Pamoku (DoN 2001b). However, due to existing contamination of harbor sediments, fish consumption is not appropriate in these fishponds.

Wetland areas adjacent to Pearl Harbor include mudflats, shallow ponds, small streams, pickleweed beds, kiawe forests, cattails, and watercress; these wetlands provide habitat for waterbirds including the endangered Black-necked Stilt, Hawaiian Coot, Common Moorhen, and Hawaiian Duck. Wetlands along the coastline also provide a nursery for a number of fish species that utilize the brackish water areas during their life cycle (DoN 2001b). Before the rapid expansion of mangrove, pickleweed was the most abundant vegetation type in the Pearl Harbor area. Pickleweed forms a thick mat that may be 1 m high in places. Pickleweed prefers the same physiographic areas as mangroves; however, the taller mangroves rapidly shade it out. Currently, there are only a few remnant patches of pickleweed around Pearl Harbor (DoN 2001b). A Kiawe (*Prosopis pallida*) forest habitat is located within the floor of the Makalapa Crater and on fossilized coral outcrop areas of NAVMAG Pearl Harbor West Loch Branch and lower Waipio Peninsula. The Kiawe trees generally form a closed-canopy forest that currently covers 16.4 ha in Pearl Harbor (DoN 2001b). Because of the high sediment loads in Pearl Harbor, benthic communities have historically been more diverse on vertical surfaces than on horizontal surfaces where sediment accumulation results in smothering. Within the soft bottom zones, most species are infaunal. There are a few stony coral communities reported within Pearl Harbor however they are sparse and very widely dispersed and generally small (DoN 2001b). In 1996, Coles et al. (1997) conducted an extensive survey of the ecosystems of Pearl Harbor; they found 434 species or higher taxa within the 15 stations sampled.

3.1.2 LAGOONS

A lagoon is a body of comparatively shallow salt water separated from the open sea by a shallow or exposed sandbank, coral reef, or similar feature. Lagoons are often formed when such sandbanks or reefs are built up parallel to the coastline and partially cuts off the nearshore water from the open ocean (Nybakken 1997).

In the Hawaiian Islands, lagoon and ocean waters are exchanged by passages cut through the reefs. In the Hawaiian Islands OPAREA, the most significant lagoon is located in Kaneohe Bay, Oahu (Figure 3-2); in this lagoon, pinnacle and patch reefs occur in the center of the lagoon and fringing reefs line the shoreline (Maragos 1998). The floor of the lagoon is mostly sandy and flat or undulatory; coral rubble, coral mounds (patch reefs), seagrass, and algae are also found. Coral mounds tend to be more abundant in the outer reaches of lagoons and are widely scattered or absent in the inner lagoons (PBEC 1985; NCCOS/NOAA 2005). The biota is the same as colonized hard bottom and deep soft sandy bottom habitats. Threatened green sea turtles and endangered hawksbill turtles feed on the barrier reefs and in lagoons (Maragos 1998).

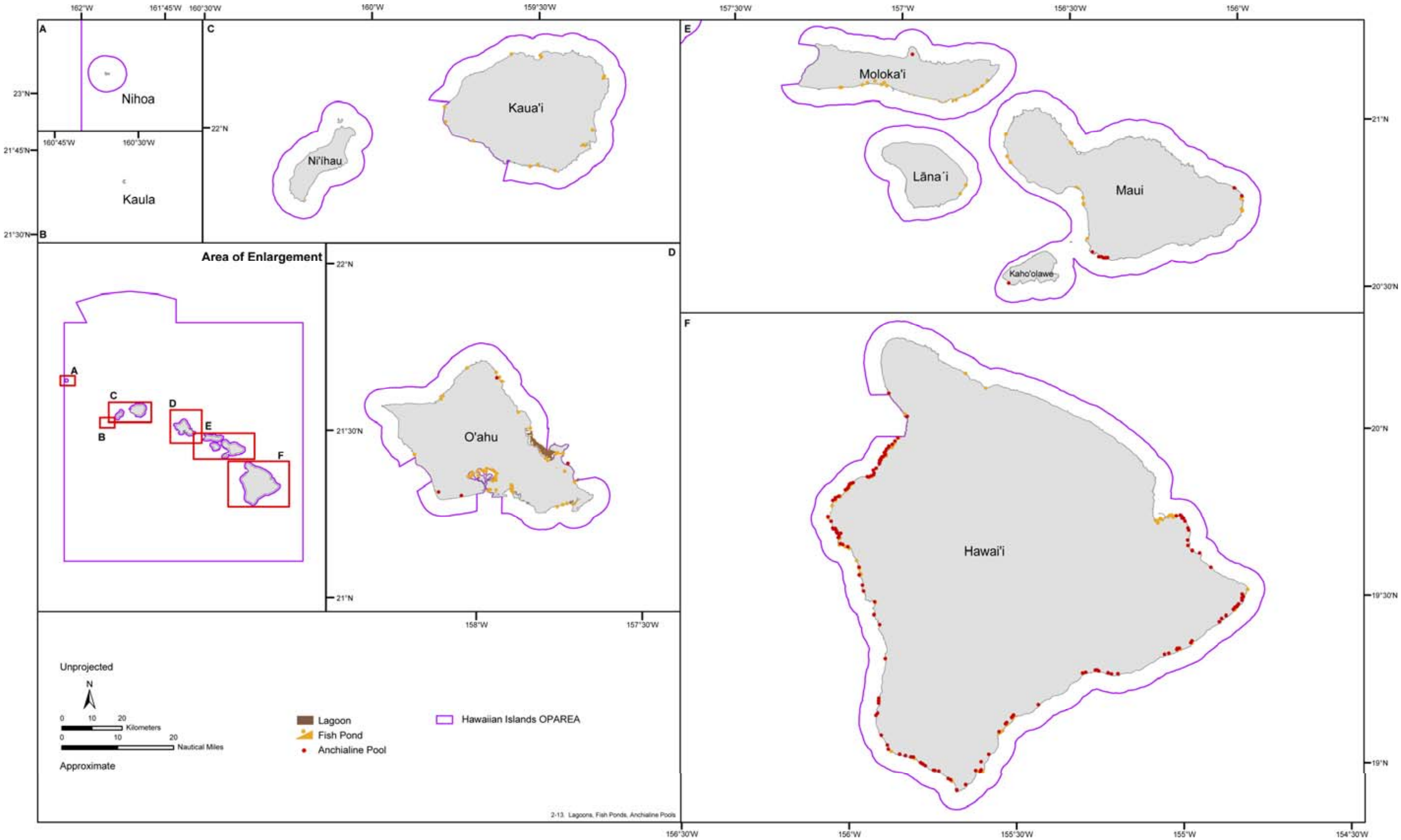


Figure 3-2. Fishpond, lagoon, and anchialine pool habitat distribution in the Hawaiian Islands OPAREA and vicinity. Source Data: NOS (2001), NOAA (2003), and State of Hawaii, Office of Planning (2005).

3.1.3 SEAGRASS

Seagrasses are submerged aquatic vegetation that form extensive underwater meadows (or beds). They are a group of approximately 60 species and are found in shallow-water depths and various temperatures and salinity ranges throughout many parts of the world (Phillips and Meñez 1988). Most seagrasses have flattened leaves that help them adjust to light restrictions and slow rates of gas diffusion in the water column (Thayer et al. 1984). Their extensive rhizome (root) system forms dense and tough belowground mats that function in anchorage and the absorption of nutrients. The leaves are capable of transporting oxygen to the rhizomes, allowing seagrasses to grow in anoxic sediments (Thayer et al. 1984).

Seagrass beds are among the most productive habitats in the ocean. This production comes from the leaves, epiphytic organisms, underground biomass, and associated flora and fauna (50 to 95%) (Brouns and Heijs 1986). The macrophytic and microphytic algae that form a dense layer on the bottom of seagrass beds can account for 10 to 20% of the above ground production (Zimmerman 2003) and the phytoplankton residing above and between the seagrass contribute considerably to oxygen production (Brouns and Heijs 1986). Seagrass beds provide a substantial element in the sustainability of coastlines, fisheries, benthic invertebrates (e.g., shrimp, lobster), marine mammals (e.g., manatees, dugongs), reptiles (e.g., green sea turtles), and waterfowl. They sustain ecosystem productivity with internal nutrient cycles by trapping detrital material and sustaining detrital-feeding pathways (Phillips and Meñez 1988; Nybakken 1997). In addition, seagrass beds slow currents and waves to prevent coastline erosion by stabilizing sediments and promoting sedimentation. They also improve water quality by filtering sediments and sediment borne pollutants, excess nutrients, and dissolved and particulate pollutants from terrestrial run-off. Thus, they play an important role in nutrient regeneration and recycling, water quality, primary production, and carbon sequestration. As perennial structures, seagrasses are one of the few marine ecosystems capable of storing carbon for relatively long periods. This carbon can be bound into sediments or transported to the deep ocean and play an important role in long-term carbon sequestration (Phillips and Meñez 1988). However, primary production is probably the most essential function of the seagrass ecosystem.

Seagrass ecosystems promote biodiversity by providing a variety of unique niches and have been found to parallel that of adjacent high diversity ecosystems (e.g., coral reefs, mangroves, salt marshes, and bivalve reefs) (Green and Short 2003). Seagrasses can grow up to 10 millimeters per day (mm/d) (Phillips and Meñez 1988); this high rate of growth sustains the feeding pathways of many herbivores and detrital-feeders.

Short et al. (2000) and Green and Short (2003) have determined that, worldwide, between the mid 1980s and the mid 1990s, 1,200,000 ha of seagrass habitat have been lost. Coastal modifications that cause shading, resuspension of sediment (via dredging, recreational watercraft, ferries, tankers, and freighters), deposition of upland soils, and oil spills may reduce the transmission of light to and/or bury seagrasses.

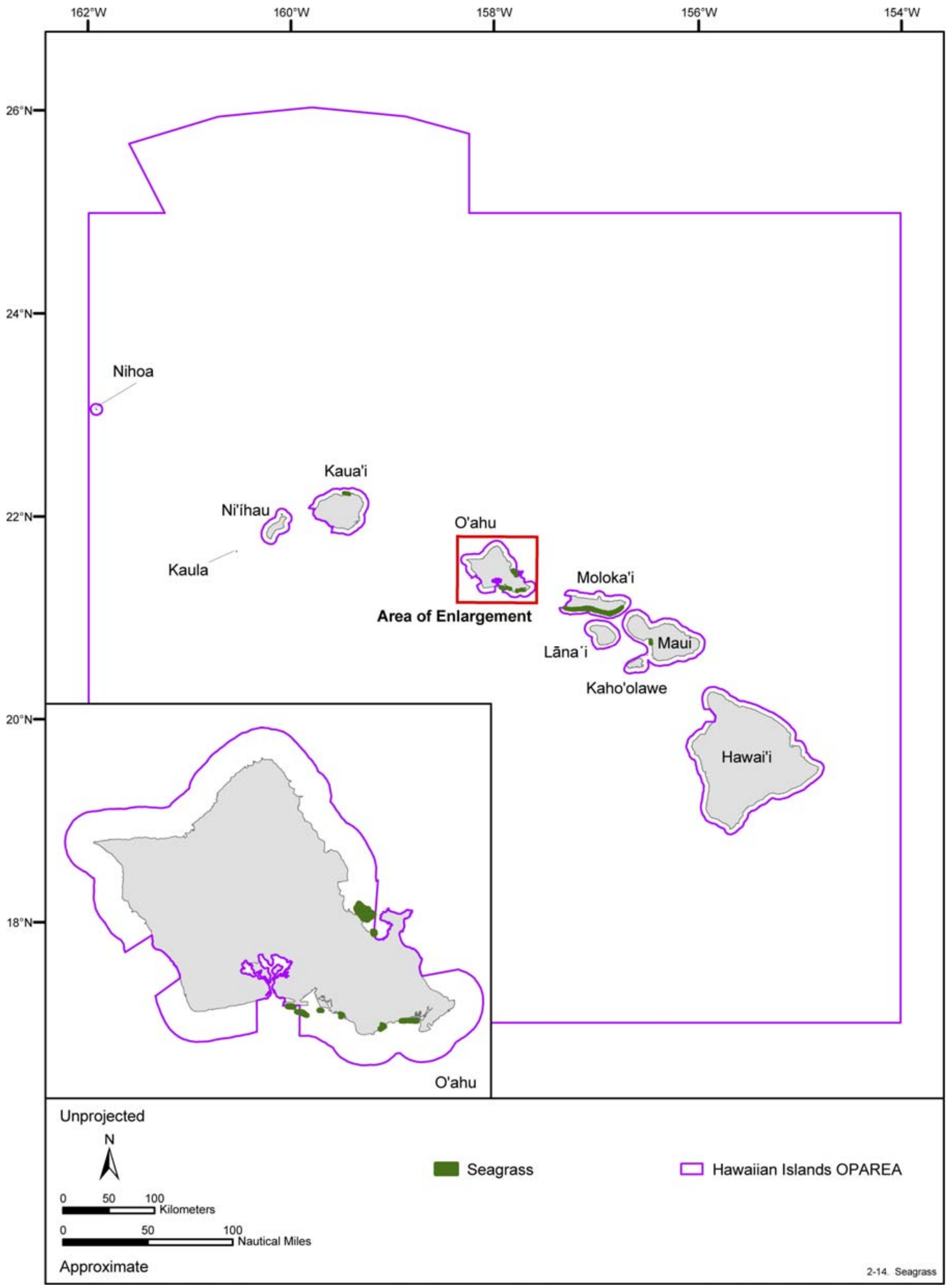
Within the Hawaiian Islands, seagrass beds are not abundant; they are found subtidally on shallow, sandy bottoms near coasts protected by reefs and embayments (Maragos 2000). Seagrasses colonize carbonate or terrigenous sands and muds. One known endemic seagrass species occurs in the Hawaiian Islands, *Halophilia hawaiiana* (Maragos 2000). In addition, *Halophila decipiens* is possibly an indigenous species as well. There is currently no indication that *H. decipiens* was introduced to the Hawaiian Islands. On the other hand, there is not enough evidence to speculate as to how *H. decipiens* may have come to the Hawaiian Islands, but given its broad, scattered distributions, it has probably been in the Islands at a low level and has been overlooked rather than introduced. *H. decipiens* is currently found scattered throughout the Hawaiian Islands and usually occurs in deeper water, separate from and not in direct competition with *H. hawaiiana* (Russell et al. 2003). Common animals found inhabiting seagrass beds of the Hawaiian Islands include sea cucumbers (*Holothuria*), sand-dwelling gastropods, clams, crabs, shrimps, flagtails (*Kuhlia*), mullets (*Mugil*), and rudderfish (*Kyphosus*) (Maragos 1998).

Geographic distributions of seagrasses are based upon individual species tolerances to hydrological and atmospheric conditions (i.e., water temperature, salinity, irradiance, depth, substrate, and exposure) (Phillips and Meñez 1988). In the Hawaiian Islands, seagrasses are found off the inner reef flats of south Molokai, ‘Anini (Kauai), and a few other locations but are generally not widespread (Maragos 2000; Figure 3-3). In addition, seagrasses are found on the south and north coasts of Oahu near Mamala Bay and Kaneohe Bay, respectively. However, the distribution of seagrass beds in the Hawaiian Islands is poorly known due to the difficulty of delineating seagrass habitats.

3.1.4 MANGROVE

Mangroves are small tropical trees with salt-tolerant roots that grow in wetlands at the edge of the ocean. They often form mangrove forests that are essential habitat for many fishes and animals. Mangroves are the tropical equivalent of salt marshes; they line the shores of coastal embayments and the banks of rivers to the upper tidal limits (Myers 1999). They have large roots that spread laterally and the extensive root systems can consolidate sediments, eventually transforming surrounding mudflats into dry land (Myers 1999). Mangrove forests provide nutrient rich waters that make them among the richest nursery grounds for marine life (Scott 1993; Myers 1999).

In most parts of the tropics, mangroves are highly regarded for the ecosystem they provide; however, in the Hawaiian Islands, they are invasive and have adverse ecological and economic impacts. Mangrove colonization in the Hawaiian Islands has resulted in a reduction in habitat quality for endangered waterbirds (e.g., the Hawaiian stilt, *Himantopus mexicanus knudseni*), colonization of endemic habitats (e.g., anchialine pools), overgrowth of native Hawaiian archaeological sites, and drainage and aesthetic problems (Allen 1998). Mangrove colonization has some positive aspects including the local use of *B. gymnorrhiza* flowers for making leis, development of mangrove ecosystem habitat, sediment retention, and organic matter export (Allen 1998). Also, mangroves appear to have a positive influence on water quality in the Hawaiian Islands and may contribute to improving the quality of offshore waters (Allen 1998). In general, the turbidity of waters adjacent to mangrove habitat was lower than in areas lacking mangrove habitat. On Molokai, turbidity was lower on coral reefs adjacent to mangroves than on reefs far from mangrove habitat (Allen 1998). In addition, mangroves may serve as a sink for high nitrate and phosphate levels. In the He‘eia stream, nitrate and phosphate levels were significantly reduced in the upper reaches of the mangrove habitat (Allen 1998).

1 

2 **Figure 3-3. Seagrass distribution in the Hawaiian Islands OPAREA and vicinity. Source**
3 **data: NOS (2001).**

4

In the Hawaiian Islands, mangroves are not found naturally; they were intentionally introduced in the early 1900s. In 1902, *Rhizophora mangle* was introduced to south Molokai and Kaneohe Bay, Oahu primarily for the purpose of stabilizing coastal mud flats (Allen 1998). This species is now well established in the MHIs and has spread to mud flats and estuarine waters around most of the Islands and to some rocky coastal areas around Hawaii Island (Maragos 1998). Subsequently, at least five additional species of mangroves or associated species were introduced to the Hawaiian Islands and at least two of these species have established self-maintaining populations (*Bruguiera gymnorrhiza* and *Conocarpus erectus*) (Allen 1998).

Mangroves have colonized nearly all of the MHI. Specifically, in the Hawaiian Islands OPAREA, *B. gymnorrhiza* and *R. mangle* are found on Oahu in the He‘eia marsh on the Northeastern coast and in the Pearl Harbor estuary on the southern coast; *R. mangle* is also found on the western coast of Hawaii in Kihalo Bay (Allen 1998). Unfortunately, there has not been an extensive survey of mangrove-colonized areas in the MHI and there is no comprehensive data source to depict the occurrence of these affected areas. However, Figure 3-1 depicts a few of the mangrove-colonized areas in the MHI.

In some areas, mangroves have also become established in anchialine pools, most notably on the west coast of Hawaii (Allen 1998). Once mangroves reach anchialine pools they rapidly colonize all suitable shoreline habitats, completely filling in the shallower anchialine pools (Allen 1998). Common animals that utilize mangrove habitat include the mangrove or Samoan crab (*Scylla serrata*), other crabs, oysters, and clams. Also, the native black-crowned night heron, cattle egret, and the endangered Hawaiian stilt nest and feed among the mangroves (Maragos 1998).

3.1.5 MUDFLAT

Mudflats are relatively flat, muddy regions found in intertidal areas that are submerged by the rise of the tide; they are able to support plant life and are found in sheltered bays and estuaries. Mudflats are critical habitats for many endangered waterbirds inhabiting the Hawaiian Islands. Recently the Navy created 2 ha of critical mudflat habitats for endangered water birds on the shores of Pearl Harbor within the Honouliuli Unit of the Pearl Harbor NWR (Hommon and Stovell 2000). This refuge, which is owned by the Navy, was created as a mitigation measure to replace mudflat habitat lost when Honolulu’s “reef runway” was built; the refuge is managed by the Fish and Wildlife Service (Hommon and Stovell 2000). The mudflats were created in West Loch of Pearl Harbor and are home to a number of Hawaiian waterbirds, including four endangered species and a variety of migratory waterbirds. The endangered waterbirds include the koloa or Hawaiian duck (*Anas wyvilliana*), the ae‘o or Hawaiian stilt (*Himantopus mexicanus knudseni*), the `alae-ke‘oke‘o or Hawaiian coot (*Fulica americana alai*), and the `alae`ula or Hawaiian moorhen (*Gallinula chloropus sandvicensis*) (Hommon and Stovell 2000). Common plants that occur in Hawaiian mudflat habitat include pickleweed (*Batis aritime*), *Panicum purpurascens* and *Schoenoplectus* spp., and some green algae (*Ulva*, *Enteromorpha*) (Maragos 1998). In the Hawaiian Islands OPAREA, mudflat habitat is located along the southern and northern coasts of Oahu in Mamala Bay, Pearl Harbor and in Kaneohe Bay, respectively (Figure 3-1).

3.2 ROCKY INTERTIDAL

The rocky intertidal habitat is present on all shorelines of the Hawaiian archipelago where sand is absent due to constant wave action, currents, steep submarine slopes, and a lack of offshore sand reservoirs (Figure 3-4). Biological assemblages common to rocky intertidal habitats are defined by extreme physical factors including exposure to air and potential desiccation, strong wave and surf exposure, rocky substrate, competition for living space, and the need to find food and shelter while avoiding predators. Cracks, crevices, and overhangs create microhabitats for organisms to hide from predators, minimize wave shock, and avoid desiccation. These characteristics create a strong pattern of vertical zonation in which the distribution of an organism is determined by its physiological tolerance to desiccation and competitive and predatory interactions with other species (MMS 2001). Four zones of life occur in a rocky coast habitat: the upper intertidal, mid-intertidal, lower intertidal, and subtidal (Maragos 1998); in the Hawaiian Islands the tidal range is only about 1 m, making this vertical zonation range small.

The substrates of Hawaiian rocky intertidal habitats are mostly consolidated basalts with some consolidated limestones (cemented beach rock or raised coral reefs). Common plants found in rocky intertidal habitats include sea lettuce (*Ulva*), Sargasso or *kala* (*Sargassum*), coralline red algae (*Hydrolithon*), red fleshy algae (*Melanamansia*, *Pterocladiella*, *Jania*), brown algae (*Padina*, *Turbinaria*, *Dictyota*), and fleshy green algae (*Neomeris*, *Halimeda*, and *Caulerpa*). Common animals found in rocky intertidal habitats include keyhole limpet or *‘opihi* (*Cellana*), periwinkles, littorine snails (*Littorina*, *Nerita*), rock crabs or *‘a‘ama* (*Metapograpsus*), gastropods (*Drupa*, *Morula*, *Cypraea*, *Strombus*), and rock urchin (*Colobocentrotus atratus*). Adjacent to rocky shoreline, offshore waters are possible feeding areas for the threatened green turtle (Maragos 1998). Other than rocky shoreline, the Hawaiian Islands have two distinct rocky intertidal habitats, tide pools and anchialine pools.

3.2.1 TIDE POOLS

As the tide recedes, depressions between rocks can retain water. These areas form pools known as tide pools. Tide pools are flooded during rising tides and are continuous with the open ocean at the surface. In the Hawaiian Islands, tide pools are formed by lava rock depressions that have subsided to sea level and where wave action breaks down the surface barriers, exposing the pool to the open ocean (Maragos 1998). A variety of reef animals and plants occupy tide pools such as crabs, small fish, snails, and many types of algae (Maragos 1998). Organisms that reside in a tide pool may be subjected to desiccation and drastic salinity and temperature changes; they are therefore uniquely adapted to survive under the harsh conditions of this habitat.

3.2.2 ANCHIALINE POOLS

Anchialine pools are land-locked, marine or brackish pools of water located along coasts and connected to the sea via underground caves, tunnels, or fissures (Frankel 2004). These pools are found along rocky coasts up to several hundred meters inland. Depending on the distance from the sea and the extent of groundwater input, pools range in salinity and water quality (dissolved nutrients). The porous rock walls allow them to maintain subsurface connections with the sea. Anchialine pools are often found along the basaltic coasts of younger volcanic islands (e.g., Maui and Hawaii) and where coral reefs have been uplifted (e.g., Oahu) (Maragos 2000). Anchialine pools in basalt rock are generally located where the lava rock is porous and

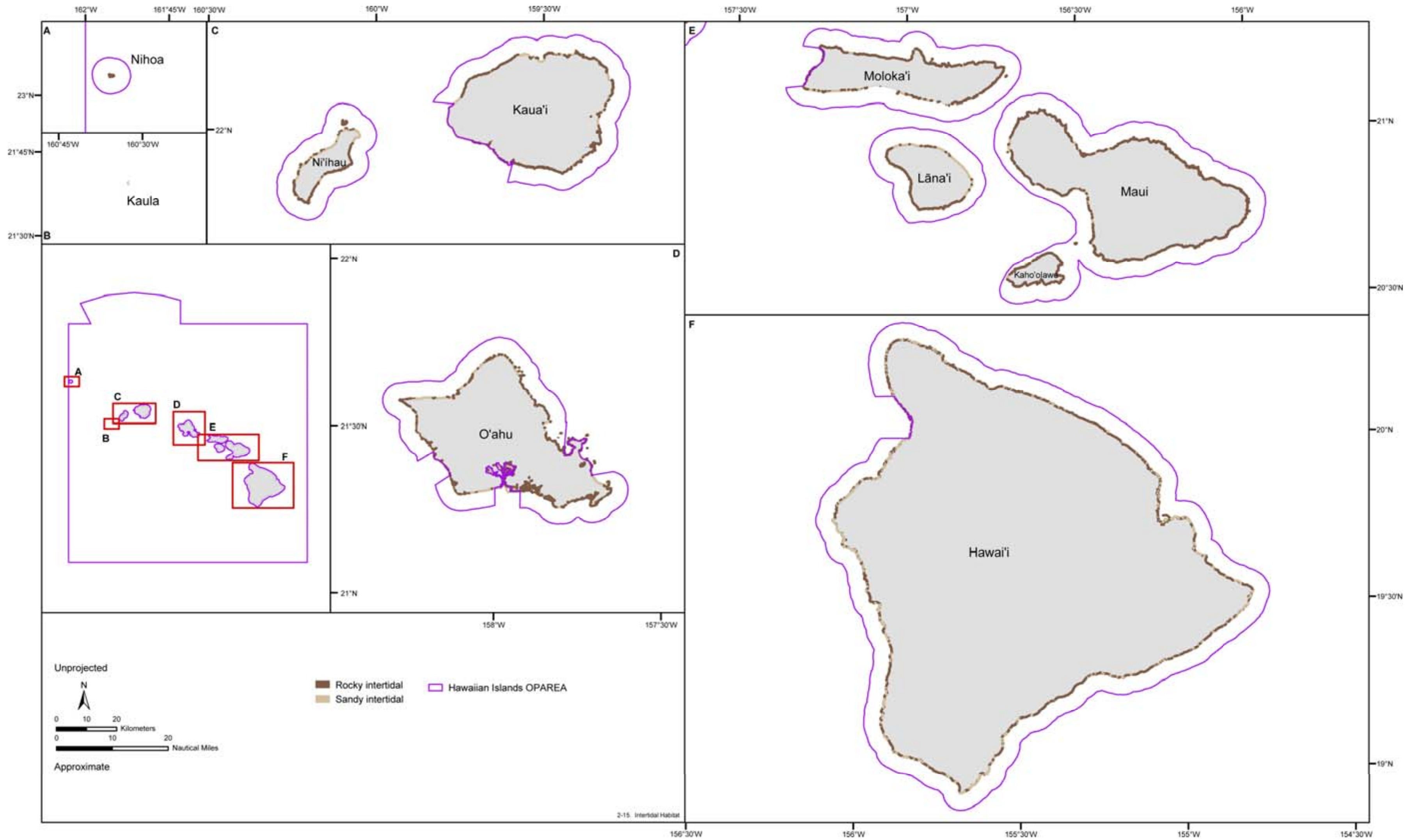


Figure 3-4. Rocky and sandy intertidal habitat distribution in the Hawaiian Islands OPAREA and vicinity. Source Data: NOS (2001) and NOAA (2003).

creates broad shallow shelves near the coast. Limestone anchialine pools are found in karstic formations that consist of fossilized coral reefs now positioned above sea level; these formations have undergone extensive weathering and dissolution (Meier et al. 1993). Lava rock depressions that have subsided to sea level become flooded with seawater during tidal flow and anchialine pools are created; eventually these anchialine pools form tide pools (Maragos 1998).

Hundreds of anchialine ponds are found throughout the Hawaiian archipelago (Figure 3-2). Anchialine habitats are best known for their unique community assemblages, particularly invertebrate species such as the red-colored shrimp or opae-ula (Meier et al. 1993). Also, distinctive microorganism assemblages are present in the unique anchialine habitats. The microbial diversity of these habitats is important to assess because the majority of the ponds have been drastically impacted by human development. Anchialine pools have been filled for residential or resort development, including a large pond complex at the Waikola Resort at Anaeho‘omalu, Hawaii (Meier et al. 1993).

The Kaloko-Honokohau Park on the western coast of Hawaii contains 10% of Hawaii’s anchialine ponds (Frankel 2004). The pools have a large algal component and highly specialized and vulnerable fauna; this unique biota is continually reduced by mangrove invasion (Allen 1998). Marine algae and cyanobacteria are commonly found in anchialine pools; widgeon grass (*Ruppia maritima*), rushes (*Juncus*), or pickleweed (*Batis maritima*) may become established where sediments accumulate along edges. Common animals include shrimp (*Metabetaeus lohena* and *Halocaridina rubra*), eels (*Gymnothorax*), mullets (*Mugil*), and other crustaceans and mollusks (Maragos 1998).

3.3 SANDY INTERTIDAL

Sandy beaches provide important habitat for sand-dwelling crustaceans, mollusks, and fish; they also supply resting and nesting sites for seabirds, sea turtles, and the Hawaiian monk seal. Beaches are the most abundant along the lagoon reaches of atoll islets and along the coasts of several of the MHI, especially the west and south sides of Kauai, Oahu, Molokai, Maui, Lanai, and Hawaii (Maragos 2000; Figure 3-4). Four types of beaches have been recognized. White sand beaches are the most common; they are formed from the breakdown of coralline algae and corals to make white carbonate sand. Black sand beaches are derived from recent lava flows when molten lava flows into the sea and tiny tephra particles are formed; these beaches are common off Hawaii and Maui. Pink sand beaches are derived from the breakdown of iron-rich coastal cinder cones; one is located off east Maui. Green sand beaches consist of olivine crystals that have eroded from lava rock; they are found off south Hawaii and off northeast and southeast Oahu (at Mokapu Peninsula and Hanauma Bay) (Maragos 1998, 2000). Beach sand tends to be coarser off wave-exposed and windy reaches of islands and finer within lagoons, embayments, mangroves, harbors and fishponds (Maragos 2000); wave action and biological and chemical erosion determine the composition and longevity of beaches (Maragos 1998).

Sandy beaches provide extensive benthic habitat; the invertebrate communities of these habitats provide important inputs to reef systems at higher trophic levels including reef-associated fish populations (DeFelice and Parrish 2001). In tropical shallow waters, the carbonate sediments of coral reefs generally cover more area than hard substrates. Carbonate sediments support diverse invertebrate assemblages; the specific assemblage structure is based upon the mean grain size and wave exposure of the site (DeFelice and Parrish 2001). In general, the number of individuals and diversity increases with increased mean grain size and decreased wave exposure (DeFelice and Parrish 2001).

Common plants that inhabit sandy beach intertidal habitat include the beach morning glory (*Ipomoea*), beach heliotrope (*Tourneforita*), milo (*Thespesia*), and hau (*Hibiscus*) (Maragos 1998). Common animals utilizing and inhabiting sandy beach intertidal habitat include ghost crabs (*Ocypode*), mitre and auger shells (*Terebra*), clams, and seabirds (Maragos 1998). On Hawaii, two capitellids (*Diopatra dexiognatha* and *Pygospio muscularis*) are key species in the beach intertidal habitat that provide sediment stabilization for the invertebrate community structure during normal as well as severe episodic disturbances (Dreyer et al. 2005).

3.4 SUBTIDAL COLONIZED HARDBOTTOM

Rocky substrate can provide support to extensive communities of marine plants and animals that require attachment for survival. Subtidal rocky substrates provide habitat for a diverse ecosystem of fish and invertebrates including seaweeds, sponges, octopus, feather stars, and the commercially valuable spiny lobster and abalone (Chess and Hobson 1997). Live bottoms, as defined by the Bureau of Land Management, are areas "containing biological assemblages consisting of such sessile invertebrates as sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans, and hard corals living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; and whose lithotope favors accumulation of turtles, pelagic and demersal fish."

In the Hawaiian Islands, shallow benthic communities are found in depths of up to 50 m or more, on basalts, and on consolidated limestones (reef carbonates, beach rock). The distribution of benthic communities is determined by light penetration, temperature, wave action, availability of substrate, and movement and accumulation of sediments. Macroalgal beds dominate the shallow inner reaches of fringing reef flats and stony coral communities dominate the outer flats and upper reef slopes (Maragos 2000). Common communities include brown algae (*Sargassum*, *Turbinaria*, *Dictyota*, *Padina*, and *Dictyopteris*), green algae (*Halimeda*, *Dictyosphaeria*, *Cladophora*, *Caulerpa*, and *Ulva*), and red algae (*Pterocladiella*, *Melanamansia*, *Asparagopsis*, and *Laurencia*) (Maragos 1998). Crustose coralline algae are prevalent in wave-exposed littoral and sublittoral habitats and are strong reef builders (Maragos 2000). *Porolithon* spp. are the most common coralline algal communities and *Cyphastrea*, *Fungia*, *Psammocora*, *Porites*, *Pocillopora*, *Montipora*, *Pavona*, and *Leptastrea* are also common among coral communities (Maragos 1998).

Invertebrate communities commonly associate with the macrofauna. Of the many sessile and motile invertebrates associated with colonized hard bottom habitat in the Hawaiian Islands, the spiny and slipper lobsters are of particular interest (DoN 2001c). Spiny lobsters (family Palinuridae) and slipper lobsters (family Scyllaridae) are found throughout the Indo-Pacific Region. The Hawaiian spiny lobster (*Panulirus marginatus*) is endemic to the Hawaiian Islands and is typically found on rocky substrate in well-protected areas, in crevices, and under rocks and is the primary species of interest in the northwest Hawaiian Island (NWHI) fishery (DoN 2001c). The reported depth preference of the Hawaiian spiny lobster is from 3 to 200 m but it is generally more abundant in 90 m or less (DoN 2001c). Common reef and shore animals associated with subtidal colonized hard bottom habitat include parrotfishes, wrasses, damselfishes, surgeonfishes and other reef fishes, jacks, sea urchins, and sea cucumbers. In addition, the endangered Hawaiian monk seal feeds in the deeper colonized hard bottom offshore communities (Maragos 1998).

In the Hawaiian Islands OPAREA, colonized hard bottom, macroalgae, invertebrates, deep-slope terraces, and islets are found on every island (Figure 3-5). The marine benthic invertebrate assemblages are extremely diverse and include representatives of nearly all phyla. Subtidal colonized hard bottom habitats in the Hawaiian Islands include coral reefs and communities, deep-slope terrace, and islets.

3.4.1 CORAL REEFS AND COMMUNITIES

While this section includes a general discussion of coral reefs and communities of the Hawaiian archipelago, a focused discussion is provided for coral reefs and communities in the nearshore area of the Hawaiian Islands OPAREA, including coastal segments of the islands of Oahu, Molokai, Kauai, and Hawaii (Figures 3-6a and 3-6b). Information on coral reefs for the island of Nihoa, the only island of the NWHI encircled by the Hawaiian Islands OPAREA, is also provided. This report uses high resolution benthic habitat maps (1 m per pixel resolution) of the southern coastline of Molokai produced by Cochran-Marquez (2005), benthic habitat maps of the MHIs (1 acre [ac] minimum mapping unit [MMU]) produced by NCCOS/NOAA (2003), and a benthic habitat map of Nihoa Island (4 m per pixel resolution) produced by NCCOS/NOAA (2004). Therefore most of the benthic habitat delineations used in this report depict broad habitats and lack in accuracy. Future benthic habitat mapping of the MHI would benefit from higher resolution techniques and site-specific input on reef structure and coral coverage from local experts. The site specific information on coral cover provided in this report is based on peer-reviewed publications and reports. In areas where coral cover was not reported in the literature we approximated coral cover using NCCOS/NOAA (2005).

Depicted reef habitats based on NCCOS/NOAA (2003) data are linear reefs, aggregated coral, spur and groove reefs, patch reefs, coral heads, scattered coral/rock in unconsolidated sediments, colonized pavement, and colonized volcanic rocks and boulders. Linear reefs are defined as “coral formations that are oriented parallel to shore or the shelf edge” (NOAA 2003). As a category of reefs, linear reefs include fore reefs, fringing reefs, and shelf edge reefs. Aggregated corals are reef habitats that are primarily composed of reef-building corals and have high topographic complexity. Spur and groove reefs typically occur in the fore reef environment and have alternating coral ridges (spurs) and sand channels (grooves) oriented perpendicular to the shore. Patch reefs are coral formations that are isolated by sand or seagrass from other reef habitats and that do not have a structural organization related to the shoreline or insular shelf edge. Scattered coral/rock in unconsolidated sediments (sand or seagrass) are smaller than individual patch reefs. Colonized pavement is low relief carbonate rock colonized by plentiful macroalgae, hard corals, zoanthids, and other sessile invertebrates. These organisms also constitute the live substrate of colonized volcanic rocks and boulders (NOAA 2003).

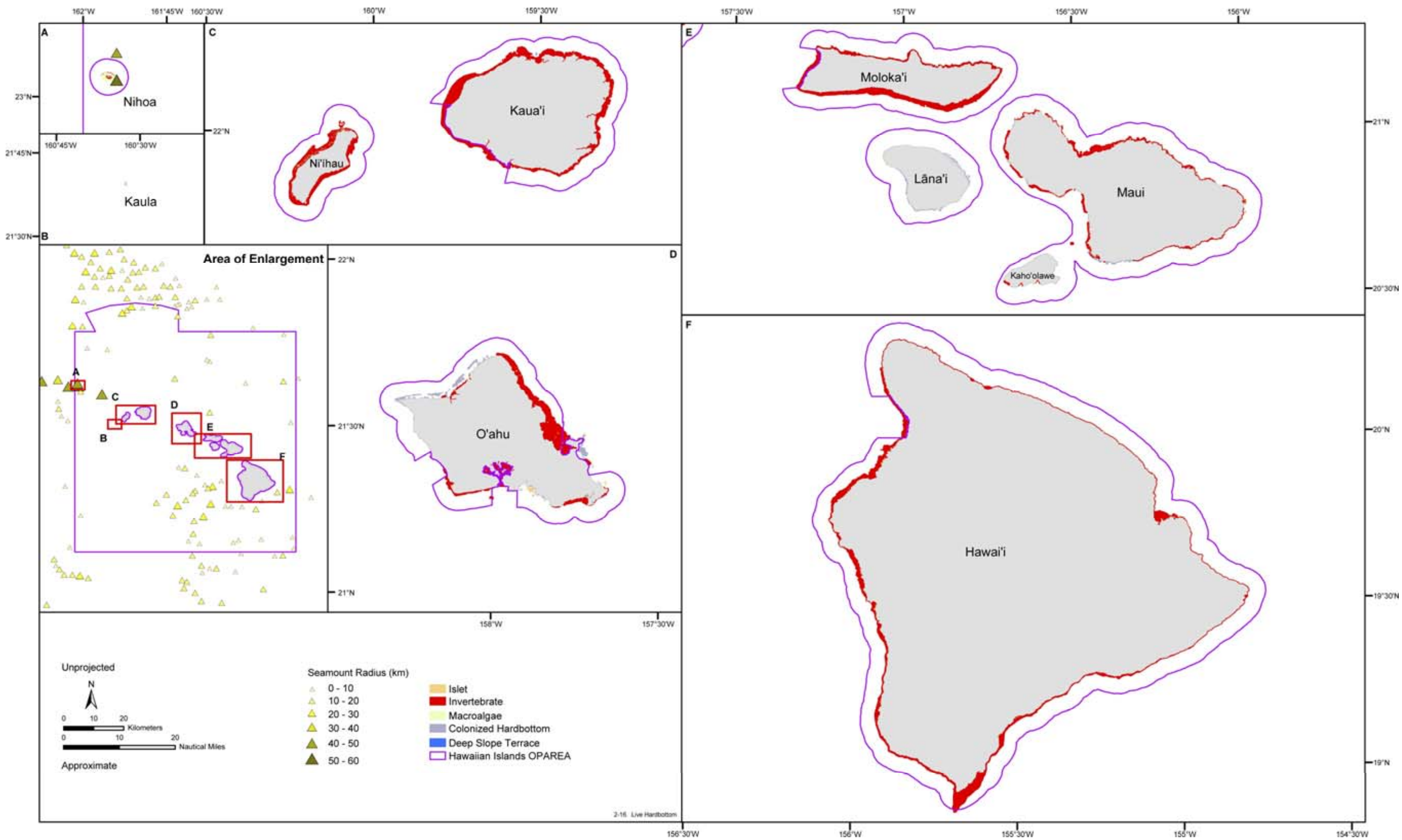


Figure 3-5. Subtidal colonized hardbottom habitat distribution in the Hawaiian Islands OPAREA and vicinity including islet, invertebrate and macroalgae assemblages, colonized hardbottom, deep slope terrace, and seamount habitat. Source Data: Bridges (1997), Itano and Holland (2000), NOS (2001), NOAA (2003), and State of Hawaii, Office of Planning (2005). Map adapted from: Eakins et al. (2003).

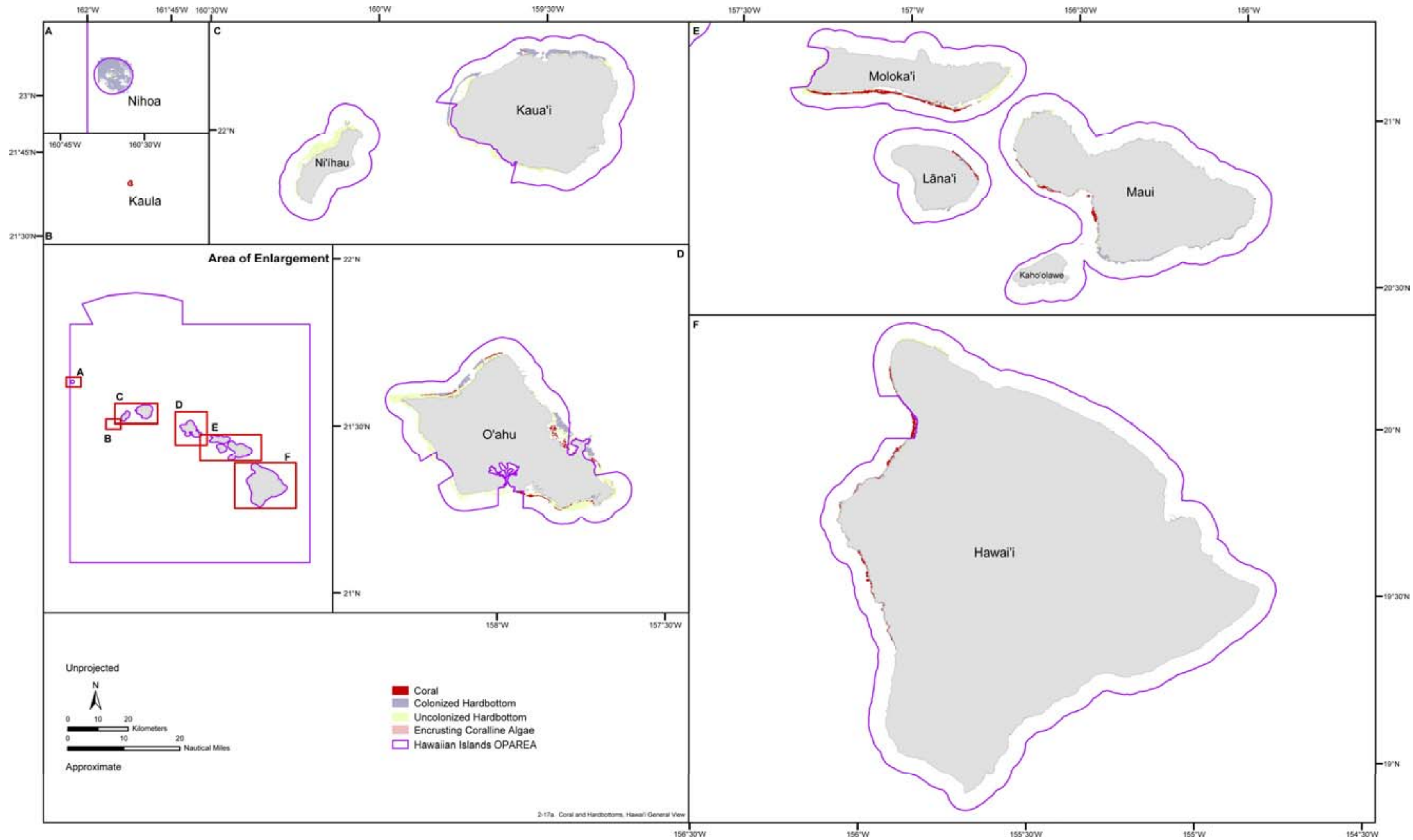


Figure 3-6a. Nearshore hardbottom habitats of the Main Hawaiian Islands and Nihoa. Depicted coral cover ranges from 10 to 100% on the south coast of Molokai, is greater than 10% on Nihoa, but is undefined for the remaining locations of the Hawaiian archipelago. Encrusting coralline algae cover ranges from 10 to 100% for all locations. Source data: NOS (2001); NCCOS/NOAA (2003, 2004); Cochran-Marquez (2005).

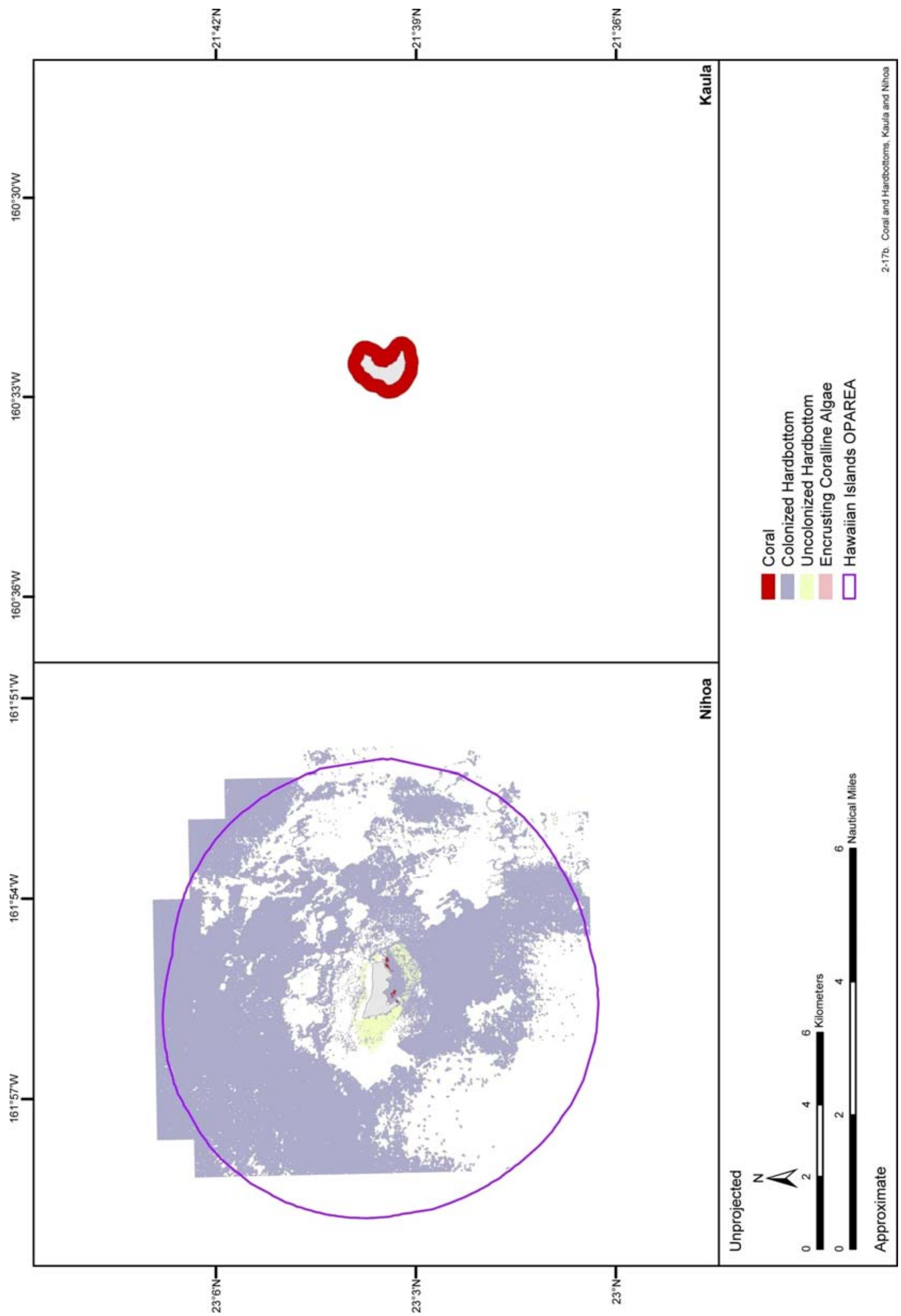


Figure 3-6b. Nearshore hardbottom habitats of Nihoa and Kaula. Depicted coral cover is greater than 10% on Nihoa. Encrusting coralline algae cover ranges from 10% to 100%. Source data: NOS (2001) and NCCOS/NOAA (2003, 2004).

3.4.1.1 Regional distribution, composition, and condition

Regional Distribution—Coral reefs of the Hawaiian archipelago are found on the MHI, NWHI, and islets that fringe the MHI (Maragos 2000). The geographic extremities of coral occurrence in the Hawaiian archipelago are the island of Hawaii on the southeastern end of the archipelago and Kure Atoll at the northwestern end of the archipelago (Maragos 2000). While coral reefs occur throughout the Hawaiian archipelago, the rate of coral accretion (calcium carbonate production) gradually decreases from 15 kilograms per square meters per year ($kg/m^2/yr$) at Hawaii to 0.3 $kg/m^2/yr$ at Kure Atoll. Reef accretion decreases with increasing latitude due to changes in incident light and SST; there is a 10° latitude difference between the island of Hawaii and Kure Atoll (Grigg 1981).

The Hawaiian Islands have 17,520 km^2 of coral reef area, representing 84% of the coral reef area in the U.S. (3,504 km^2 in the MHI and 14,016 km^2 in the NWHI) (Maragos 2000). The NWHI contain approximately 80% of the coral reef habitat in the Hawaiian archipelago (Maragos et al. 2004). The MHI are for the most part high volcanic islands that include "non-structural reef communities," fringing reefs, and two barrier reefs (Kaneohe Bay and Moanalua Bay, Oahu) (Grigg 1997a, 1997b; Friedlander et al. 2004). Reefs of the NWHI consist of atolls, islands, and banks (Grigg 1997a). Kure Atoll is known as the Darwin Point, a threshold of atoll formation or extinction. The accretion of calcium carbonate at Kure Atoll due to coral growth is in balance with the loss of calcium carbonate due to bioerosion and subsidence (Grigg 1981). Drowned guyots and seamounts are found northwest of Kure Atoll. Due to the motion of the Pacific Plate, the Hawaiian Islands have been transported in a north to northwest direction away from their original location of formation over the hot spot at a rate of about 10 centimeters per year (cm/yr) (Grigg 1988, 1997b). The youngest island in the archipelago is Hawaii, where the youngest fringing reefs and barrier reefs are found; the youngest fringing reefs on the western coast of Hawaii are from 100 to 1,000 years old. The barrier reefs in the Hawaiian archipelago take approximately 2.5 million years to form while atolls take 10 million years to form (Grigg 1988, 1997b).

Wave action is the main natural control on coral reef structure along the coastline of the Hawaiian Islands (Grigg 1997a; Jokiel et al. 2001, 2004). Corals in wave-exposed areas die as fast as they can be replaced (Grigg 1997a). The breaking, scouring, and abrading action caused by waves on corals yields high mortality. Hence, no coral accretion takes place in wave-exposed areas. Other natural factors that influence the formation of coral reefs along the Hawaiian Islands include sedimentation, turbidity, incident light, and dissolved nutrients (Grigg 1997a). The greatest reef accretion occurs in areas sheltered from wave action such as embayments and on the leeward side of islands (Grigg 1997a; Jokiel et al. 2001, 2004). Coral reefs are particularly well developed on the western coast (Kona coast) of Hawaii and on the south coast of Molokai (Maragos 2000; Jokiel et al. 2001, 2004). Despite the fact that wave action limits the accretion of reef building corals, reefs are also found along the south and northeast coastlines of Oahu, the north coastline of Kauai, and the northeast coastline of Lanai (Maragos 2000). Stony corals, or reef-building corals, are primarily located on the seaward edge of fringing reefs and the fore reef slope (Maragos 2000); in the absence of stony corals crustose coralline algae colonize coastlines that are exposed to wave action (Maragos 2000).

Regional Composition—There are 59 known species of stony corals occupying the reefs of the Hawaiian archipelago (Maragos et al. 2004). Compared to the coral reefs of the Indo-Pacific, which can contain up to 500 species of stony corals, the reefs of Hawaii have a low diversity (Grigg 1997a). Over 25% of the animals found on the reefs of Hawaii are endemic (Clark and

Gulko 1999); in the NWHI, at least 30% of the stony corals are endemic (Maragos et al. 2004). Overall, 29% of coral species found on Hawaiian reefs are endemic to the MHI and the NWHI (Maragos et al. 2004).

The paucity of reef corals is due in part to the geographic isolation of Hawaii from larval sources (Grigg 1988). Prevailing surface water transport is from east to west, driven by the northeast trade winds. There are no coral reef ecosystems to the east of the Hawaiian archipelago capable of acting as a source of coral larvae. The non-endemic coral species originated in the western Pacific and were transported to the Hawaiian Islands as larvae by the Kuroshio Current and Subtropical Counter-Current (Grigg 1988, 1997b). The distant source of coral larvae has created a region of low species diversity and relatively high endemism (Maragos et al. 2004). Coral reefs of Hawaii are also populated by 700 species of fish, 400 species of algae, 1,000 mollusk species, and 1,326 species of invertebrates (excluding stony corals) (Grigg 1997a).

<u>Regional Condition</u>—Humans have significantly impacted reefs of the MHI starting in the late 1700s (Maragos 2000). Historically, factors that have contributed to accelerated soil erosion and the discharge of sediments onto reefs from runoff include land clearing, construction of roads, development of sugar cane and pineapple plantations, logging, livestock ranches, and overgrazing by a growing population of game animals and livestock (Maragos 2000). Overgrazing by goats and deer accentuates soil erosion and sedimentation onto reefs on the southeast coast of Molokai and the north coast of Kauai (Maragos 2000).

More recently, human impacts have affected the reefs of Hawaii including coastal development, urbanization, coastal pollution, increased sedimentation, excessive nearshore fishing, resort development, overuse of nearshore reefs (including reef walking and snorkeling), ship groundings, anchor damage, and invasive species (Maragos 2000; Jokiel et al. 2001, 2004; Friedlander et al. 2004). Up to 75% of the human population lives on Oahu and 45% of the population of Oahu lives in Honolulu (Maragos 2000; Friedlander et al. 2004); 10% of the population lives on Maui (Friedlander et al. 2004). Molokai is not as populated as Maui but does have excessive sediment-laden runoff impacting reefs on the south shore of the island.

In 2004, coral reefs of the MHI were considered to be in fair to good condition but were certainly degraded (Friedlander et al. 2004; Jokiel et al. 2004; Pandolfi et al. 2005). In the MHI, coral reefs have been mainly impacted by population growth and the degradation of watersheds (Jokiel et al. 2004). Over fishing on the reefs of Hawaii is a major concern (Pandolfi et al. 2003, 2005); the loss of herbivores allows algae to out compete corals (Pandolfi et al. 2003). In contrast, the coral reefs of the NWHI are in good condition (Friedlander et al. 2004; Pandolfi et al. 2005); bleaching and marine debris are the primary sources of impacts on corals in the NWHI (Friedlander et al. 2004). While human disturbances can be managed on a local scale, global climate change is an ongoing threat (Hughes et al. 2003).

Climate change can affect coral reefs in three principal ways: (1) increased atmospheric carbon dioxide alters ocean chemistry, weakening coral skeletons and diminishing skeletal accretion at high latitude reefs (Kleypas et al. 1999); (2) increased frequency of hurricanes and tropical storms, reducing the recovery time between storms; and (3) increased magnitude of bleaching episodes and disease epidemics (Hughes et al. 2003). The coral reefs of the Hawaiian Islands are potentially susceptible to all three consequences of climate change. Therefore, coral reefs of the MHI, more so than those of the NWHI, are at risk of further degradation caused by climate change and accelerated degradation if existing human disturbances are continued or intensified (Friedlander et al. 2004; Pandolfi et al. 2005).

Coral cover increased between 2000 and 2003 on the reefs of Hawaii and Kauai (Friedlander et al. 2004; Jokiel et al. 2004). Sedimentation on the reefs of Kahoolawe ceased to be a problem when grazing animals were removed and the island was revegetated (Maragos 2000; Friedlander et al. 2004). In 2002, hard coral cover ranged from 2.3 to 84% in 59 sites on the MHI (Jokiel et al. 2004). Six coral species made up 20.3% of the total cover: *Porites lobata* (6.1%), *Porites compressa* (4.5%), *Montipora capitata* (3.9%), *M. patula* (2.7%), *Pocillopora meandrina* (2.4%), and *M. flabellata* (0.7%). Areas of the coastline on older islands (including Kauai and Oahu) that are exposed to the west and northwest moving swells had lower coral cover and lower species richness and diversity (Friedlander et al. 2004). Over 25% of the stations surveyed incurred a significant decrease in coral cover from 2000 to 2003 (Friedlander et al. 2004). Coral cover of the majority of the reefs Jokiel et al. (2004) assessed in 2002 in the MHI was contained between 10% and 50%. Of the six islands Jokiel et al. (2004) surveyed (Kauai, Oahu, Molokai, Kahoolawe, Maui, and Hawaii), Oahu had the highest proportion (41.7%) of reefs with cover lower than 10%. Molokai and Kahoolawe had the highest proportion (50%) of reefs with coral cover exceeding 50% (Jokiel et al. 2004).

Unlike other reefs of the world, Hawaiian reefs have, until recently, been spared from coral disease epidemics (Friedlander et al. 2004). The potential causes of coral tissue necrosis on Hawaiian reefs include elevated dissolved nutrient levels in the water column, mechanical abrasion of the coral tissue, and pulses of excessive sedimentation (Hunter 1999). In three sites of the MHI, Hanauma Bay (Oahu), Honolua (Maui), and Puako (Hawaii), colonies of *Porites lobata* bore tumors and necrotic tissue (Hunter 1999). In addition to coral tissue necrosis, band diseases also occur on corals of Hawaii. The diseased portions of the coral colonies are initially colonized by turf algae (Hunter 1999).

3.4.1.2 Coral communities and reefs of Nihoa

The island of Nihoa is located at the southeastern end of the NWHI. There is a small area of shallow reef habitat around this island exposed to strong wave action and currents (Maragos and Gulko 2002; Maragos et al. 2004). Because of the high energy environment surrounding the island, reef development is limited to encrusting forms and to substrates found in water depths greater than 10 m. On the north side of Nihoa, corals are only found in water deeper than 20 m (Maragos and Gulko 2002). The soft coral, *Sinularia abrupta,* occurs on the windward side in areas shallower than 10 m (NOAA 2001). Most of the shallow reefs on the insular shelf of Nihoa are located on the south side of the island (NCCOS/NOAA 2004; Figure 3-6b).

There are 17 species of stony corals recorded at Nihoa; an encrusting form of *Porites lobata* is the most common species (Maragos and Gulko 2002) and *Pocillopora*, *Porites*, and *Montipora* are the most common genera (Maragos et al. 2004). Impacts incurred by the coral reefs of Nihoa are potentially limited to derelict fishing gear (including nets) and coral bleaching (Friedlander et al. 2004).

3.4.1.3 Coral communities and reefs of Kauai

Receiving over 11.4 m of rainfall per year, upland watersheds on Kauai deliver large quantities of sediments to the coastal area and restrict the development of fringing reefs, particularly in shallow areas and embayments (Grigg 1997a). The exposure to the northeast trade winds creates a condition in which the northeast side of the island receives the majority of the rainfall. Yet, Kauai reefs are best developed along the north and northeast coasts where prevalent wave exposure and currents disperse the sediment-laden runoff before it can impact nearshore reefs. Reefs of Kauai are best developed between 15 and 25 m of water depth where little exposure to sedimentation occurs (Grigg 1997a; Figure 3-7). In 2002, coral cover ranged from 3.6% to 26% on the northern shore of Kauai (Jokiel et al. 2004). Coral cover at two sites on the southern shore ranged from 5.7% to 11.4% (Jokiel et al. 2004).

A fringing reef lies parallel to most of the northern shoreline of Kauai from Haena Point to Papaa Bay except between Kalihiwai Bay and Kilauea Bay and at Moloaa Bay (Figure 3-7). The fringing reef is primarily composed of linear reef and in a few places coralline algae. Seaward of the reef crest, the fore reef and reef slope consist mostly of colonized pavement and linear reef. The colonized pavement on the north shore typically extends 700 m seaward from the reef crest. From Moloaa Bay to Papaa Bay, there is uncolonized pavement seaward of the reef crest. The back reef area on the northern shore contains areas of scattered corals and rock on unconsolidated sediments.

The southern shore from Nahumaalo Point to Port Allen is bordered by a narrow fringing reef. There are six short, narrow stretches of the fore reef slope where the reef consists of colonized volcanic rocks and boulders. These reefs measure approximately 180 to 1,000 km in length and 70 m in width. The longest of these fore reefs is located between Lawai Bay and Makaokahai Point.

West of Puolo Point, a fringing reef hugs the coastline to Poo Point. Seaward of the fringing reef the fore reef slope is colonized volcanic rock and boulders. The remainder of the insular shelf seaward of the fringing reef is comprised of uncolonized volcanic rocks and boulders. The colonized volcanic rock and boulders do not occur further than 400 m northeast of Kaumakani Point. From Kaumakani Point to Poo Point, the seafloor of the nearshore area is primarily covered with uncolonized volcanic rock and boulders with no coral reefs. Beyond Poo Point and up to Mana Point, the nearshore environment does not contain coral reefs and the insular shelf is uncolonized pavement. Off Kokole Point a stretch of sand (1.4 km long) interrupts the uncolonized pavement.

Located 48 NM southwest of Kauai is Kaula Island (21°39'N, 160°33'W), which sits on Kaula Bank. Coral communities surround the crescent-shaped Kaula Island (NOS 2001; Gulko et al. 2002; Figure 3-6b). The entire bank upon which Kaula Island is found is designated as a coral reef ecosystem habitat area of particular concern (HAPC) (WPRFMC 2004). There are potentially 18 km^2 of reef communities within 3 NM of the island, and potentially 10 km^2 of reef communities within the Federal waters that surround the island (Gulko et al. 2002). The island is uninhabited but its nearshore habitats are visited by recreational fishermen and SCUBA divers (Gulko et al. 2002). Nearshore coral communities are potentially impacted by fishing gear, anchoring, and ship groundings (Gulko et al. 2002; Lahela-Adventures.com 2003; RedSea Ocean Adventures 2005).

<u>Nearshore Hawaiian Islands OPAREA, Port Allen to Nohili Point/Barking Sands</u>—North of Mana Point, a narrow fringing reef follows the coastline up to Nohili Point and Barking Sands. Seaward of the fringing reef, broad uncolonized pavement (540 m wide) and colonized pavement (700 m wide) stretch along the coastline. North of Nohili Point, the uncolonized

pavement ends and the colonized pavement continues along a northward heading; it turns gradually to the east to join the coastline north of Keawanui.

3.4.1.4 Coral communities and reefs of Oahu

Coral reefs on the island of Oahu include linear reefs, spur-and-groove reefs, patch reefs, aggregated coral heads, and colonized pavement (NOAA 2003); reefs occupy most of the northern, eastern, and southern sides of the island (Figure 3-8). The Hawaiian Islands OPAREA includes three nearshore areas of Oahu: the Nanakuli Area on the southwestern side, the Pearl Harbor region on the south side, and Kaneohe Bay, Kailua Bay, and Waimanalo Bay area on the eastern side of the island.

Considerable reef development occurs in embayments and sheltered areas on Oahu including Kaneohe Bay and Hanauma Bay (Figure 3-8). Sediment-laden runoff and polluted runoff have impacted reefs of Oahu, and specifically Pearl Harbor and Kaneohe Bay (Banner 1974; Smith 1977; Maragos et al. 1985; Grigg 1997a).

The NCCOS/NOAA (2003) benthic habitat maps show no coral reefs along the western side of Oahu from the U.S. Naval Reservation to the Makua Valley Military Reservation. Furthermore, no reefs are shown along the southeastern end of the island (Kaloko to Wailea Point) (NOAA 2003; Figure 3-8). Fringing reefs are well developed on the southern side of Oahu from the Wailupe Peninsula to Kawaihoa Point and Hanauma Bay while west of Kawaihoa Point, fringing reefs as well as spur-and-groove reefs are well developed (NOAA 2003).

Other spur-and-groove reefs are found along the northern shoreline (from Dillingham Airfield to Kahuku Point), in Kailua Bay and along the southern coastline (Wailupe Peninsula to Honolulu International Airport). North of Waimea Bay on the north coast, limited coral communities have developed in two locations known as Shark's Cove and The Tables (CRAMP 1998a). The most common corals at these ites are *Porites lobata* and *Pocillopora meandrina*. In addition, the encrusting corals *Leptastrea purpurea*, *Pavona varians*, and *Montiora flabellata* are known to occur. Coral reef development has been limited in this area due to exposure to the North Pacific swell (CRAMP 1998a).

In Kaneohe Bay patch reefs are the most common reef type; however, aggregated coral heads are also found. Colonized pavement is present along most of the northern and eastern coastline; patch reefs and colonized pavement are also found between Halona Point and Kaloko (NOAA 2003; Figure 3-8).

<u>Nearshore Hawaiian Islands OPAREA, Nanakuli Area</u>—Even though NCCOS/NOAA (2003) indicates that no coral reefs occur from Kahe Point to Maili Beach Park, corals are located in the Kahe area and have been monitored for anthropogenic impacts since the 1970s (Coles 1998; Jokiel et al. 2004; Figure 3-8, inset map A). The outfall was moved to an offshore location to prevent further impacts on nearshore corals (Coles 1998). From 1983 to 1997, high coral cover developed in the immediate vicinity of the new outfall. Up until 1997, the coral species with the highest cover at Kahe Point were *Porites lobata* and *Pocillopora meandrina*. Coral cover has fluctuated at this site due to natural disturbances (e.g., Hurricane Iniki in 1992) and recovery processes (Coles 1998). In 2002, coral cover a Kahe Point was 15.1% (Jokiel et al. 1998).

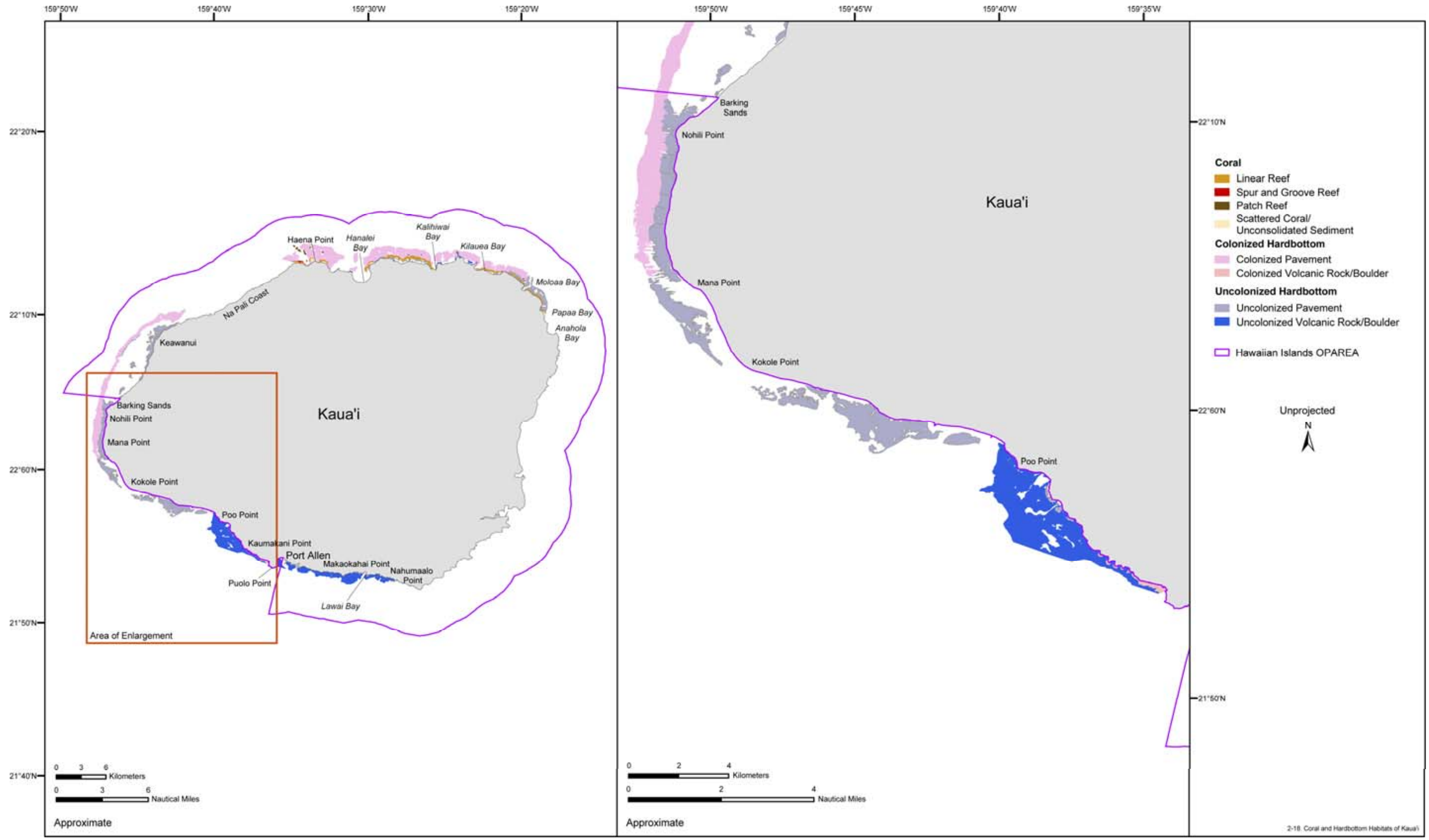


Figure 3-7. Nearshore hardbottom habitats of the Hawaiian Islands OPAREA, Kauai. The percent cover of coral depicted is unknown. Source data: NCCOS/NOAA (2003, 2004).

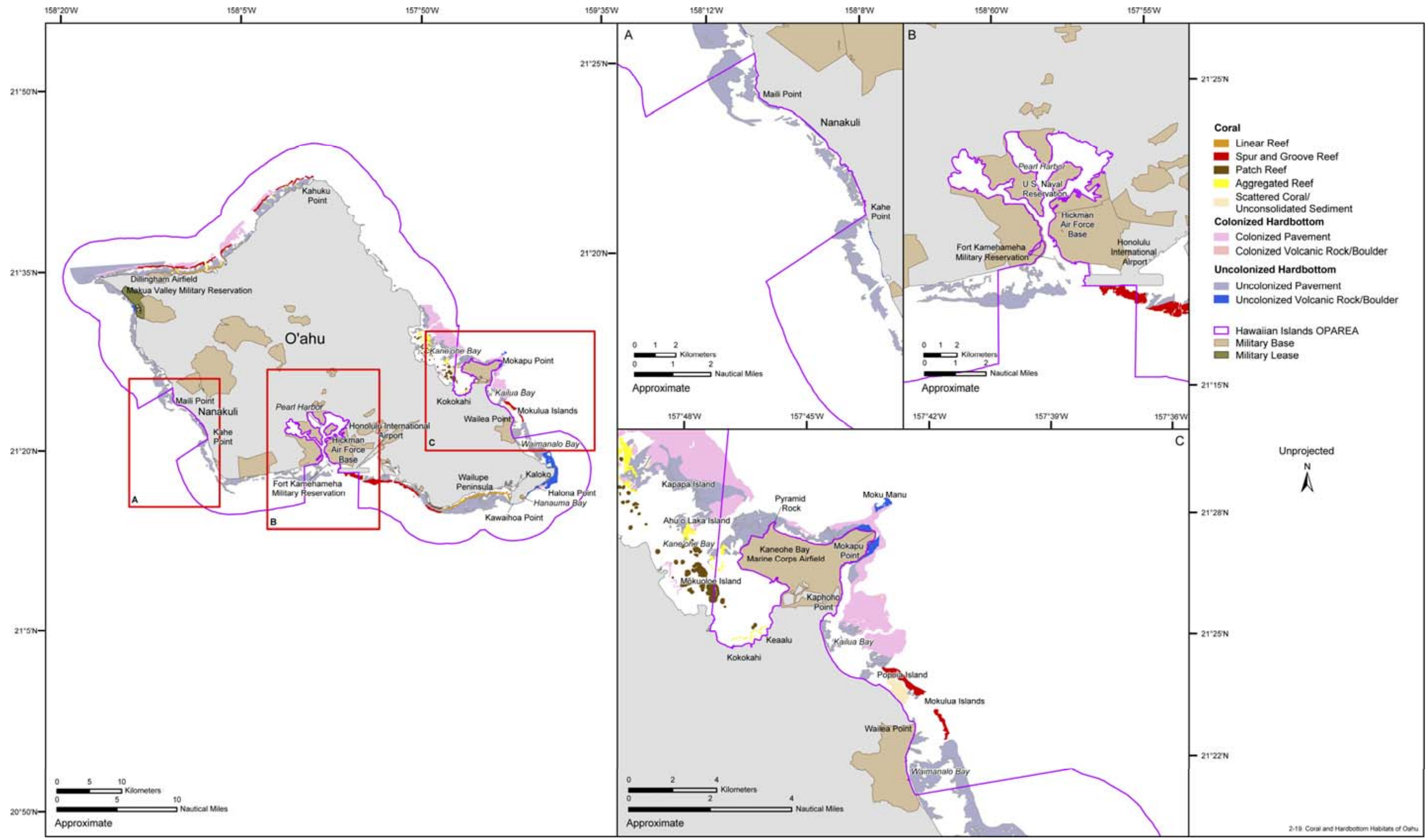


Figure 3-8. Nearshore hardbottom habitats of the Hawaiian Islands OPAREA, Oahu. The percent cover of coral depicted is unknown. Source data: NCCOS/NOAA (2003, 2004).

<u>Nearshore Hawaiian Islands OPAREA, Pearl Harbor Area</u>—A fairly large spur-and-groove reef is found adjacent to the runway of the Honolulu International Airport and on the insular shelf beyond the fore reef (NOAA 2003; Figure 3-8, inset map B). The reef is oriented east-west and is approximately 2.8 km long and 540 m wide (NOAA 2003; Figure 3-8). This reef extends further eastward from the airport area toward Waikiki Beach covering an approximate distance of 8.7 km.

According to NCCOS/NOAA (2003), no coral reefs occur to the west of the airport runway, along the shoreline of the Fort Kamehameha Military Reservation, the Hickam AFB, the U.S. Naval Reservation, or within Pearl Harbor (Figure 3-8). Contrary to the NCCOS/NOAA (2003) data, moderately developed spur and groove reefs do occur on either side of the Pearl Harbor entrance channel, including Tripod Reef and Ahua Reef (Smith personal communication). Tripod Reef is a spur-and-groove system where average coral cover is approximately 40% and live coral cover on Ahua Reef is 40% but in some parts of the reef, coral cover reaches 80% (Smith personal communication).

Five species of stony corals occur within Pearl Harbor: *Pocillopora damicornis*, *P. meandrina*, *Porites compressa*, *Leptastrea purpurea*, and *Montipora patula* (Coles 1999). In 1996, the most common coral in Pearl Harbor was *L. purpurea,* and corals were most abundant at the entrance of the West Loch Channel. Corals may have begun to settle in Pearl Harbor starting in 1993 following the improved water quality conditions and in particular significantly decreased sedimentation (Coles 1999). Stony corals are found on the reef flat bordering the Pearl Harbor shoreline and in particular along the eastern side of the entrance channel from the Fort Kamehameha Sewage Treatment Plant to Hickam Harbor (DoN 2001b).

<u>Nearshore Hawaiian Islands OPAREA, Kaneohe Bay to Waimanalo Bay</u>—In Kaneohe Bay a narrow reef crest is located approximately 1 km offshore that consists of uncolonized pavement. Seaward of the reef crest a fore reef and slope are covered by colonized pavement (NOAA 2003). The colonized pavement is approximately 7 km long and 2 km wide running more or less parallel to the shoreline in a northwest to southeast direction. Aggregated coral heads are located on the back reef and isolated patch reefs occur on the reef flat shoreward of the back reef. The patch reefs range in size from 70 m in diameter to an area of 900 m by 600 m (NOAA 2003; Figure 3-8, inset map C). Three of the patch reefs encircle Kapapa Island, Ahu o Laka Island, and Mokuoloe Island. The largest patch reef encircles Mokuoloe Island. At the southern end of Kaneohe Bay off of Kokokahi and Keaalu, there are three narrow reefs (each approximately 40 m wide) made of aggregated coral heads. The lengths of these reefs range from 350 to 700 m (NOAA 2003; Figure 3-8). The back reef zone to the northeast of the Kaneohe Marine Corps Airfield contains three reefs made of aggregated coral heads located approximately 700 to 1,000 m from the shore and the reef farthest north measures approximately 100 m by 500 m. The other two reefs are relatively narrow (less than 30 to 100 m wide and up to 1,400 m long) (NOAA 2003; Figure 3-8).

Sediment-laden runoff and sewage discharged into the southeastern area of the Kaneohe Bay from 1939 to 1978 caused the luxuriant coral communities in the southeastern and central areas of Kaneohe Bay to become severely degraded (Banner 1974). Coral reefs of the northwestern area of the bay were less affected because of better circulation (Maragos et al. 1985). In 1977 and 1978, the two sewage outfalls in the southeastern part of the bay were diverted to the oceanside of the Mokapu Peninsula, which reduced nutrient concentrations in the bay (Marszalek 1987). This in turn generated unfavorable conditions for the growth of phytoplankton, the green alga *Dictyosphaeria cavernosa,* and particulate and detritus feeders, which led to recovery of the corals (Maragos et al. 1985; Marszalek 1987). The recovery of the coral reefs in Kaneohe Bay is occasionally inhibited by exposure to freshwater, sediments, and nutrients following heavy rainfall (Grigg 1997a; Jokiel 1998).

In 1998, the most common coral species within the Kaneohe Bay was *Porites compressa*, a species that is not wave resistant and thus occurs in protected embayments (Jokiel 1998). Other common coral species of the Kaneohe Bay are *Montipora verrucosa*, *Pocillopora damicornis*, *Cyphastrea ocellina*, *Pavona varians*, and *Fungia scutaria*. The most common coral species on the seaward side of the barrier reef of Kaneohe Bay are *Porites lobata* and *Pocillopora meandrina*. Both species are resistant to high energy environments; mean coral cover on the barrier reef ranges from 5 to 10% (Jokiel 1998). In 2002, the overall range of coral cover at six sites of Kaneohe Bay (two sites at Kaalaea, two sites at Heeia, and two sites at Moku o Lo‘e) was 2.5% to 67.5% (Jokiel et al. 2004).

Outside of Kaneohe Bay and along the Mokapu Peninsula colonized pavement covers a 30 to 700 m wide strip of the nearshore insular shelf from Pyramid Rock to Moku Manu and around Mokapu Point into Kailua Bay and Kaphoho Point (NOAA 2003; Figure 3-8). At Kaphoho Point the colonized pavement changes from a relatively narrow strip to a fairly large area (2 km wide and 3 km long) and is interrupted by a meandering sand channel running east to west (NOAA 2003).

Starting in the area of Popoia Island, the colonized pavement ends and gives way to a reef system that runs parallel to the shore and ends before the Mokulua Islands (NOAA 2003; Figure 3-8). The reef crest is made of encrusting coralline algae that is located 570 m from the shoreline and is approximately 100 m wide and 1.6 km long. Seaward of the reef crest is a relatively large spur-and-groove reef (140 to 350 m wide and 2,100 m long). Landward of this reef crest is a back reef area made of unconsolidated sediments. The area is 540 m wide and 1,250 m long and supports scattered corals and rocks (NOAA 2003).

Further south, past the Mokulua Islands and into the Waimanalo Bay area, coral reefs are limited to a spur-and-groove reef located on the fore reef slope about 1 km east of Wailea Point; this reef is up to 200 m wide and 1.1 km long (NOAA 2003).

3.4.1.5 Coral communities and reefs of Molokai

There are well-developed reefs along the southern coastline of Molokai, few reefs on the eastern side of the island, and no reefs on the western shoreline (NOAA 2003; Cochran-Marquez 2005; Figure 3-9).

The southern coast of Molokai contains the largest and longest fringing reef in the Hawaiian Islands (Grigg 1997a). The reefs of southwestern Molokai are exposed to heavy sedimentation resulting from natural runoff and erosion caused by overgrazing by introduced ungulates (Grigg 1997a). The reefs off Kamiloloa are also in an area impacted by high sedimentation and there is low coral cover on both the reef flat and the fore reef, possibly caused by high sedimentation (CRAMP 1998b). Coral cover is low on the fore reef down to a depth of 12 m. Coral species found on the reef flat include *Montipora capitata*, *Porites compressa*, *Pocillopora damicornis*, and *Psammocora stellata* (CRAMP 1998b). In 2002, coral cover at two sites at Kamiloloa ranged from 2.3% to 2.7% (Jokiel et al. 2004).

The eastern side of Molokai from Halawa Bay to Pukoo harbors corals in only five small areas (NOAA 2003; Figure 3-9). Three of the areas are back reef regions with scattered corals on unconsolidated sediments. The largest of the three areas is about 350 m long and 70 m wide. The other two areas are small (70 m diameter) patch reefs (NOAA 2003).

East of Kamalo, located near the southeastern end of the island, the reef flat is very wide and punctuated by blue holes (submerged karst dissolution features) (CRAMP 1998c). There is a high cover of *Porites compressa* on the eastern vertical faces of the blue holes. The reef crest and fore reef are also wide and extend seaward on the insular shelf. In 1998, the fore reef supported an 80% coral cover; in the 1960s. This site had been impacted by silt produced during the dredging of the Kalae Loa Harbor. Once dredging operations ceased, the reef of Kamalo began to recover; the reefs had fully recovered by 1990 (CRAMP 1998c). In 2002, coral cover at two sites at Kamalo ranged from 55.7% to 59.3% (Jokiel et al. 2004).

West of Pukoo Fishpond, a well-developed barrier reef extends to the western tip of Molokai at Laau Point (approximately 60 km) (NOAA 2003). The reef crest of the barrier reef is 35 to 145 m wide and made of uncolonized and colonized pavement and linear reef. The fore reef and fore reef slope contain aggregated coral heads, colonized pavement, and an extensive spur-and-groove reef. The width of the spur-and-groove reef is typically 250 m and the approximate width ranges from 70 to 780 m. Colonized pavement and scattered coral and rock on unconsolidated sediments are common immediately landward of the reef crest (NOAA 2003).

<u>Nearshore Hawaiian Islands OPAREA, Laau Point to Ilio Point</u>—This nearshore area along the western side of Molokai (Laau Point to Ilio Point) consists of uncolonized volcanic rock and boulders (Figure 3-9).

3.4.1.6 Coral communities and reefs of Hawaii

Overall, coral communities of Hawaii are considered to be in good condition (Grigg 1997a). The accretion of coral reefs around the island Hawaii is correlated to the intensity and frequency of wave disturbance (Grigg 1997a). Coral reefs are primarily found on the western (leeward) side of the island, which includes the nearshore Hawaiian Islands OPAREA between Waikui and Mahukona (Figure 3-10). During summer, an occasional Kona storm generates storm swells of 3 to 6 m in height that can remove accreted reefs on the leeward side.

The windward (eastern) side is exposed to the northeast trade wind swell and the large north Pacific swell; in some locations these factors limit the development of coral communities to scattered coral colonies and thin crusts consisting of coralline algae. Well-developed reefs do occur, however, on the windward side of the island, for example, offshore Hilo Harbor (Smith personal communication). At this location, coral cover exceeds 70% and mainly consists of the coral genera *Montipora* and *Porites* (Smith personal communication). Coral communities of the leeward side are well developed within the 15 to 27 m depth range. The dominant coral on these reefs is *Porites compressa*. In 2002, the coral cover at four sites on the western coast of Hawaii (Kaapuna, Kawaihae, Laaloa, Nenue Point) ranged from 12.2% to 38.6% (Jokiel et al. 2004). Coral cover at two locations on the eastern coast (Laupahoehoe, Leleiwi) ranged from 7.2% to 24.5% (Jokiel et al. 2004).

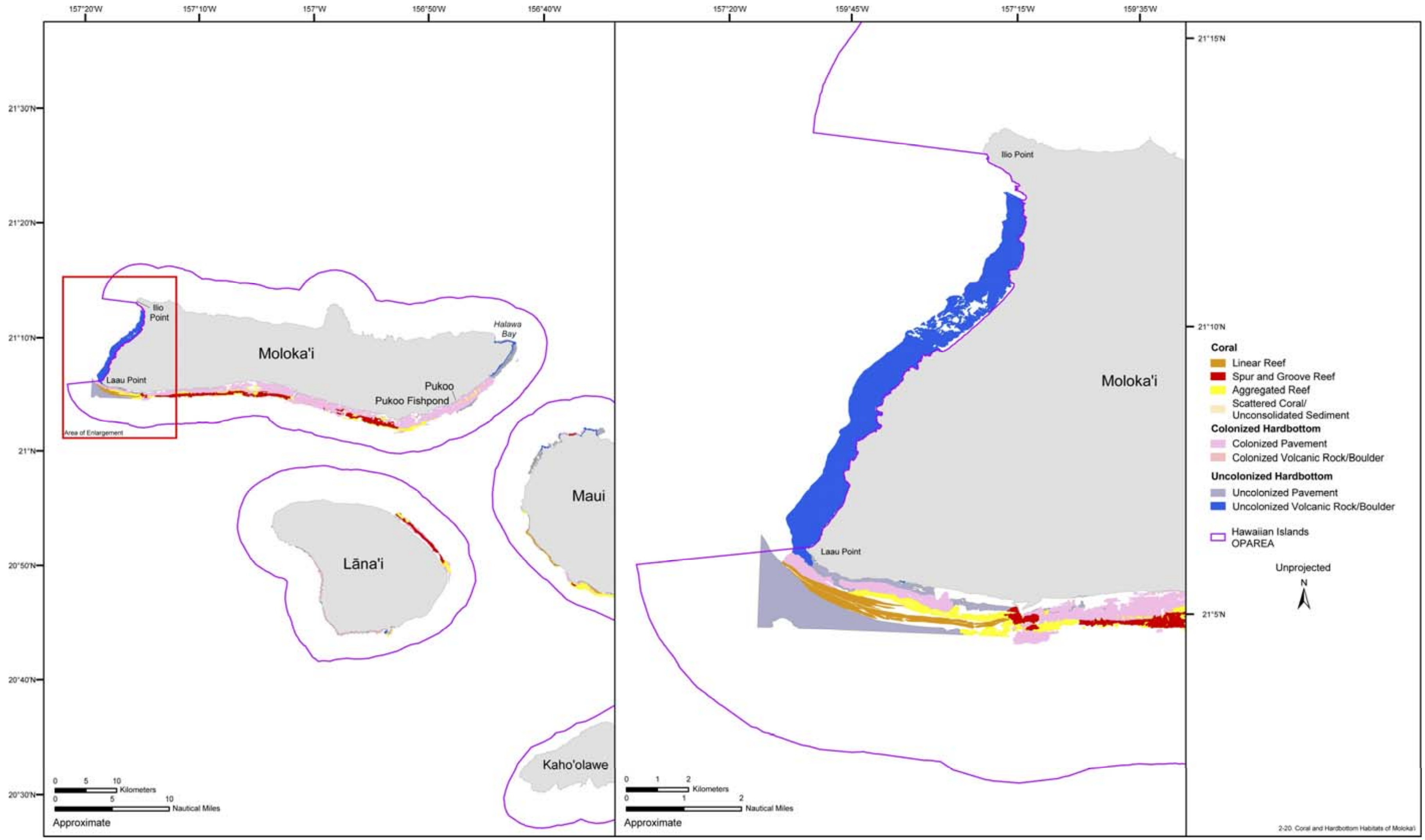


Figure 3-9. Nearshore hardbottom habitats of the Hawaiian Islands OPAREA, Moloka'i. Depicted coral cover ranges from 10 to 100% on the south coast of Moloka'i but is unknown for the remaining coastline. Source data: NCCOS/NOAA (2003, 2004); Cochran-Marquez (2005).

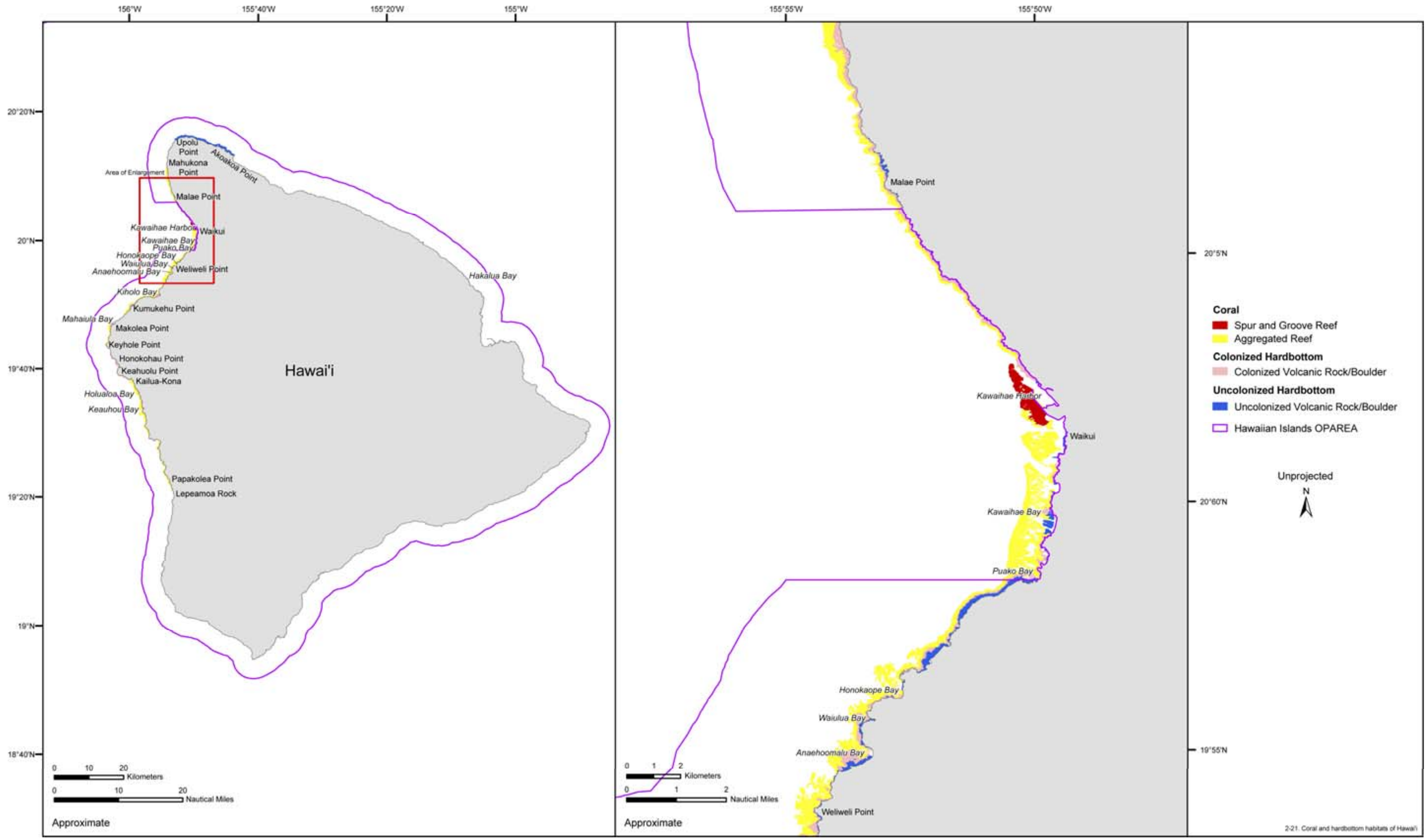


Figure 3-10. Nearshore hardbottom habitats of the Hawaiian Islands OPAREA, Hawaii. The percent cover of coral depicted is unknown. Source data: NCCOS/NOAA (2003, 2004).

The main human-induced disturbances that impact coral reefs of Hawaii are over fishing and aquarium fish collecting (Grigg 1997a). These disturbances limit the reef fish biomass on all of the MHI (Grigg 1997a; Gulko et al. 2002).

A 550 m wide swath of uncolonized volcanic rocks and boulders border the northern coastline of Hawaii from Upolu Point to Akoakoa Point (NOAA 2003; Figure 3-10). There are no coral reefs on this stretch or from Akoakoa Point to Hakalua.

In contrast to the north coast of Hawaii, the west coast supports coral reefs. The shoreline from Papakolea Point to Makaohule Point is typically bordered by an intertidal and nearshore area consisting of uncolonized volcanic rock (Figure 3-10). Seaward of the uncolonized volcanic rock, the insular shelf is successively covered by colonized volcanic rock and aggregated coral heads. No benthic habitats were identified between Keahuolu Point and Honokohau, likely due to the steep topography. The width of the benthic habitats along the west coast (uncolonized volcanic rock, colonized volcanic rock, and aggregated coral heads) varies from narrow (less than 100 m) to very wide (more than 1 km). Roughly, half of the coastal area has narrow benthic habitats while the other half features relatively wide habitats, particularly the colonized volcanic rock and the aggregated coral heads.

South of the nearshore Hawaiian Islands OPAREA, several locations occur along the coastline where the aggregated coral head habitat has developed into fairly large areas. Immediately north of Kualanui Point, the aggregated coral head habitat extends 1 km seaward of the colonized volcanic substrate and is roughly 900 m wide. Keauhou Bay, located 1.8 km north of Kualanui Point, also contains an aggregated coral head habitat that is 1.7 km long and 430 to 640 m wide. Further north along the coast, Holualoa Bay and Kailua-Kona harbor aggregated coral head habitat extending more than 500 m seaward of the colonized volcanic substrate.

From Kailua-Kona to Keahole Point, aggregated coral head habitat was only a very narrow strip at Keahuolu Point. In the bay off Honokohau, aggregated coral head habitat is replaced by a fairly large area of colonized volcanic substrate. North of Keahole Point, the aggregated coral head habitat succeeds the colonized volcanic rock. Off Makolea Point, the aggregated coral head substrate is 1.2 km long and 200 to 350 m wide. In Mahaiula Bay, landward of the aggregated coral head habitat, there is a 350 to 700 m wide and 1.4 km long area of colonized volcanic rock (Figure 3-10).

South of the nearshore Hawaiian Islands OPAREA, there are colonized volcanic rock and/or aggregated coral head habitats at Kumukehu Point, Kiholo Bay, Weliweli Point, Anahoomalu Bay, Waiulua Bay, Honokaope Bay, and Kawaihae Bay (Figure 3-10). From Puako Bay to Waikui, fragments of aggregated coral head habitat are interspersed by sand within a 1 km swath from the shoreline. The most well-developed aggregated coral head habitat is located at the seaward edge.

Nearshore Hawaiian Islands OPAREA, Waikui to Mahukona—North of Waikui, there is a fairly large spur-and-groove reef system (2.5 km long, 180 to 540 m wide) off the Kawaihae small boat harbor (Figure 3-10). This is the only spur-and-groove reef that the NCCOS/NOAA (2003) benthic habitat mapping program recorded for the island of Hawaii. From the Kawaihae small boat harbor to Malae Point, the shoreline is flanked by a narrow intertidal area consisting of uncolonized volcanic rock (approximately 40 m wide); just seaward there is a strip of colonized volcanic rock (40 to 140 m wide) and aggregated coral heads (40 to 140 m wide). Another 4 km north of Malae Point, there is similar habitat zonation and sizes. From Malae Point to Makaohule Point the widths of colonized volcanic rock and aggregated coral head habitats range from 100 to 250 m and 180 to 360 m, respectively.

3.5 DEEP SLOPE TERRACE

A deep-slope terrace is an area with a near-vertical gradient from shore to the insular shelf or shelf break and is typically represented by a very narrow range of depths. The deep-slope terrace habitat is highly stratified as a result of depth zonation and provides high relief and extensive shelter for biota (fish, invertebrates, and macroflora) in the form of holes, crevices, and overhangs (Hixon and Beets 1993; Friedlander and Parrish 1998). Planktivorous fishes are very abundant along deep-slope terrace habitats where the larger diurnal species are found at deeper depths because their major prey is most accessible there. Transient species (i.e., piscivores or planktivores) are generally found at the shallower depths, presumably positioned to forage (Friedlander and Parish 1998).

Two important characteristics of deep-slope terrace habitats result in a region of abundant biota, biomass, and diversity. First, depth and high relief produce regions of habitat zonation as a function of depth. Second, rugosity (roughness or irregularity of a solid surface) provides important microhabitat niches for the resident biota and grazers (Friedlander and Parish 1998). Deep-slope terraces are located offshore of almost every island in the MHI; however, the distribution and location of these important habitats is poorly known. Off the coast of Lanai, only one deep-slope terrace habitat has been identified (Figure 3-5).

3.6 ISLETS

In the MHI, offshore islets (small islands) are abundant; however, they are more common around the larger and older islands. Volcanic islets were initially connected to the larger, main islands before subsidence and erosion separated them; limestone islets are lithified dunes or relict reefs, both types occur in Hawaii (Maragos 1998). Topographically, rocky beaches, sea cliffs, and some small white sand beaches characterize islets (Maragos 1998). They are typically located on sloping rocky submarine topography and have occasional caves covered with live coral and coralline algae. Generally, an islet is similar in composition/substrate to the adjacent island from which it was formed. For example, if an islet is located offshore from sandy beaches, sand substrates and beaches are more common (Maragos 1998).

Islet habitats support abundant biota that is comparable to the benthic communities that are found on fringing and barrier reefs (Maragos 1998). Human impact is generally minor, allowing islets to provide sheltered habitat for coral communities, important nesting beaches and rookeries for seabirds (Maragos 2000), and many of the beaches may be used for hauling out by sea turtles and monk seals (Maragos 1998).

In the MHI, approximately 30 small, coral islets have been identified. Rare endemic plant life is found on several of these islets and almost all are designated as State Offshore Island Seabird Sanctuaries. All but one of the islets (Coconut Island in Kaneohe Bay) are uninhabited (Maragos 2000). A few of the islets in the Hawaiian Islands OPAREA are shown on Figure 3-5 in Pearl Harbor (Oahu), Mamala Bay (Oahu), Kaneohe Bay (Oahu), and Molokini Crater (Maui).

3.7 WATER COLUMN

The water column makes up the largest habitat on earth but its biology is the least known and explored (Nybakken 1997). The water column can be divided into two primary areas: neritic (waters overlying continental shelf from the subtidal zone to a depth of approximately 200 m) and pelagic (open ocean) (Nybakken 1997). Neritic waters can be described as a euphotic zone and pelagic waters consist of both a euphotic zone and an aphotic zone. Each zone is distinct in its characteristics of water movement, quantity of sunlight, temperature, pressure, availability of food, oxygen, and salinity. In the euphotic zone, sunlight reaches approximately 100 to 200 m below the water's surface and provides the energy for photosynthesis. The aphotic zone is a stable environment that is characterized by cold temperatures, extreme water pressure, very little sunlight, and less abundant biota. In the mesopelagic zone (the transition area between the light and dark zone) deep-living zooplankton and other pelagic animals capable of swimming against currents undergo diurnal vertical migration, moving upwards into the light zone at night to feed on the abundant phytoplankton and downwards during the day to avoid predation.

3.7.1 NERITIC OCEAN

The neritic zone consists of the waters that overlie the continental shelf up to depths of approximately 200 m; these waters are directly associated with coasts surrounding all of the Hawaiian Islands. Neritic waters in the Hawaiian Islands receive discharges and effluents from the land, have high oxygen concentrations, and are exposed to swells, waves, and surf (Chave and Malahoff 1998; Maragos 1998). Most pelagic animals capable of swimming against currents live near the sea surface where food is plentiful but many live or eventually migrate deeper in the water column (DoN 2001c). The endangered hawksbill turtle, Hawaiian monk seal, humpback whale, and threatened green turtle forage, rest, or otherwise use neritic waters. In addition, neritic waters support the majority of the oceanic photosynthetic plants including phytoplankton and floating algae (*Sargassum* and others) (Maragos 1998).

3.7.2 PELAGIC OCEAN

The pelagic zone encompasses open ocean waters beyond the neritic zone (Maragos 1998). Pelagic environments in the Hawaiian Islands extend from the surface to water depths of more than 6,000 m, are usually pristine, are exposed to swells, currents, and winds from all directions, have deep eddies, and experience an oxygen minimum zone at 600 m depth causing a dramatic shift in deep-sea fauna (Chave and Malahoff 1998; Maragos 1998, 2000).

Pelagic biota live in the water column and have little or no association with the benthos. The organisms living in pelagic communities may be drifters (plankton) or swimmers (pelagic animals capable of swimming against currents). Plankton drift with the ocean currents and can be plant-like organisms (phytoplankton) or animals (zooplankton). Phytoplankton floats in the photic zone and provide food for zooplankton and some other larger marine animals. Zooplankton (70% are crustaceans) live throughout the water column; they can float about freely throughout their lives or spend only the early part of their lives as plankton others settle or attach to the seafloor and become part of the benthos (DoN 2001c). In addition, there are many animals that associate and forage in the pelagic habitat including fishes, marine mammals (e.g., endangered humpback whale and monk seal), the threatened green turtle, and seabirds (e.g., endangered Newell's shearwater) (Maragos 1998).

3.8 DEEP BENTHIC

The deep benthic habitat and its associated boundary layer has long been perceived as a remote and exotic environment; however, it is closely coupled with the physical and biological dynamics of the upper ocean. Significant physical, chemical, and biological interactions occur between the upper ocean and the deep benthos on time scales of days to millennia (Smith 1991). Benthic communities live within, upon, or are associated with the ocean bottom and rely on the input of food or falling detritus from the surface waters. In general, benthic biomass decreases and diversity increases with increasing distance from shore. Deep benthic fauna living on or in the benthos grow more slowly, live longer, and have smaller broods than animals living in shallow waters.

The bottom substrate of the deep-sea is typically covered with silts, clays, and fine sediments; however, there is the occasional hard bottom substrate offered by seamounts and guyots. The type of bottom substrate governs the abundance and diversity of deep-sea organisms because there are distinct differences between hard bottom and soft bottom communities. Abundance and diversity are generally higher on hard, irregular substrates than on smooth, hard surfaces. However, in soft bottom habitats, it has recently been shown that although abundance decreases with depth, diversity increases with depth (Gage 1996). This rich species diversity can be attributed to both biological and physical mechanisms. Biological mechanisms include competition, predation, larval recruitment, and biological structuring of the substrate; physical mechanisms include nutrients, light, waves, and currents.

In the Hawaiian Islands, very productive deep benthic microhabitats and communities extend to depths of more than 6,000 m and include rocky outcroppings (e.g., seamounts and guyots), deep-sea corals, hydrothermal vents, chemosynthetic communities, and abyssal plains (Maragos 2000). The bottom sediments covering the sea floor in much of the Hawaiian Islands are volcanic or marine in nature (carbonate sediments from coral reefs) (Eldredge 1983). Basalt and carbonate rock substrates are common on the insular slopes; whereas, sediments (e.g., sands, gravels, and pebbles) are prevalent along the flattened surfaces of the abyssal plain. Some of the more prevalent sand-dwelling communities include cone shells (*Conus*), tritons (*Charonia*), pen shells (*Pinna*), and garden eels. This habitat supports many fish, invertebrates, and deep-sea corals including the rare, depleted precious corals (e.g., gold and pink coral, *Corallium*); however, living plants are rare or absent on the deep sea floor because of the lack of light (Maragos 1998).

Of the sponge, coral, and echinoderm species found in the Hawaiian Islands, 45% occur at depths of 15 to 400 m, 15% at 400 to 800 m, and 12% at 800 to 2000 m (Chave and Malahoff 1998). Glass sponges, crinoids, and most gorgonians occur at depths greater than 300 m; only a few gorgonians and black corals are found above 250 m (Chave and Malahoff 1998). Benthic fish and crustacean communities rapidly decrease in abundance and diversity with depth. With increasing depth, light intensity declines and eventually algae and plants are unable to survive. Benthic algae and reef-building corals also decrease in abundance and size with increasing depth. Below 100 m only a few, if any, small, stony corals are found (Chave and Malahoff 1998). Thus, there is a change in community structure with depth; at greater depths animals, including non-reef-building corals, obtain their food through suspension feeding. Suspension-feeders capture food particles from the plankton or detritus suspended in the water column. This method of food capture is efficient in the deep-sea benthic environment because it takes advantage of the swift currents that commonly flow over ridges, banks, and pinnacles on the seafloor (Chave and Malahoff 1998).

3.8.1 ABYSSAL PLAIN

The abyssal plain extends from bordering continental rises to mid-oceanic ridges; it is a relatively flat expanse of sea floor that is 3,000 to 5,000 m below sea level. Abyssal plains are covered with fine particles that constantly rain down from the overlying water column. These particles, fine, clay-sized sediments and the remains of marine life, drift slowly downward filling in depressions on the irregular rocky ocean floor. They have accumulated to make up the 5,000 m thick sediment bed that constitutes the largest portion of the ocean floor (O'Dor 2003). Because of this thick layer of sediment, abyssal plains are among the smoothest surfaces on the planet, with less than five feet of vertical variation for every mile. It is regarded as the true ocean floor and is characterized by extremely cold water, no light, and extremely diverse marine inhabitants (e.g., deep sea isopods, polychaetes, worms, sponges, crustaceans, and sea stars) that are adapted to near freezing temperatures and immense pressure (Wilson 1976; Beaulieu 2001a, b; O'Dor 2003; Cunha and Wilson 2003). The deep sea is one of the largest and least explored ecosystems on Earth and is a major reservoir of biodiversity and evolutionary novelty.

Extensive areas of abyssal plains exist in the Hawaiian Islands OPAREA. These areas vary in water depth, sediment type, organic content, terrestrial influence, oceanographic conditions, and contaminant inputs (Grassle 1991). As a result, the soft substrate benthic assemblages of the region are complex and diverse. In general, organism abundance decreases and diversity increases with depth.

3.8.2 DEEP-SEA CORALS

Deep-sea corals live in complete darkness, in temperatures as low as 4°C, and in waters as deep as 6,000 m (CoRIS 2003). They lack the symbiotic zooxanthellae found in tropical reef-building corals. Thus, deep-sea corals do not benefit from a carbon supply provided by symbiotic algae but rather survive solely on suspension feeding. Deep-sea corals can form large communities ranging in size from patches of small solitary colonies to massive reef structures (mounds, banks, and forests) spanning an estimated total spatial coverage of about of 2,000 km^2 (Cairns 1994; Freiwald 2004). Much like shallow-water corals, deep-sea corals are fragile, slow growing, and can survive for hundreds of years (Roberts and Hirshfield 2003). Deep-sea corals can be of two basic types: 1) the hard or stony corals which are related to those found on tropical coral reefs; and 2) the soft corals which include the familiar gorgonians of tropical shallow seas, as well as a broad diversity of other fleshy or tree-like forms. Some of the stony corals are small but they can grow to be very massive. The soft corals may be small and delicate or very large and tree-like (Watling 2003).

Deep-sea coral communities provide habitat, feeding grounds, recruitment, and nursery grounds for a range of deep-water organisms including epibenthic invertebrates (e.g., echinoderms, sponges, polychaetes, crustaceans, and mollusks), fishes, solitary precious corals (e.g., black corals), and marine mammals (e.g., monk seals) (Maragos 1998; Midson 2000; CoRIS 2003; Roberts and Hirshfield 2003; Freiwald et al. 2004). The biological diversity of deep-sea corals is high; from an economic perspective this diversity creates valuable habitat for several commercially fished species (Gass 2003). However, the full ecological importance/value of deep-sea coral habitat is still unknown.

Deep-sea coral communities are prevalent throughout the Hawaiian archipelago (Figure 3-11). They often form offshore reefs that surround all of the MHI at depths between 50 and 200 m (Maragos 1998). Although light penetrates to these depths, it is normally insufficient for photosynthesis. The term 'deep-sea corals' may be misleading because substrate, currents, temperature, salinity, and nutrient supply are more important factors in determining the distribution of growth rather than depth (Chave and Malahoff 1998). In the benthos of the neritic zone these offshore reefs form on a variety of substrates ranging from rocky (e.g., outcrops and steep slopes) to sandy sediment beds. In addition to corals, depth-adapted algae are common. The common coral reef-forming species include *Cycloseris*, *Leptoseris*, and *Coscinaraea* (Maragos 1998). However, most deep-sea corals are not reef-builders (Gass 2003).

In the Hawaiian Islands, gorgonians are the most common group of deep-sea corals. Of the gorgonians, primnoids are the most abundant group in the Hawaiian archipelago and are dominant off Molokai (Chave and Malahoff 1998). In the deep waters of the Hawaiian Islands and Johnston Atoll, deep-sea corals belonging to Milleporina and Stylasterina (the hydrocorals) and Alyconacea (soft corals) are usually found in small colonies cemented to rocks (Freiwald et al. 2004). Off Penguin Bank (Maui) at 180 m depth, small colonies of yellow dendrophyllid corals, harp primnoids, and precious corals inhabit the limestone cliffs (Chave and Malahoff 1998). Deeper than 250 m on the older lava flow and limestone formations there are some small, solitary and a few small, colonies of stony corals that dot the landscape (Chave and Malahoff 1998). Table 3-1 lists the most abundant deep-sea corals located in the Hawaiian Islands OPAREA and vicinity. However, very little of the Hawaiian Islands seafloor has been surveyed; therefore, the distribution of Hawaiian deep-sea corals is not well known (Freiwald et al. 2004). Potential threats to deep-sea corals includes fishing (e.g., bottom trawling), oil- and gas-related activities, cable laying, seabed aggregate extraction, shipping activities, the disposal of waste in deep waters, coral exploitation, other mineral exploration, and increased atmospheric CO_2 (Gass 2003; Freiwald et al. 2004).

Precious corals are heavily exploited by the coral trade to make beads, idols, and jewelry (Midson 1999). In the Hawaiian archipelago, the distribution of three precious corals (i.e., red and pink, Hawaiian gold, and black) ranges between 200 and 600 m depth; they are found in relatively (on a large scale) aggregated areas where the bottom has been free of sediment for extended periods of time. The red (*Corallium regale*) and pink (*Corallium secundum*) corals are found at depths of 150 to 300 m; they grow at a very slow rate of only 0.64 cm/yr (Midson 1999). The Hawaiian gold coral (*Gerardia* spp.) is found off Makapu'u Point at 365 m depth, on Cross Seamount (Oahu) at 400 m depth, and off Keahole Point (Hawaii) at 400 m depth. In Hawaii the larvae of gold corals settle on bamboo corals (Chave and Malahoff 1998). They grow at a rate of about 7.6 cm/yr. Black coral (*Antipathes Grandis*) form mature colonies that may take up to 50 years to grow. Black corals are found attached to ridges, benches, and hummocks where currents are strong (Midson 1999). The distribution of precious coral beds is patchy and poorly known. In 1958, the first new black coral bed to be found in centuries was discovered off Lahaina (Maui) (Freiwald et al. 2004). Fish utilize precious coral beds for shelter and Hawaiian Monk Seals feed on these resident fish. Precious corals range in age to as much as 75 years; human harvesting could alter the habitat for decades. Currently, harvest regulations are being amended to protect this endangered Hawaiian Monk Seal habitat (Midson 1999). The Makapu'u precious coral bed is an established bed that is restricted from harvest; for all the other precious coral beds in the Hawaiian Islands, both State and Federal laws strictly regulate the harvest to approximately 3% of the bed annually (Freiwald et al. 2004).

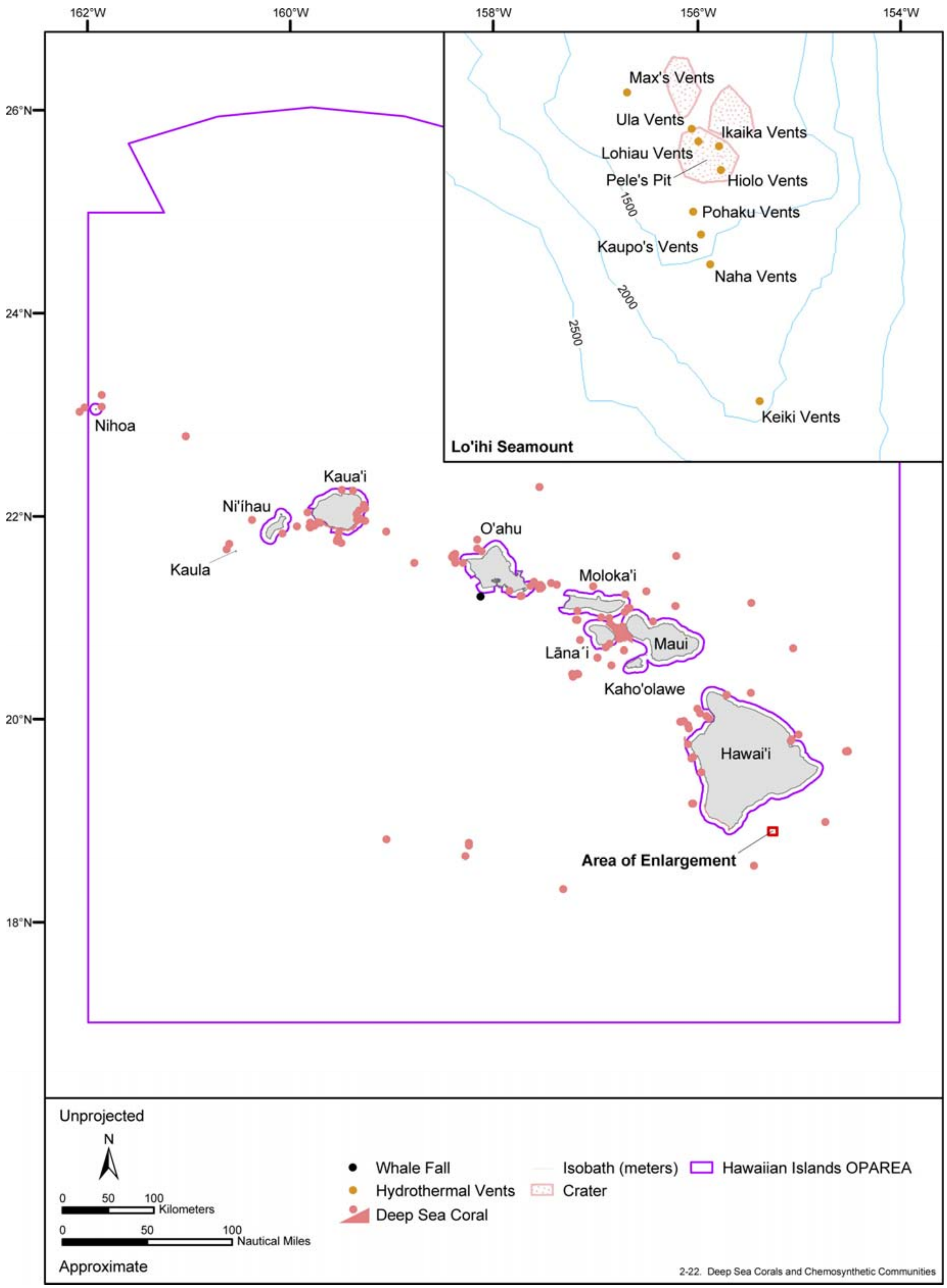


Figure 3-11. Distribution of deep-sea corals, hydrothermal vents, and the one known whale fall in the Hawaiian Islands OPAREA and vicinity. Source data: MCBI (2003) and Dahlgren et al. (2004). Map adapted from: Wheat et al. (2000).

Table 3-1. The most abundant deep-sea corals located in the Hawaiian Islands OPAREA and vicinity (adapted from Chave and Malahoff 1998).

Species	Depth (m)	Location (observed) in Hawaiian Islands OPAREA and vicinity
*Corallium secundum**	183-1380	Cross Seamount; Hawaiian archipelago
Paramuricid blue	180-1530	Cross Seamount; high Hawaiian Islands
Paramuricid tan	251-1500	Cross Seamount; Hawaiian archipelago
Narella spp.	327-515	Leeward Oahu; windward Hawaii; windward Oahu
Eunicella spp.	332-450	Leeward Oahu; windward Hawaii; windward Oahu
Lepidisis olapa Musik	318-2040	Cross Seamount; Hawaiian archipelago
Calibelemnon symmetricum	196-1650	Cross Seamount; Hawaiian archipelago; Johnston Atoll
Gerardia spp.*	343-1500	Cross Seamount; high Hawaiian Islands
Parazoanthus spp.	332-1025	Leeward Hawaii; Leeward Oahu; Windward Hawaii; Windward Oahu
Montipora spp.	35-158	Hawaiian archipelago; Johnston Atoll
Leptoseris spp.	54-168	High Hawaiian Islands; Johnston Atoll
Madracis kauaiensis Vaughan	122-268	High Hawaiian Islands; Johnston Atoll
Porites spp.	15-187	Hawaiian archipelago; Johnston Atoll
Cirrhipathes spiralis	107-450	Hawaiian archipelago; Johnston Atoll

Species labeled with a "*" are the precious corals and are described in further detail in Appendix A.

3.8.3 DEEP ROCKY SUBSTRATE

In the Hawaiian Islands, rocky areas (e.g., rocky outcroppings, rubble, talus, vertical wall, and seamounts) are interspersed with soft substrate such as sand or gravel. Characteristically, on deep hard substrate, patterns of species distribution and abundance are related to substrate relief (Thompson et al. 1993). These habitats are challenging to study because they usually lie beyond the range of SCUBA and mechanical sampling is difficult. In general, most deep hardbottom organisms are suspension feeders; for example, corals, anemones, ophiuroids, and crinoids are all common in the Hawaiian Islands area. In the Hawaiian Islands, the macrophyte and macrofauna assemblages associated with seamount habitats have been extensively studied; this information is detailed below.

3.8.3.1 Seamounts

Seamounts are found in all oceans but are more numerous in the Pacific Ocean, with over 2,000 having been identified (Thompson et al. 1993). Seamounts occur wherever magma has risen to the sea floor and erupted. Lava or magma that has erupted and hardened then forms new seafloor. 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). Very little research has been conducted on seamounts; they are among the least understood habitats in the ocean-basins and are even more poorly understood than abyssal plains (Rogers 1994). Seamounts provide a unique habitat for both deep-sea and shallow water organisms due to the large ranges of depth, hard substrate, steep vertical gradients, cryptic topography, variable currents, clear oceanic waters, and geographic isolation that characterize seamount habitats (Rogers 1994). Thus, seamounts are capable of supporting a wide range of organisms (Wilson and Kaufman 1987). The most common invertebrates found on seamounts worldwide are cnidarians and the most common fishes are scorpaenids and morids (Wilson and Kaufman 1987). The abundant and diverse benthic fauna consists of a wide array of sponges (including large brilliant-yellow barrel sponges that have been known to support intrinsic communities), coral (including large gorgonians and huge golden coral seafans), brittlestars, crinoids, clams, seastars, polychaetes, crabs, tunicates, sea urchins, sea cucumbers, and octopi (Rogers 1994).

Seamounts attract significant commercial species as a result of the aggregation of exploitable populations of benthopelagic animals. A rich and diverse benthic fauna with a high degree of endemism exists on seamounts. Levels of endemism among 850 macro- and megafaunal species could be as high as 29 to 34% (Johnston and Santillo 2004). Thus, seamounts can function ecologically as island groups or chains, leading to localized species distributions with apparent speciation. Seamount-associated fish are in general very long-lived species and are thus extremely vulnerable to overexploitation. Some seamount fish and benthos are already known to have been seriously impacted by fishing activities (Johnston and Santillo 2004).

Although there are numerous seamounts located in the Hawaiian Islands OPAREA (Figure 3-5), the Lo‘ihi Seamount is significant because it may become the newest volcanic island in the archipelago (Maragos 2000). Lo‘ihi also provides additional habitat because it harbors chemosynthetic communities in and around its hydrothermal vents.

3.9 CHEMOSYNTHETIC COMMUNITIES

In a normal marine ecosystem, the primary producers (e.g., phytoplankton and seagrasses) produce energy through photosynthesis (a photosynthetic ecosystem). In environments rich in methane and sulfides, chemosynthetic bacteria, sulfur-oxidizing bacteria, methane-oxidizing bacteria, and sulfide-reducing bacteria, create the energy that can be used by the organisms in the environment (a chemosynthetic ecosystem) (JAMSTEC 1998). Chemosynthetic communities are a significant source of biological productivity on the deep-sea floor where bacterial communities undergo chemosynthesis to utilize chemicals released from the seafloor to create energy. Little is known regarding the significance of bacterial productivity on the ocean floor on a global scale.

Chemosynthetic habitats are formed by a variety of geological and biological processes on continental margins. Chemosynthesis-based communities, despite their location in the deep sea, have high biomasses maintained by chemosynthetic bacterial production (Fujikura et al. 2002). Hydrothermal vent communities are found across plate formation regions and at submarine volcanoes where volcanic activity is high (Hessler and Lonsdale 1991; Hashimoto et al. 1995; Galkin 1997). Gas hydrates that seep from the sediment bed support extensive chemosynthetic communities (Fisher et al. 2000; Lanoil et al. 2001; Reed et al. 2002). In addition, chemosynthetic communities are also found around whale carcasses and grain carriers that have sunk to the deep-sea floor where the benthic fauna are sustained by the methane and sulfides produced during the decay of fat and grain (JAMSTEC 1998).

3.9.1 HYDROTHERMAL VENTS

Deep-sea hydrothermal vents occur in areas where new crust is being formed, at or near mid-ocean ridge systems both in fore-arc and back-arc regions (Humphris 1995). Seawater permeating through the crust and upper mantle is superheated by hot basalt and is chemically altered to form hydrothermal fluids. These less dense hydrothermal fluids rise through the network of fissures in the newly-formed seafloor (Humphris 1995; McMullin et al. 2000). The temperature of the hydrothermal fluid is characteristically 200° to 400°C in areas of focused flows and less than 200°C in areas of diffuse flow. Hydrothermal vent fluids are therefore rich in chemicals as the heated seawater reacts with the molten rock, causing metals and other minerals such as sulfur to go into solution.

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 the much cooler seawater overlying the vent, heavy metals precipitate out and accumulate, forming chimneys and mounds. In complete darkness, high ambient pressure, and extreme thermal and chemical conditions of the deep sea, metazoans (multicellular animals) are able to adapt and colonize these sites to form luxuriant chemosynthetic communities. Chemosynthetic bacteria use the reduced chemicals of the hydrothermal fluid (primarily hydrogen sulfide) as an energy source for carbon fixation and generate chemosynthetic-based primary production. Metazoans consume the chemosynthetic bacteria or form symbiotic relationships 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.

Since 1979, more than 200 seafloor vent sites have been located (Wheat et al. 2000). These plumes are of fundamental importance to the composition of the oceans. These hot springs support a unique ecosystem of micro-organisms and animals that do not need sunlight to survive: some 500 new species have been found. In the Hawaiian Islands OPAREA, there was one known hydrothermal vent field, Pele's Vents, on the summit of the Lo'ihi Seamount (Hawaii) (Chave and Malahoff 1998). Pele's Vents supports an active, deep-sea hydrothermal vent ecosystem which is surrounded by cold seawater; this provides specific and unique physical, chemical, and biological inputs that affect all of the habitats contained therein (Moyer et al. 1998). Vertical dikes filled with molten magma fill the interior of Lo'ihi. Seawater interacts with the hot dikes located there by circulating freely through the porous pillow lava and talus that cover the slopes of Lo'ihi. The seawater becomes hot, leaches minerals from the surrounding basalt, and migrates upward as a mineral-laden heated solution. The 30°C fluid exiting the vents comes into contact with the much cooler 2°C seawater, resulting in the precipitation of minerals such as iron oxide, a yellow to red powdery substance seen covering the summit (Chave and Malahoff 1998). The composition of hydrothermal discharge from Lo'ihi is similar to the composition of the discharge from other non-mid-ocean-ridge axis hydrothermal systems (i.e., rich in Fe and CO_2) (Wheat et al. 2000).

For at least 9 years prior to July 1996, hydrothermal fluids flowed from Pele's Vents on Loihi Seamount (Wheat et al. 2000). In July/August 1996, a tectonic event destroyed Pele's Vents, creating a pit crater (Pele's Pit) and several of the hydrothermal venting sites (Wheat et al. 2000; Figure 3-11). Thermal and mass fluxes resulting from the 1996 event impacted the regional hydrography. The currently active areas of Lo'ihi volcano have created hostile environments for marine animals by the noxious particles emitted from hydrothermal vents, sulfur-rich sediments, and unstable rocks (Wheat et al. 2000). While large bacterial mats are present at the vent sites, only a few small animals inhabit the vents, unlike the rich faunal assemblages inhabiting older hydrothermal areas of the Pacific Ocean (Wheat et al. 2000). Large metazoans inhabit the slopes of Lo'ihi away from the hydrothermal deposits, vents, and older lava flows on the volcano's flanks; cnidarians and large sessile sponges inhabit the areas several hundred meters from the vent fields (Chave and Malahoff 1998).

3.9.2 METHANE HYDRATES

Hydrates are crystalline solids comprising water molecules linked by hydrogen bonds in a tight polyhedral cage structure. Methane (or other hydrocarbon) molecules are packed closely together in the hydrate lattice. They are stable at depths below 200 m and at temperatures below 10 to 15°C (Gornitz and Fung 1994). A cubic meter of hydrate yields about 160 m^3 of methane at standard temperature and pressure and about 0.87 m^3 of water (Masutani and Coffin 2001). Methane hydrates are found in high-pressure, moderate temperature regimes in ocean sediments and low-temperature Arctic permafrost zones. Estimates of the total volume of hydrocarbon gas locked in hydrate deposits worldwide range widely from about 2.8×10^{15} to 7.6×10^{18} m^3 (Masutani and Coffin 2001). Significant hydrate deposits have been identified worldwide in undersea basins on continental margins; sediment layers in deep ocean basins also may contain large deposits of methane hydrates but these areas have not yet been thoroughly explored. Methane hydrates may exercise a profound effect on the global climate if the carbon sequestered in these solids is released into the environment by commercial exploitation of the fuel or through destabilization and outgassing induced by ocean warming (Masutani and Coffin 2001). Methane hydrates have the potential to form in the deeper areas of the Hawaiian Islands OPAREA where the water is cold and the pressure is high enough to support hydrate formation.

3.9.3 WHALE FALLS

In addition to hydrothermal vents and methane hydrates, whale carcasses on the seafloor support a high abundance of organisms commonly found near vents and other deep-sea hard substrates (Baco and Smith 2003). It has been estimated that at any given time there may be in excess of 500,000 sulfide-rich whale skeletons on the deep-sea floor (Smith and Baco 2003). These "whale falls" promote high species diversity by providing hard substrates for settling, organic enrichment, and free sulfides on a typically organic-poor, sediment covered sea floor (Bennett et al. 1994; Butman et al. 1995; Smith and Baco 2003); these whale falls can support productive communities of chemosynthetic organisms for decades.

The biota of geological reducing habitats (e.g., vents and hydrates) can be compared with those of biogenic origin (due to large organic falls) to fully understand the biogeography and evolution of chemosynthetic communities (Smith et al. 2003). Natural whale falls and wood falls, hydrothermal vents, and wood falls provide specific habitat duration and faunal community. Each of these chemosynthetic habitats appears to foster a characteristic fauna; sulfide-rich whale falls (50 to 80 year habitat duration) harbor a highly diverse assemblage (100 to 200 species) dominated by bathymodiolin mussels, cocculiniform limpets, dorvilleid polychaetes, and in some cases vesicomyid clams (Smith et al. 2003). Wood falls harbor low-diversity assemblages of wood-boring bivalves, galatheids, and ampharetid, dorvilleid and polynoid polychaetes. At present, whale falls are known to share 11 species with hydrothermal vents and 20 species with cold seeps (Smith et al. 2003).

Whale falls are intense point sources of organic enrichment at the deep-sea floor; the decay of the whale fall passes through three successional stages. At less than 1.5 months, whale falls have largely intact carcasses with soft tissue; at this stage, predominantly hagfish, sleeper sharks, and lysianassic amphipods scavenge the whale fall (Dahlgren et al. 2004). Carcasses at the seafloor for 4 to 18 months still attract hagfish but are essentially stripped of soft tissue; at this stage the whale fall primarily supports invertebrate opportunists on bones and in organically enriched sediments. Organic-rich bones and sediments characterize the "enrichment opportunist" stage approximately 4 to 24 months after carcass arrival on the seafloor (Dahlgren et al. 2004). The bones of carcasses at the seafloor for 4.5 to >15 years are colonized by chemoautotrophic microbial mats and macrofaunal invertebrates including some taxa known from vents such as vesicomyid clams, bathymodiolin mussels, and vestimentiferan polychaetes (Baco and Smith 2003; Dahlgren et al. 2004). During all stages, whale falls harbor a number of potentially endemic species and have been shown to create ephemeral habitats. These ephemeral habitats have been hypothesized to be a significant source for broad dispersal across the deep-sea floor and effective local recruitment for new sites (Dahlgren et al. 2004).

There is one known whale fall community in the Hawaiian Islands OPAREA and vicinity located off the coast of Oahu (Figure 3-11). This community was implanted on the slope of Oahu at 1000 m and consists of one sperm whale and balaeanopterid bones (Dahlgren et al. 2004).

3.10 ARTIFICIAL HABITAT

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, fish aggregating devices (FAD) are suspended in the water column and anchored on the seafloor to attract fish (Klima and Wickham 1971; Bohnsack et al. 1991; Blue Water 2002). Artificial structures provide a substrate upon which a marine community can develop (Fager 1971). 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 (Fager 1971; Bohnsack et al. 1991). In the Hawaiian Islands OPAREA, there are a significant number of artificial habitats available for the marine communities. Shipwrecks are the most common followed by FADs and artificial reefs (Figure 3-12).

3.10.1 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 (Seaman and Jensen 2000). 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) (ARS 1997). The purpose of deploying artificial reefs in the marine environment is to: (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 (Seaman and Jensen 2000).

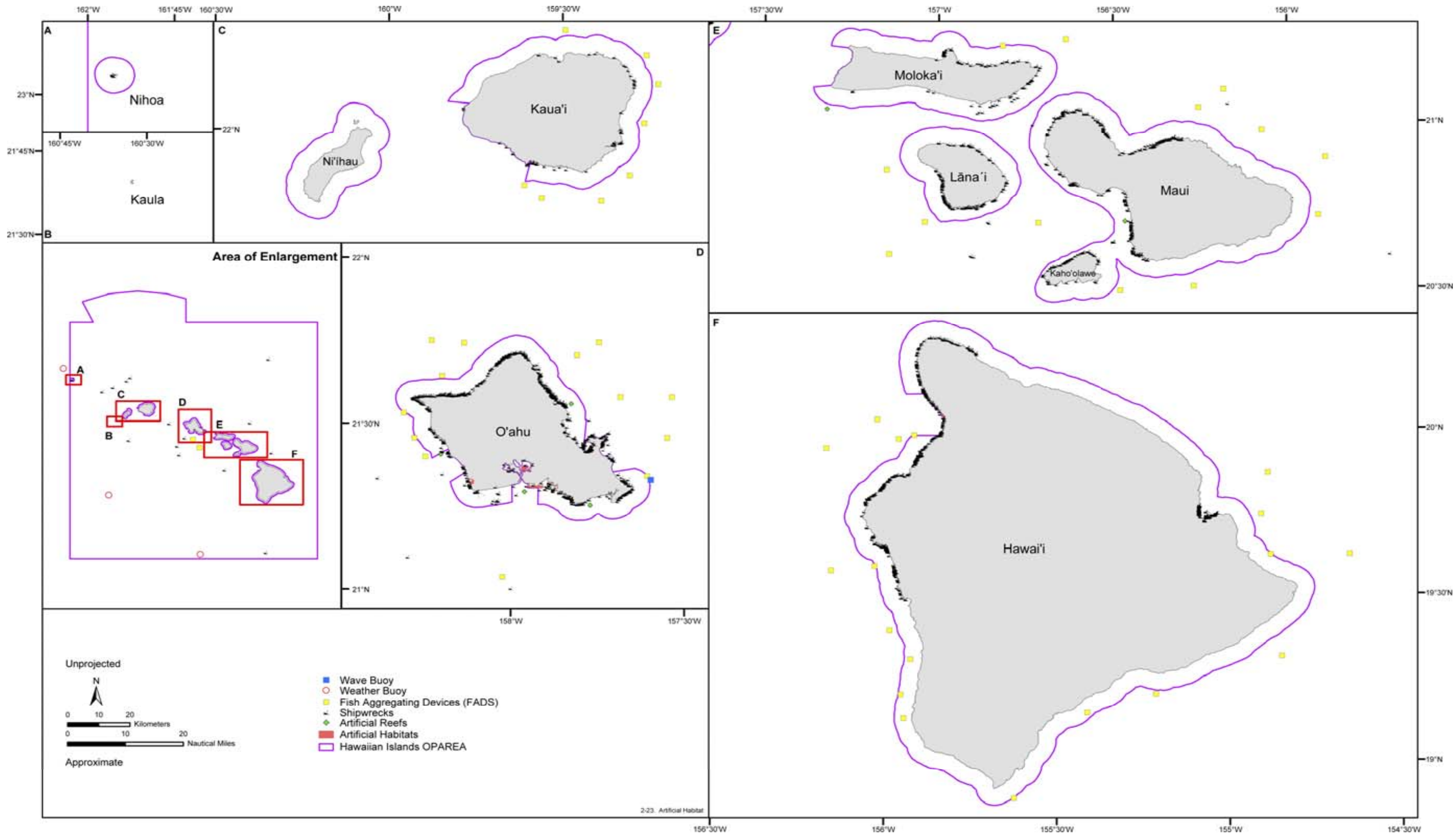


Figure 3-12. Artificial habitats (artificial reef, shipwreck, fish aggregating device (FAD), weather buoy, wave buoy, and artificial substrate) in the Hawaiian Islands OPAREA and vicinity. Source Data: NOS (2001), Veridian Corporation (2001), Hawaii Fishing News (2004), and SHOP (2005).

Artificial reefs have been constructed from a variety of materials in the Hawaiian Islands including old cars, concrete pipes, tires, and concrete modules designed specifically for reefs (Fitzhardinge and Bailey-Brock 1989). The material chosen for construction could influence benthic community development. Concrete has been recommended for artificial reef construction because community development is most similar to coral; it is durable in seawater and it can be shaped to specification. Coral community development has been estimated to take at least 20 years in Hawaiian offshore environments; coral growth in the Hawaiian ecosystem is slow compared to lower latitude reefs (Fitzhardinge and Bailey-Brock 1989). Thus, it is important that artificial reefs should be durable and last for 20 years or more to allow for coral communities to develop. Transplantation of corals was also recommended to accelerate natural reef development (Fitzhardinge and Bailey-Brock 1989).

There are currently 4 artificial reefs dedicated around Oahu, one artificial reef located off the southwest coast of Molokai, and one located off the southwest shore of Maui. The two artificial reefs located off the southern shore of Oahu and the one artificial reef located off of Molokai are located within the Hawaiian Islands OPAREA (Figure 3-12).

3.10.2 SHIPWRECKS

In the Hawaiian Islands, there have been thousands of wrecks, from junked trucks to WWII submarines, most from the past two centuries (Figure 3-12). A WWII era Japanese submarine, scuttled by the Navy, is one of two I-400 Sensuikan Toku class subs captured in the Pacific a week after Japan surrendered in 1945. The U.S. deliberately sank both submarines. The 400 ft long hulls were the largest built prior to the nuclear ballistic missile submarines of the 1960s (Lee 2005). Also, in 2002, a Japanese midget submarine was discovered in the waters off Oahu that had been sunk an hour before Japan's aerial attack on Pearl Harbor in 1941. However, the majority of current small boat groundings are the result of operator error. The Hawaiian shipping boom began in the 1800s, well after the heyday of piracy in the late 1600s to mid 1700s (Lee 2005). The Hawaiian island chain will most likely yield 19th century cargo ships, submarines, old whaling and merchant ships, fishing boats, or twentieth century recreational craft and land vehicles. Certain sunken vessels, such as the battleship USS Arizona at Pearl Harbor, are federally protected gravesites and cannot be used for recreational diving (Lee 2005). The Mahi, a scuttled Navy minesweeper off the Waianae Coast, has grown into a 58 m artificial reef that is home to corals, leaf scorpion fish, pufferfish, triggerfish, eels and magnificent eagle rays (Lee 2005). The nearby 30 m landing craft utility (LCU) ship also houses white-tipped reef sharks (Lee 2005).

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).

3.10.3 FISH AGGREGATING DEVICES

It has long been known that pelagic fishes will aggregate to floating objects like logs, nets, and other debris. However, these objects drift around and may only be occasionally encountered by lucky fishermen. Researchers have found that anchoring a buoy or platform in the open ocean will also attract and hold pelagic fishes; although, whether the fish are attracted to the anchored FADs for the same reasons they associate with natural drifting objects is not yet known. Using acoustic transmitters, data loggers attached to some FAD moorings monitor the long-term movement patterns of tunas returning to the FADs (Sea Grant 2005). These studies have found that tunas tagged around seamounts behave very similarly to tunas tagged around FADs. It is thought that maybe the FAD serves the same function as a seamount, providing a point of reference for the tuna (Sea Grant 2005).

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 an 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 1,800 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 15 to 30 m (Rountree 1990).

The State of Hawaii has placed FADs in the waters surrounding the MHI. These buoys attract schools of tuna and other important pelagic fishes, such as dolphinfish (mahimahi), wahoo (ono), and billfish. FADs allow fishermen to easily locate and catch these species (Sea Grant 2005). In 1980, the Division of Aquatic Resources designed, constructed and deployed 26 FADs in waters around the MHI. The FADs were located 2.4 to 25 miles offshore and in depths of 146 to 2,760 m as recommended by Hawaiian fishermen through statewide public meetings (Sea Grant 2005). In 1996, the State FAD program came under the operation of Hawaii Institute of Marine Biology (HIMB), SOEST, University of Hawaii in cooperation with the State of Hawaii's Division of Aquatic Resources (HDAR) (Sea Grant 2005).

Over the last 16 years, FAD designs and deployment have been greatly improved to increase the life and effectiveness of the system. The State of Hawaii's FAD Program utilizes two types of FADs: surface and subsurface (Sea Grant 2005). Surface FADs anchored using a catenary mooring method have an average life expectancy of about 3 to 4 years depending on sea and weather conditions. Subsurface FADs tend to last longer (5 to 6 years) because of decreased tugging on the mooring line and are less likely to be run over by ships. However, because they are beneath the surface, they tend to be harder for fishermen to locate (Sea Grant 2005). Currently, there are 55 surface and 4 subsurface FADs monitored and maintained statewide (Figure 3-12).

In the Hawaiian Islands, FADs have been shown to attract a wide variety of pelagic fish species of commercial and recreational fishing importance. The most commonly caught species include: skipjack tuna (aku), yellowfin tuna (ahi), bigeye tuna (ahi), albacore, dolphin fish (mahimahi), wahoo (ono), blue marlin (au), striped marlin (nairagi), mako sharks, silky sharks, oceanic whitetip sharks, galapagos sharks, mackerel (opelu), bonito (kawakawa) (Sea Grant 2005).

<u>Buoys</u>—A buoy is a floating platform used for navigational purposes or supporting scientific instruments that measure environmental conditions. Currently one wave buoy and two weather buoys capable of measuring wave energy, wave direction, and SST are active and located in the Hawaiian Islands OPAREA (Figure 3-12).

3.11 MARINE MANAGED AREAS

MPAs, as defined in EO 13158, are "any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein." Section 5 of EO 13158 stipulates, "Each Federal agency whose actions affect the natural or cultural resources that are protected by MPAs shall identify such actions. To the extent permitted by law and to the maximum extent practicable, each federal agency, in taking such actions, shall avoid harm to the natural and cultural resources that are protected by an MPA."EO 13158" also calls for the preparation of annual reports by federal agencies describing the actions they have taken over the previous year to implement the order. EO 13158 proposes the development of a national system of MPAs and provides a formal but vague definition of an MPA. As such, the National MPA Center is developing an MPA classification system providing definitions and qualifications for the various terms within the EO.

The new MPA definition will be narrower and will have stricter criteria. The new classification system is designed to objectively define MPAs by six fundamental characteristics: primary conservation goal, level of protection, permanence of protection, constancy of protection, scale of protection, and allowed extractive activities (NMPAC 2004a). The intent of MPAs is to be an effective conservation tool for sustaining ocean ecosystems (Agardy 1999; NRC 2000).

Many areas of the U.S. marine environment receive some level of management protection. The NOAA and the Department of the Interior (DoI) are documenting all marine sites and the National MPA Center is compiling a comprehensive inventory of all federal, state, tribal, and local sites that meet certain criteria of either a MMA or an MPA. MMAs are similar to MPAs in that they have a conservation or management purpose, defined boundaries, and some legal authority to protect resources. MMAs encompass a wider range of management intents, including areas of protection for geological, cultural, or recreational resources that might not be included under the definition provided in EO 13158 for MPAs. MMAs may also include areas that are managed for reasons other than conservation (e.g., security zones, shellfish closures, sewage discharge areas, and pipeline and cable corridors).

To date, federal sites have been added to the national MMA Inventory with an initial subset of data being collected; full data sets are at various stages of completion for some sites. The data are in the process of being reviewed and updated by each responsible agency. Data collection was to have been completed by 2004 with the Inventory being finalized in 2005. Once the MMA Inventory is complete, the MPA Classification System will be applied and official MPA designations will be made. Only sites in the MPA list are subject to the ‘avoid harm’ stipulation stated in EO 13158 (NOAA 2004).

There are 10 federal and 61 state MMAs in the Hawaiian Islands OPAREA and vicinity (Table 3-2). Federal MMAs located in the OPAREA and vicinity include two sites managed under the National Marine Sanctuaries Program (NMSP), three National Park (NP) System sites, three NWR, and two NMFS-managed threatened/endangered species protected areas. There are 61 state MMAs in the area of interest including 11 Marine Life Conservation Districts (MLCD), 19 Fisheries Management Areas (FMA), nine Fisheries Replenishment Areas (FRA), two wildlife sanctuaries, two natural area reserves, and 18 Bottomfish Restricted Fishing Areas (BRFA) (Figure 3-13).

Table 3-2. Federal and state marine managed areas (MMAs) located in the Hawaiian Islands OPAREA and vicinity.

FEDERAL MMAS	**State MMAs (cont.)**
1. Hawaiian Islands Humpback Whale NMS	36. Kiholo Bay FMA
2. Kalaupapa NHP	37. Kona Coast FMA
3. Kaloko-Honokohau NHP	38. Kailua Bay FMA
4. *U.S.S. Arizona* Memorial	39. Keauhou Bay FMA
5. Kilauea NWR	40. Hilo Harbor FMA
6. Pearl Harbor NWR	41. North Kohala FRA
7. Kakahaia NWR	42. Puako-Anaehoomalu FRA
8. Longline Protected Species Zone	43. Kaupulehu FRA
9. Lobster Closed Areas	44. Kaloko-Honokohau FRA
10. Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve	45. Kailua-Keauhou FRA
	46. Red Hill FRA
	47. Napoopoo-Honaunau FRA
STATE MMAS	48. Hookena FRA
11. Pupukea MLCD	49. Milolii FRA
12. Waikiki MLCD	50. Coconut Island - Hawaii Marine Laboratory Refuge
13. Hanauma Bay MLCD	
14. Honolua-Mokuleai Bay MLCD	51. Paiko Lagoon Wildlife Sanctuary
15. Manele-Hulopoe MLCD	52. Kahoolawe Island Reserve
16. Molokini Shoal MLCD	53. Ahihi-Kinau Natural Area Reserve
17. Lapakahi MLCD	54. Makawana Point to Pauwela Point BRFA
18. Waialea Bay MLCD	55. Kaupo to Kaapahu Bay BRFA
19. Old Kona Airport MLCD	56. Kalohi/Pailolo Channels BRFA
20. Kealakekua Bay MLCD	57. Ilio Point to Panalaia Point BRFA
21. Waiopae MLCD	58. Niihau BRFA
22. Waimea Bay FMA	59. Makahuena Point to S. Kawai Point BRFA
23. Port Allen FMA	60. Hanalei-Kilauea Point BRFA
24. Nawiliwili Harbor FMA	61. Kaena Point to Makua BRFA
25. Hanamaulu Bay FMA	62. Kaneohe Bay BRFA
26. Waialua Bay FMA	63. Barbers Point BRFA
27. Pokai Bay FMA	64. Maunalua Bay BRFA
28. Honolulu Harbor FMA	65. Makapuu Point BRFA
29. Waikiki-Diamond Head Shoreline FMA	66. Palemano Point to Alika BRFA
30. Heeia Kea Wharf FMA	67. Hakalau to Onomea Bay BRFA
31. Kaunakakai Harbor FMA	68. Leleiwi Point to Kaloli Point BRFA
32. Manele Harbor FMA	69. Ka Lae BRFA
33. Kahului Harbor FMA	70. Penguin Bank, Pinnacle BRFA
34. Kawaihae Harbor FMA	71. Penguin Bank, Third Finger BRFA
35. Puako Bay and Puako Reef FMA	

For the actual locations of these MMAs, refer to Figure 3-13.
NMS = National Marine Sanctuary
NHP = National Historical Park
NWR = National Wildlife Refuge
MLCD = Marine Life Conservation District
FMA = Fisheries Management Area
FRA = Fisheries Replenishment Area
BRFA = Bottomfish Restricted Fishing Area

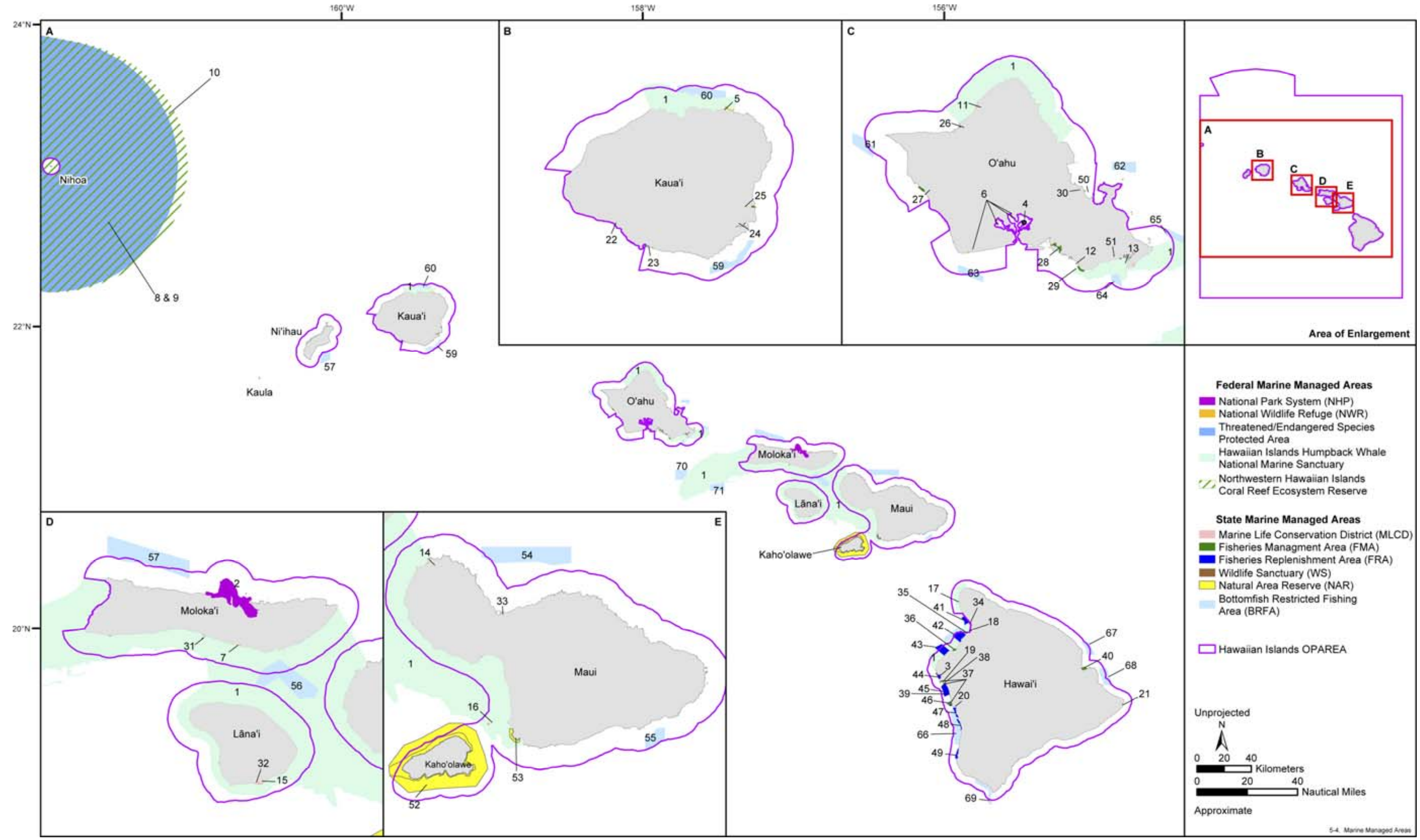


Figure 3-13. Locations of federal and state marine managed areas (MMAs) in the Hawaiian Islands OPAREA and vicinity. Numbers listed within figure correspond to Table 3-2. Source data: HDLNR (2003) and NOAA (2005b).

3.11.1 NATIONAL MARINE SANCTUARIES PROGRAM

There are 14 NMSP sites included in the MMA Inventory: 13 NMS and one CRE Reserve, which is being proposed as the fourteenth NMS under EO 13178 (U.S. Office of the President 2000). Designated and managed by the NOAA, these 14 sites protect over 390,000 km^2 of coastal and ocean habitat. Comprehensive management plans have been written for each NMS to guide their activities and programs, set priorities, and enforce relevant regulations. More information on both existing and proposed NMS can be found at the NOAA's NMSP website (http://www.sanctuaries.noaa.gov). Two NMSP sites are located within the Hawaiian Islands OPAREA and vicinity: the HIHWNMS and the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve (NWHICRER) (Figure 3-13).

The shallow, warm waters surrounding the MHI constitute one of the world's most important humpback whale habitats. Scientists estimate that two-thirds of the entire North Pacific humpback whale population migrates to Hawaiian waters each winter to engage in breeding, calving, and nursing activities (HIHWNMS 2004). Due to the importance of Hawaiian coastal waters to humpback whales, the NOAA designated five separate areas abutting six of the state's major islands as the HIHWNMS. Created in 1992, the HIHWNMS includes relatively shallow nearshore areas built up from the sea floor by the development of the Hawaiian Islands chain, protecting over 3,600 km^2 of humpback whale habitat in the Hawaiian archipelago (NOS 2003). The HIHWNMS encompasses waters along the north shore of Kauai, the north and south coasts of Oahu, the four-island area of Maui County (Maui, Molokai, Lanai, and Kahoolawe), and the northwest portion of Hawaii.

The goals of the HIHWNMS are to: (1) protect humpback whales and their calving grounds; (2) educate and interpret for the public the relationship of humpback whales to the Hawaiian Islands marine environment; (3) manage human uses of the sanctuary consistent with the designation and the NMSA; and (4) provide for the identification of marine resources and ecosystems of national significance for possible inclusion in the sanctuary. Sanctuary regulations protect humpback whales and their calving habitats by prohibiting vessel approaches within 100 yards (yd), low aircraft overflights, discharge of wastes into sanctuary waters, and alteration of the sea floor, all of which have the potential to harm either humpback whales or their preferred habitat (NOS 2003; HIHWNMS 2004).

The NWHICRER spans 340,000 km^2 of ocean habitat in the NWHI, making it the second largest MPA in the world. It extends 2,200 km across the central North Pacific Ocean from Nihoa to Midway and Kure Atolls. While U.S. waters contain only 3% of the world's coral reefs, approximately 70% of the coral reefs found in U.S. waters are located in the NWHI. The 14,000 km^2 of coral reefs located within the NWHICRER are some of the most pristine and spectacular marine environments on Earth. This vast area supports a dynamic reef ecosystem that is home to more than 7,000 marine species, of which approximately one quarter are endemic to the Hawaiian Islands chain. This diverse ecosystem is home to a number of coral, fish, bird, marine mammal, and sea turtle species including the endangered Hawaiian monk seal, the threatened green turtle, and the endangered leatherback and hawksbill turtles. In addition, this area has great cultural significance to Native Hawaiians as well as linkages to early Polynesian culture (NOAA 2005b).

3.11.2 NATIONAL PARK SYSTEM SITES

The NPS administers all areas that are protected and managed under the U.S. National Park System. The NPS Organic Act of 1916 established the NPS with "the fundamental purpose to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment for the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (NPS 2003).

The NPS is composed of 388 areas covering more than 340,000 km^2 in 49 states, the District of Columbia, American Samoa, Guam, Puerto Rico, Saipan, and the USVI (DoI 2005). The system includes NPs, monuments, seashores, memorials, preserves, historical parks, historical sites, recreational areas, and many other similarly named areas that are distinguished for their historic or prehistoric importance, scientific interest, or superior recreational assets. Two national historical parks (NHP) and one memorial are located in the Hawaiian Islands OPAREA and vicinity. These include Kalaupapa NHP on Molokai, Kaloko-Honokohau NHP on Hawaii, and the *U.S.S. Arizona* Memorial on Oahu (Figure 3-13).

Kalaupapa NHP is located on the north shore of Molokai and contains the Kalaupapa Peninsula, adjacent cliffs and valleys, offshore islands, and submerged lands and waters out to 0.4 km from shore. Established in 1980, this park is the physical setting of two tragic events in Hawaiian history: (1) the removal of indigenous peoples in 1865 and 1895 and (2) the forced isolation of individuals stricken with Hansen's disease (leprosy) from 1866 until 1969. Native Hawaiians inhabited the Kalaupapa Peninsula and valleys for hundreds of years prior to the establishment of the isolation settlement in 1866. Evidence of this occupation is relatively undisturbed and represents one of the richest archeological preserves in the state. Several areas within the park provide rare native habitat for threatened and endangered Hawaiian plants and animals. Endangered Hawaiian monk seals have been known to give birth on Kalaupapas beaches. These marine mammals require solitude and the physical isolation of Kalaupapa NHP provides an ideal habitat to support these births and subsequent care (NPS 2005a).

Kaloko-Honokohau NHP, located near Kailua-Kona on the west coast of Hawaii, is a 470 ha park that was established in 1978 for the preservation, protection, and interpretation of traditional native Hawaiian activities and culture. Situated at the base of Hualalai Volcano, it is the site of an ancient Hawaiian settlement that encompasses portions of four different ahupua'a, or traditional sea-to-mountain land divisions. Resources housed within the park include fishponds, house site platforms, petroglyphs, stone slides, and religious sites. Hiking, fishing, swimming, snorkeling, scuba diving, and kayaking are all popular activities that can be performed within the confines of Kaloko-Honokohau NHP (NPS 2005b).

Located in Pearl Harbor on the island of Oahu, the U.S.S. Arizona Memorial is the final resting place for many of the ship's 1,177 crewmen who lost their lives during the Japanese attack on 7 December 1941. The 56 m long memorial structure spans the mid-portion of the sunken battleship and consists of three main sections: the entry and assembly rooms, a central area designed for ceremonies and general observation, and the shrine room where the names of those killed on the U.S.S. Arizona are engraved on the marble wall. Completed in 1961 and dedicated in 1962, the U.S.S. Arizona Memorial grew out of wartime desire to establish some sort of memorial at Pearl Harbor to honor all those who died in the attack (NPS 2005c).

3.11.3 NATIONAL WILDLIFE REFUGES

The USFWS, which oversees the National Wildlife Refuge System (NWRS), also protects a significant amount of marine habitat within U.S. waters. The NWRS is comprised of 544 established NWR, of which approximately 140 to 150 contain marine and estuarine habitat. These MMAs provide important habitat for a number of threatened and endangered mammals, plants, birds, and reptiles. The NWRS also contains about 10,500 km^2 of coral reefs and adjacent ocean habitat. There are four NWR in the Hawaiian Islands OPAREA and vicinity that are currently designated as federal MMAs: Kilauea Point NWR on Kauai, Pearl Harbor NWR on Oahu, Kakahaia NWR on Molokai, and the Hawaiian Islands NWR, which encompasses Nihoa and several other remote islands in the NWHI chain (Figure 3-13).

Kilauea Point NWR was established in 1985 after its transfer from the USCG. It consists of 82 ha of protected land on the northernmost tip of Kauai, and is one of the few Hawaiian refuges open to the public. Protected marine species encountered at the refuge include humpback whales, Hawaiian monk seals, spinner dolphins, green turtles, and Laysan albatrosses. The refuge's seaside rocky cliffs have been a premier seabird nesting area for thousands of years, providing protected coastal nesting and roosting habitat for seven species of native Hawaiian seabirds. The most prominent feature of Kilauea Point NWR is the Kilauea Lighthouse, which was built in 1913 as a navigational aid for commercial shipping between the Hawaiian Islands and the Orient. For 62 years its gigantic lens guided ships and boats safely along the rugged north shore of Kauai (USFWS 2005a).

Managed under a cooperative agreement with the Navy, Pearl Harbor NWR was established in 1976 as mitigation for construction of the Honolulu International Airport Reef Runway. This refuge, located in southern Oahu, is composed of three units: the 15 ha Honouliuli Unit (bordering West Loch), the 10 ha Waiawa Unit (bordering Middle Loch), and the 15 ha Kalaeloa Unit (located on the leeward side of the island). Kalaeloa, the newest unit, was formerly part of Barbers Point Naval Air Station, but was transferred to the USFWS in 2001. The Kalaeloa Unit protects the largest native remnant stand of the endangered *Achyranthes* plant. The Honouliuli and Waiawa Units are freshwater wetlands that are extensively managed for endangered waterbirds, migratory shorebirds, and waterfowl (USFWS 2005b).

Established in 1977, Kakahaia NWR is situated on the southern shore of Molokai. This 18 ha refuge contains a 6 ha pond and a man-made 3 ha impoundment. The spring-fed pond, originally used as an artificial fish pond, lies on a narrow plain just above sea level at the foot of the island’s volcanic hills. Twelve species of birds, including the endangered Hawaiian stilt, use this area. Wildlife observation and environmental education activities conducted in the refuge require a special use permit (USFWS 2005c).

The Hawaiian Islands NWR is also located in the vicinity of the Hawaiian Islands OPAREA but is not depicted on Figure 3-13. This is due to a lack of geographic data available for this federal MMA. The Hawaiian Islands NWR is a chain of eight islands, reefs, and atolls extending about 1,300 km northwest from the MHI (from Nihoa in the east to Pearl and Hermes Reef in the west). It supports four endangered and endemic birds, 14 million seabirds, endangered Hawaiian monk seals, threatened green turtles, and eight endangered plant species. Several thousand species of inshore tropical fish, algae, coral, and other marine organisms inhabit the more than 100,000 ha of marine habitat found in and around the refuge. Except for field stations on Tern and Laysan Islands, these remote islands are not inhabited by humans and are protected by the USFWS. Scientific research is limited and closely scrutinized to minimize unnecessary disturbance; entry is by special use permit only (NMPAC 2005a; USFWS 2005d).

3.11.4 THREATENED/ENDANGERED SPECIES CRITICAL HABITATS AND PROTECTED AREAS

One of the many responsibilities of the NMFS is to promote the recovery of federally protected species. To satisfy this responsibility, the NMFS uses its authority to designate critical habitats and protected areas for threatened and endangered species. There are two threatened/endangered species protected areas and one critical habitat located in the Hawaiian Islands OPAREA (Figure 3-13). However, the Hawaiian monk seal critical habitat, which is located in 10 areas around the NWHI (including Nihoa), is not currently included in the federal MMA Inventory, as it does not have additional federal regulations beyond its designation as a critical habitat.

The Longline Protected Species Zone is located in the NWHI and stretches 92.6 km offshore from the following points: Nihoa, Necker Island, French Frigate Shoals, Gardner Pinnacles, Maro Reef, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Islands, and Kure Island. Established in 1991 by the WPRFMC, this area encompasses the Hawaiian monk seal critical habitat area outside of territorial waters. Inside the protected species zone, longline fishing is prohibited. Species protected by this MMA include Hawaiian monk seals, sea turtles, seabirds, and juvenile swordfish (NMPAC 2005b).

The Lobster Closed Areas were designated in 1983 under the authority of the MSFCMA (NMPAC 2005c) and also encircle the NWHI, encompassing the same ocean area as the Longline Protected Species Zone. These areas are closed to all types of lobster fishing year round in order to protect the endangered Hawaiian monk seal.

3.11.5 FISHERIES MANAGEMENT ZONES

An additional responsibility of the NMFS includes rebuilding and maintaining sustainable fisheries. To satisfy this responsibility, the NMFS uses fisheries management zones as one of several tools to conserve fish stocks and fish habitat. Fisheries management zones are areas that are closed, at least partially, to fishing activities. The NMFS has the authority to restrict or even prohibit the use of specific fishing gear types in areas where they are aiming to better protect habitats, fish stocks, or species assemblages and/or to promote the recovery of threatened and endangered species such as marine mammals, sea turtles, or seabirds. There are no federally designated fisheries management zones in the Hawaiian Islands OPAREA, although a year-round closure established to protect precious corals is located just west of the map extent.

This fisheries management zone, known as WestPac Bed, was established by the NMFS in 1983 under the authority of the MSFCMA and the Western Pacific Precious Corals FMP. Under 50 CFR 660.87, it is illegal to fish for corals on the WestPac Bed. The WestPac Bed closure, located west of Nihoa, includes all waters within a 2 NM radius of 23°18'N, 162°35'W.

3.11.6 STATE MARINE MANAGED AREAS

In 1967, Hanauma Bay MLCD on Oahu was designated as the first MMA in the Hawaiian Islands. Since then, the Hawaii Department of Land and Natural Resources (DLNR) has established a number of state-level MMAs tailored to address various human impacts and uses at each site. Fishing activities (including vessel anchoring) are highly regulated at most of these sites (HDLNR 2005; Figure 3-13).

MLCDs are designed to conserve and replenish marine resources by allowing only limited fishing and other consumptive uses. They provide fish and other aquatic life with a protected area in which to grow and reproduce, and are home to a great variety of species. MLCDs are often popular sites for snorkeling, diving, and underwater photography. At present, there are 11 MLCDs statewide with additional sites under consideration. MLCDs are established by the Hawaii DLNR as authorized by Chapter 190 of the Hawaii Revised Statutes. Suggestions for areas to be included in the system may come from the state legislature or the general public. The HDAR, a branch of the DLNR, conducts surveys of marine ecosystems throughout the state and may recommend MLCD status for areas that appear promising (NMPAC 2004b).

The HDAR has also established a network of FMAs in the Hawaiian Islands. One of the most prominent FMAs in the MHI is the Waikiki-Diamond Head Shoreline FMA, which is closed to fishing for the calendar year 2005. Since its inception in 1978, this area has been closed to fishing during alternate (odd-numbered) years to help restore fish populations. Only hook-and-line, throw net, hand net, spear fishing, and hand harvesting methods are permitted in this FMA during "open" periods (HDAR 2005).

In 1998, the Hawaii State Legislature enacted Act 306, which attempted to improve management of fish resources by declaring a minimum of 30% of the west Hawaii coastline as FRAs, where fish collecting is prohibited. The same year, the West Hawaii Fisheries Council proposed the location and size of nine FRAs along the west coast. In April 1999, a public hearing was held on the management plan developed by the council. It was one of the largest ever held in the state of Hawaii on a natural resource issue, resulting in overwhelming public support for FRAs. The nine established FRAs were officially closed to aquarium collecting on 1 January 2000 (HCRI 2002).

As implied by their name, BRFA are restricted areas where bottom fishing is prohibited. Under Hawaiian state law, it is unlawful to capture or possess bottomfish while drifting or anchored within a BRFA, except in the case of an emergency. BRFAs comprise 20% of important habitat for spawning onaga and ehu, two of the most highly valued commercial fish species found in Hawaiian waters. The Hawaii DLNR is charged with selecting appropriate areas and distributing them statewide, using input from local bottomfish fishermen. Other fishing activities, such trolling or hand lining for pelagic species, are permitted within the boundaries of a BRFA (HDAR 2002).

4.0 ESSENTIAL FISH HABITAT

The Essential Fish Habitat information and citations provided below comes from the *Marine Resources Assessment for the Hawaiian Islands Operating Area* (Navy 2005), with additional technical information and changes incorporated throughout this section.

4.1 NMFS MANAGED ICHTHYOFAUNA PRESENT IN THE HAWAII RANGE

The Western Pacific Regional Fishery Management Council (WPRFMC) manages major fisheries within the Exclusive Economic Zone (EEZ) around Hawaii and the territories and possessions of the U.S. in the Pacific Ocean (WPRFMC 1998, 2001a). The WPRFMC, in conjunction with the State of Hawaii, Department of Land and Natural Resources, HDAR, manages the fishery resources in the study area. The WPRFMC focuses on the major fisheries in the study area that require regional management. The WPRFMC currently oversees five major Fishery Management Plans (FMPs) and their associated amendments for bottomfish, pelagics, crustaceans, precious corals, and coral reef ecosystems.

The MSFCMA, as amended by the Sustainable Fisheries Act (SFA), contains provisions for the identification and protection of habitat essential to production of federally managed species. The act requires the NMFS to assist regional Fishery Management Councils (FMCs) in including EFH in their respective FMP.

EFH provisions impose procedural requirements on both councils and federal agencies. Councils must identify adverse impacts on EFH resulting from both fishing and non-fishing activities and describe measures to minimize or mitigate these impacts. Councils can also provide comments and make recommendations to federal or state agencies that propose actions that may affect habitat, including EFH, of a managed species. Agencies must then decide how they intend to minimize or mitigate the identified adverse impacts. Fishing activities that may adversely impact EFH include, but are not limited to, the following: anchor damage from vessels attempting to maintain position over productive fishing habitat, heavy weights and line entanglement occurring during normal hook-and-line fishing operations, lost gear from lobster fishing operations, and remotely operated vehicle tether damage to precious coral during harvesting operations. Nine non-fishing activities have been identified that directly or indirectly affect habitat used by management unit species and are as follows: infaunal and bottom-dwelling organisms, turbidity plumes, biological availability of toxic substances, damage to sensitive habitat, current patterns/water circulation modification, loss of habitat function, contaminant runoff, sediment runoff, and shoreline stabilization projects (WPRFMC 2001a).

The FMPs developed for federally managed species under the jurisdiction of these FMCs should include identification and description of the EFH, description of fishing and non-fishing threats, and suggested measures to conserve and enhance the EFH. Each of these councils is also required in the FMPs to identify the EFH/HAPC where one or more of the following criteria are demonstrated: (a) ecological function, (b) sensitivity to human-induced environmental degradation, (c) development activities stressing habitat type, or (d) rarity of habitat. In addition to the EFH status, some of these species are assigned status categories in conjunction with the

ESA and various federal or international agencies. These status categories will be discussed in the "status" section of the EFH descriptions.

EFH species, as designated by the WPRFMC (2004a), are discussed in the following subsections and are listed in Table 4-1. These species have been divided into management units according to their ecological relationships and preferred habitats. Management units include bottomfish management unit species (BMUS), pelagic management unit species (PMUS), crustacean management unit species (CMUS), precious corals management unit species (PCMUS), and coral reef ecosystem management unit species (CRE MUS). For each management unit, the status, distribution (including range), habitat preference (depth, bottom substrate), life history (migration, spawning), common prey species, and EFH/HAPC designations are provided in the following sections with figures provided in Appendix A.

4.2 MANAGEMENT UNITS

4.2.1 BOTTOMFISH MANAGEMENT UNIT SPECIES

Status—Twenty-two species are currently managed as BMUS by the WPRFMC through the Bottomfish and Seamount Groundfish Fishery Management Plan (WPRFMC 1986a) and subsequent amendments (WPRFMC 1998; 2004a; Table 4-1). In the Hawaiian archipelago, the BMUS includes 14 deep-slope bottomfish, consisting of shallow-water and deep-water complexes, and three seamount groundfish (Randall 1996). Under Draft Amendment 8, 13 deep-slope bottomfish from the shallow-water complex have been proposed by the WPRFMC for incorporation into the existing BMUS (WPRFMC 2005a). All of the existing 14 deep-slope bottomfish have viable recreational, subsistence, and commercial fisheries (WPRFMC 2004b). NMFS (2005a) has determined that over fishing is occurring on the bottomfish multi-stock complex around the Hawaiian archipelago, especially the MHI. Large carangids form an important component of shallow-water reef and lagoon fish catches throughout the Pacific Islands (Haight 2004a). In Hawaii, jacks are highly valued food and game fish (Meyer et al. 2001). Within the study area, the Hawaiian grouper (*Epinephalus quernus*) is listed as near threatened on the IUCN Red List of threatened species (Cornish 2004).

Distribution—The deep-slope bottomfish (shallow-water [0 to 100 m] and deep-water [100 to 400 m] complexes) are distributed throughout the tropical and subtropical waters on the coastal shelves and slopes in the Hawaiian archipelago of the western central Pacific (WPRFMC 1998).

Habitat Preference—Bottomfish habitats of the western central Pacific islands are divided into three broad classifications relative to their vertical distribution on the islands' shelves and slopes: shallow-water, deep-water, and seamounts (WPRFMC 1998). Eggs and larvae of all BMUS are pelagic, floating at the surface until hatching, and therefore subject to advection by prevailing ocean currents (WPRFMC 1998). Although both juvenile and adult BMUS habitats are unevenly distributed, they are found in a non-random, patchy fashion within their natural habitats. These habitats are characterized by a mosaic of sandy bottoms and rocky areas of high structural complexity at depths ranging from 60 to 350 m (WPRFMC 1998).

Table 4-1. The fish and invertebrate species with essential fish habitat (EFH) designated in the Hawaiian Islands OPAREA.

<u>Bottomfish Management Unit Species</u>

<u>Shallow-water Species Complex (0-100 m):</u>
Gray jobfish (*Aprion virescens*)
Thick lipped trevally (*Pseudocaranx dentex*)
Giant trevally (*Caranx ignoblis*)
Black jack (*Caranx lugubris*)
Amberjack (*Seriola dumerili*)
Blue stripe snapper (*Lutjanus kasmira*)

<u>Deep-water Species Complex (100-400 m):</u>
Squirrelfish snapper (*Etelis carbunculus*)
Longtail snapper (*Etelis coruscans*)
Pink snapper (*Pristipomoides filamentosus*)
Yellowtail snapper (*Pristipomoides auricilla*)
Pink snapper (*Pristipomoides sieboldii*)
Yellow-barred snapper (*Pristipomoides zonatus*)
Hawaiian grouper (*Epinephelus quernus*)
Silver jaw jobfish (*Aphareus rutilansi*)

<u>Pelagic Management Unit Species</u>

<u>Marketable Species Complex:</u>
<u>Temperate Species</u>
Striped marlin (*Tetrapurus audax*)
Broadbill swordfish (*Xiphias gladius*)
Northern bluefin tuna (*Thunnus thynnus)*
Albacore *(Thunnus alalunga*)
Bigeye tuna (*Thunnus obesus*)
Mackerel (*Scomber* spp.)
Pomfret (Bramidae)
  Sickle pomfret (*Taractichthys steindachneri*)
  Lustrous pomfret (*Eumegistus illustris*)

<u>Tropical Species</u>
Yellowfin tuna (*Thunnus albacares*)
Kawakawa (*Euthynnus affinis*)
Skipjack tuna (*Katsuwonus pelamis*)
Frigate and bullet tunas (*Auxis thazard, Auxis rochei*)
Slender tunas (*Allothunnus fallai*)
Indo-Pacific blue marlin (*Makaira nigricans*)
Black marlin (*Makaira indica*)
Shortbill spearfish (*Tetrapturus angustirostris*)
Sailfish (*Istiophorus platypterus*)
Dolphinfishes (Coryphaenidae)
  Dolphinfish (*Coryphaena hippurus*)
  Pompano dolphinfish *(Coryphaena equiselas*)
Wahoo (*Acanthocybium solandri*)
Moonfish (*Lampris guttatus)*

<u>Non-marketable Species Complex:</u>
Snake mackerels or oilfish (Gempylidae)
  Escolar (*Lepidocybium flavobrunneum*)
  Oilfish (*Ruvettus pretiosus*)

<u>Shark Species Complex</u>
Crocodile shark (*Pseudocarcharias kamoharai*)
Common thresher shark (*Alopias vulpinus*)
Pelagic thresher shark (*Alopias pelagicus)*
Bigeye thresher shark (*Alopias superciliousus*)
Shortfin mako shark (*Isurus oxyrinchus*)
Longfin mako shark (*Isurus paucus*)
Salmon shark (*Lamna ditropis*)
Silky shark (*Carcharhinus falciformis*)
Oceanic whitetip shark (*Carcharhinus longimanus*)
Blue shark (*Prionace glauca*)

<u>Crustacean Management Unit Species</u>

<u>Spiny and Slipper Lobster Complex</u>
Hawaiian spiny lobster (*Panulirus marginatus*)
Spiny lobster (*Panulirus penicillatus, Panulirus* sp.)
Ridgeback slipper lobster (*Scyllarides haani*)
Chinese slipper lobster (*Parribacus antarticus*)

<u>Kona Crab</u>
Kona crab (*Ranina ranina*)

<u>Precious Corals Management Unit Species</u>

<u>Shallow-water Species Assemblage (18-91 m)</u>
Black coral (*Antipathes dichomata*)
Pine black coral (*Antipathis grandis*)
Fern black coral (*Antipathes ulex*)

<u>Deep-water Species Assemblage (274-1,372 m)</u>
Angel skin coral (*Corallium secundum*)
Red coral (*Corallium regale*)
Pink coral (*Corallium laauense*)
Midway deepsea coral (*Corallium* sp. Nov.)
Hawaiian Gold coral (*Geraddia* sp.)
Gold coral (*Callogorgia gilberti*)
Gold coral (*Narella* sp.*)*
Gold coral (*Calyprophora* spp.*)*
Bamboo coral (*Lepidisis olapa*)
Bamboo coral (*Acanella* sp.*)*

<u>Coral Reef Ecosystem *</u>

<u>Currently Harvested Coral Reef Taxa (CHCRT):</u>
Surgeonfishes (Acanthuridae)
  Orange-spot surgeonfish (*Acanthurus olivaceus*)
  Yellowfin surgeonfish (*Acanthurus xanthopterus*)
  Convict tang (*Acanthurus triostegus*)
  Eye-striped surgeonfish (*Acanthurus dussumieri*)
  Blue-lined surgeonfish (*Acanthurus* nigroris)
  Whitebar surgeonfish (*Acanthurus leucopareius*)
  Blue-banded surgeonfish (*Acanthurus lineatus*)

Whitecheek surgeonfish (*Acanthurus nigricans*)

Table 4-1. The fish and invertebrate species with EFH designated in the Hawaiian Islands OPAREA (continued).

Surgeonfishes (Acanthuridae) (continued)

- White-spotted surgeonfish (*Acanthurus guttatus*)
- Ringtail surgeonfish (*Acanthurus blochii*)
- Brown surgeonfish (*Acanthurus nigrofuscus*)
- Yellow-eyed surgeonfish (*Ctenochaetus strigosus*)
- Bluespine unicornfish (*Naso unicornus*)
- Orangespine unicornfish (*Naso lituratus*)
- Blacktongue unicornfish (*Naso hexacanthus*)
- Whitemargin unicornfish (*Naso annulatus*)
- Spotted unicornfish (*Naso brevirostris*)
- Gray unicornfish (*Naso caesius*)

Triggerfishes (Balistidae)

- Titan triggerfish (*Balistapus viridescens*)
- Pinktail triggerfish (*Melichtys vidua*)
- Black triggerfish (*Melichtys niger*)
- Blue triggerfish (*Pseudobalistes rass*)
- Picassofish (*Rhinecanthus aculeatus*)
- Bridled triggerfish (*Sufflamen fraenatus*)

Jacks (Carangidae)

- Bigeye scad (*Selar crumenophthalmus*)
- Mackerel scad (*Decapterus macarellus*)

Requiem Sharks (Carcharhinidae)

- Grey reef shark (*Carcharhinus amblyrhynchos*)
- Galapagos shark (*Carcharhinus galapagenis*)
- Blacktip reef shark (*Carcharhinus melanopterus*)
- Whitetip reef shark (*Triaenodon obesus*)

Soldierfishes/Squirrelfishes (Holocentridae)

- Bigscale soldierfish (*Myripistris berndti*)
- Brick soldierfish (*Myripristis amaena*)
- Whitetip soldierfish (*Myripristis vittata*)
- Yellowfin soldierfish (*Myripristis chryseres*)
- Pearly soldierfish (*Myripristis kuntee*)
- File-lined squirrelfish (*Sargocentron microstoma*)
- Crown squirrelfish (*Sargocentron diadema*)
- Peppered squirrelfish (*Sargocentron punctatissimum*)
- Blue-lined squirrelfish (*Sargocentron tiere*)
- Hawaiian squirrelfish (*Sargocentron xantherythrum*)
- Saber or long jaw squirrelfish (*Sargocentron spiniferum*)
- Spotfin squirrelfish (*Neoniphon* spp.)

Flagtails (Kuhliidae)

- Hawaiian flagtail (*Kuhlia sandvicensis*)

Rudderfishes (Kyphosidae)

- Grey sea chub (*Kyphosus bigibbus*)
- Blue sea chub (*Kyphosus cinerascens*)
- Brassy chub (*Kyphosus vaigenses*)

Wrasses (Labridae)

- Saddleback hogfish (*Bodianus bilunulatus*)
- Razor wrasse (*Xyricthys pavo*)
- Whitepatch wrasse (*Xyrichtes aneitensis*)
- Ring-tailed wrasse (*Oxycheilinus unifasciatus*)
- Cigar wrasse (*Cheilio inermis*)
- Surge wrasse (*Thalassoma purpureum*)
- Redribbon wrasse (*Thalassoma quinquevittatum*)
- Sunset wrasse (*Thalassoma lutescens*)
- Rockmover wrasse (*Novaculichthys taeniourus*)

Goatfishes (Mullidae)

- Yellow goatfish (*Mulloidichthys* spp.)
- Orange goatfish (*Mulloidichthys pfleugeri*)
- Yellowfin goatfish (*Mulloidichthys vanicolensis*)
- Yellowstripe goatfish (*Mulloidichthys flaviolineatus*)
- Doublebar goatfish (*Parupeneus bifasciatus*)
- Yellowsaddle goatfish (*Parupeneus cyclostomus*)
- Side-spot goatfish (*Parupeneus pleurostigma*)
- Multi-barred goatfish (*Parupeneus multifaciatus*)
- Bantail goatfish (*Upeneus arge*)

Mullets (Mugilidae)

- Striped mullet (*Mugil cephalus*)
- Engel's mullet (*Moolgarda engeli*)
- False mullet (*Neomyxus leuciscus*)

Moray Eels (Muraenidae)

- Yellowmargin moray (*Gymnothorax flavimarginatus*)
- Giant moray (*Gymnothorax javanicus*)
- Undulated moray (*Gymnothorax undulatus*)

Octopuses (Octopodidae)

- Day squid (*Octopus cyanea*)
- Night squid (*Octopus ornatus*)

Threadfins (Polynemidae)

- Sixfeeler threadfin (*Polydactylus sexfilis*)

Bigeyes (Pricanthidae)

- Glasseye (*Heteropriacanthus cruentatus*)

Parrotfishes (Scaridae)

- Parrotfish (*Scarus* spp.)
- Stareye parrotfish (*Catolomus carolinus*)

Barracudas (Sphyraenidae)

- Heller's barracuda (*Sphyraena helleri*)
- Great barracuda (*Sphyraena barracuda*)

Aquarium Taxa/Species

Surgeonfishes (Acanhturidae)

- Yelow tang (*Zebrasoma flavescens*)
- Yellow-eyed surgeonfish (*Ctenochaetus strigosus*)
- Achilles tang (*Acanthurus rasses*)

Moorish Idols (Zanclidae)

Moorish idol (*Zanclus cornutus*)

Table 4-1. The fish and invertebrate species with EFH designated in the Hawaiian Islands OPAREA (continued).

Aquarium Taxa/Species (Continued)

Angelfishes (Pomacanthidae)
Moray Eels (Muraenidae)
Dragon moray (*Enchelycore pardalis*)

Hawkfishes (Cirrhitidae)
Longnose hawkfish (*Oxycirrhites typus*)

Butterflyfishes (Chaetodontidae)
Threadfin butterflyfish (*Chaetodon auriga*)
Raccoon butterflyfish (*Chaetodon lunula*)
Saddled butterflyfish (*Chaetodon ephippium*)

Damselfishes (Pomacentridae)

Scorpionfishes (Scorpaenidae)
Feather-duster Worms (Sabellidae)

Potentially Harvested Coral Reef Taxa (PHCRT):

Fish Management Unit Species

Other Wrasses (Labridae spp.) [1]
Requiem Sharks (Carcharhinidae spp.) [1]
Hammerhead Sharks (Sphyrnidae spp.) [1]
Whiptail Stingrays (Dasyatididae)
Eagle Rays (Myliobatidae)
Manta Rays (Mobulidae)
Other Groupers (Serranidae spp.) [2]
Jacks/Trevallies (Carangidae) [3]
Other Soldierfishes/Squirrelfishes (Holocentridae spp.)[1]
Other Goatfishes (Millidae) [1]
Other Surgeonfishes (Acanthuridae spp.) [1]
Other Emperor Fishes (Lethrinidae) [4]
False Moray Eels (Chlopsidae) [1]
Conger Eels (Congridae) [1]
Snake Eels (Ophichthidae) [1]
Other Moray Eels (Muraenidae) [1]
Cardinalfishes (Apogonidae)
Bigeyes (Pricanhtidae)
Other Butterflyfishes (Chaetodontidae spp.) [1]
Other Aangelfishes (Pomacanthidae spp.) [1]
Other Damselfishes (Pomacentridae) [1]
Scorpionfishes (Scorpaenidae) [3]
Blennies (Blenniidae)
Other Barracudas (Sphyraenidae spp.) [1]
Sandperches (Pinguipedidae)
Left-eye Flounderes (Bothidae)
Right-eye Flounderes (Pleuronectidae)
Soles (Soleidae)
Trunkfishes (Ostraciidae)
Pufferfishes (Teradontidae)
Porcupinefishes (Diodontidae)
Remoras (Echineididae)
Tilefishes (Malacanthidae)
Coral Crouchers (Caracanthidae)

Fish Management Unit Species (continued)

Soapfishes (Grammistidae)
Trumpetfishes (Aulostomidae)
Chinese Trumpetfish (*Aulostomus chinensis*)
Cornetfishes (Fistularidae)
Reef cornetfish (*Fistularia commersoni*)
Herrings and Sardines (Clupeidae)
Anchovies (Engraulidae)
Gobies (Gobiidae)
Other Snapperes (Lutjanidae) [2]
Other Triggerfishes (Balistidae spp.) [1]
Other Filefishes (Monocanthidae spp.) [1]
Rudderfishes (Kyphosidae) [1]
Hawkfishes (Cirrhitidae) [1]
Frogfishes (Antennariidae)
Pipefishes and Seahorses (Syngnathidae)

InveInvertebrate Management Unit Species

Mollusks (Mollusca) [1]
Sea Snails and Sea Slugs (Gastropods)
Bivalve (Oysters and Clams)
Black-lipped pearl oyster (*Pinctada margaritifera*)
Other Clams
Squids and Octopuses (Cephalopods)
Tunicates (Ascidians)
Moss Animals (Bryozoans)
Mantis Shrimps, Lobsters, Crabs, and Shrimps (Crustacean) [5]
Sea Cucumbers and Sea Urchins (Echinoderms)
Segmented Worms (Annelids)

Sessile Benthos Management Unit Species

Algae (Seaweeds)
Sponges (Porifera)
Corals (Cnidaria)
Hydrozoans
Hydroid Fans (Solanderidae)
Scleractinian Anthozoans
Stony Corals (Scleractinia)
Mushroom Corals (Fungiidae)
Ahermatypic Corals (Azooxanthellate)
Non-Scleractinian Anthozoans
Anemones (Actinaria)
Colonial Anemones or Soft Zoanthid Corals (Zoanthidae)
Soft Corals and Gorgonians (Alcyonaria)
Small/Large Polyp Corals
Live Rocks[6]

Table 4-1. The fish and invertebrate species with EFH designated in the Hawaiian Islands OPAREA (continued).

[1] Species not listed under the Currently Harvested Coral Reef Taxa

[2] Species not managed under Bottomfish FMP or included in proposed Bottomfish Amendment 8 (35 additional species)

• Species not listed under Currently Harvested Coral Reef Taxa, managed under Bottomfish FMP, or included in proposed Bottomfish Amendment 8

[4] Excluding hogo (*Pontinus macrocephela*) which is included in proposed Bottomfish Amendment 8 (emperors/snappers)

[5] Species not managed under Crustacean FMP

[6] For a description of deep-sea corals see section 2.7.8.2.

*Includes all other coral reef ecosystem management unit species that are marine plants, invertebrates, and fishes that are not listed under the Currently Harvested Coral Reef Taxa or are not bottomfish management unit species, crustacean management unit species, Pacific pelagic management unit species, precious coral or seamount groundfish

Habitats encompassing the shallow-water complex consist of shelf and slope areas (Spalding et al. 2001) inhabited by snappers (*Aprion* spp. and *Lutjanus* spp.) and large carangids (jacks/trevallies; WPRFMC 1998; 2004a). The shelf area includes various habitats such as mangrove swamps, seagrass beds, shallow lagoons, coral and rocky substrate, sandy inshore reef flats, deep channels, and hard, flat, coarse sandy bottoms. Seaward reefs, outer deep reef slopes, banks, and deeper waters of coral reefs comprise the slope areas (Allen 1985; Heemstra and Randall 1993; Myers 1999). The deep-water complex consists of high relief areas with hard rocky bottoms such as steep slopes, pinnacles, headlands, rocky outcrops, and coral reefs (Allen 1985; Parrish 1987; Haight et al. 1993) inhabited by deep-water lutjanids (*Etelis* spp., *Pristipomoides* spp., and *Aphareus* spp.) and the endemic Hawaiian grouper (WPRFMC 1998). Habitat requirements for all life stages of the 14 designated EFH shallow-water and deep-water complexes can be found in Table 4-2.

Life History—Little is known about the ecology (life history, habitat, feeding, migration, and spawning) of the deep-slope bottomfish in the Hawaiian archipelago (WPRFMC 1998), and limited information is available for larval, juvenile, and adult life stages for various deep-slope bottomfish genera (shallow-water and deep-water complexes).

Jacks/trevallies (carangids) occur singly, in small groups (*Caranx* spp.), or in schools (*Pseudocaranx* spp.); whereas *Seriola* spp. may be found in small to moderate schools within the shallow-water complex (Honebrink 2000). Large jacks are highly mobile, wide-ranging predators that inhabit the open waters above coral reefs or swim in upper levels of the open sea (Sudekum et al. 1991). They spawn pelagically or close to shore at temperatures of 18° to 30°C (Miller et al. 1979; Haight 2004a) and utilize estuaries (Hanalei Bay, Kauai; Kaneohe Bay, Oahu) as nurseries (Meyer et al. 2001; Smith and Parrish 2005). Spawning seasons for most carangids are fairly long, generally peaking during summer months (e.g., *Caranx* spp: April to November with June/July peak) (Honebrink 2000).

Within the shallow-water complex, snappers form large aggregations (*Lutjanus*) near areas of prominent relief (e.g., coral heads, ledges, caves) and can also be found solitarily or in small groups (WPRFMC 1998; Haight 2004b). In the deep-water complex, eteline snappers (*Pristipomoides* spp., *Etelis* spp., *Aphareus* spp.) and groupers (*Epinephelus* spp.) aggregate near areas of high bottom relief in small and large mixed groups or singularly at depths of 100 to

Table 4-2. Bottomfish Management Unit Species EFH Designations.

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
BOTTOMFISH											
Shallow-water Species Complex (0 to 100 m)											
Gray jobfish (*Aprion virescens*)		A		J	J	A,J	A,J		A	E,L	Adult depth of 3-180 m
Thicklip trevally (*Pseudocaranx dentex*)		A	A		J	A,J			A	E,L	Adult depth of 18-183 m
Giant trevally (*Caranx ignoblis*)			J		J					E,L	Adult depth of 80 m
Black jack (*Caranx lugubris*)									A	A,J,L,E	Adult depth of 12-354 m
Amberjack (*Seriola dumerili*)						J	A,J		A	A,J,L,E	Adult depth of 0-250 m
Blue stripe snapper (*Lutjanus kasmira*)		A		J		A,J			A	E,L	Adult depth of 0-265 m
Deep-water Species Complex (100 to 400 m)											
Squirrelfish snapper (*Etelis carbunculus*)						A			A	E,L	Adult depth of 90-350 m
Longtail snapper (*Etelis coruscans*)						A			A	E,L	Adult depth of 164-293 m
Pink snapper (*Pristipomoides filamentosus*)					J				A	E,L	Juvenile depth of 65-100 m; Adult depth of 100-200 m
Yellowtail snapper (*Pristipomoides auricilla*)									A	E,L	Adult depth of 180-270 m
Pink snapper (*Pristipomoides sieboldii*)									A	E,L	Adult depth of 180-360 m
Yellow-barred snapper (*Pristipomoides zonatus*)									A	E.L	Adult depth of 100-200 m
Hawaiian grouper (*Epinephelus quernus*)				J	A	A				E,L	Adult depth of 20-380 m
Silver jaw jobfish (*Aphareus rutilans*)						A			A	E,L	Adult depth of 6-100 m

Source: WPRFMC 1998, 2001a
Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A).

500 m (Allen 1985; Moffitt 1993; Haight 2004c, 2004d, 2004e; Mazurek 2004). Juvenile eteline snappers (e.g., pink snapper) form patchy aggregations on soft, featureless bottoms with sources of increased suspended materials at depths of 60 to 90 m as nursery areas (Parrish et al. 1997). Both larval snappers and groupers avoid surface waters, are more abundant over the continental shelf, and are more evenly distributed in the water column at night (Leis 1987).

Snappers may be batch or serial spawners, spawning multiple times over the course of the season (spring and summer with peak activity occurring in November and December). Some snapper species have also been known to 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). Snapper spawning coincides with lunar periodicity corresponding with new/full moon events (Grimes 1987; Myers 1999). Some snappers (e.g., pink [*Pristipomoides filamentosus]*) display a crepuscular periodicity and migrate diurnally from areas of high relief during the day at depths of 100 to 200 m to shallow (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).

Although data on the reproduction of Pacific deep-water grouper species is lacking, all grouper species studied to date have shown to be protogynous hermaphrodites, in which the fish functions first as a female and then changes to a male (WPRFMC 2001). Groupers undergo small, localized migrations of several kilometers to congregate at favored spawning sites (Heemstra and Randall 1993). Their breeding season is abbreviated (peaking one to two months) with an unknown number of spawnings occurring per individual male or female. Spawning is typically seasonal (e.g., Hawaiian grouper: January through June, peaking in April and again in June), synchronized by moon phase, and often takes place in large aggregations (Myers 1999; Cornish 2004).

Common Prey Species—Carangids prey upon fish (parrotfish, roundscad, wrasses, bigeyes, eels), crustaceans (lobsters, crabs, shrimp), gastropods, and cephalopods (squid, octopus) (Sudekum et al. 1991; Honebrink 2000). Snappers feed on a wide range of food items including fish, polychaetes, crabs, shrimp, other benthic crustaceans (stomatopods, lobsters), and large plankton (pelagic larval urochordates, larval gastropods, and larval tunicates); whereas the Hawaiian grouper consumes fish and crustaceans, particularly shrimp (WPRFMC 1998).

EFH Designations—(WPRFMC 1998; Figures A-1, A-2, A-3, A-4, A-5, and A-6; Table 4-2)

<u>Eggs and Larvae</u>—EFH for these life stages is the water column extending from the shoreline to the outer limit of the EEZ down to a depth of 400 m and encompasses both the shallow-water and deep-water complexes.

<u>Juveniles and Adults</u>—For these life stages, EFH is the water column and all bottom habitat which encompass steep-slope and high relief habitat extending from the shoreline to a depth of 400 m and includes the shallow-water and deep-water complexes.

HAPC Designations—(WPRFMC 1998; Figures A-2, A-3, A-4, A-5, and A-6)

Based on the known distribution and habitat requirements, all life stages of the BMUS have HAPC designated in the study area. These areas include all slopes and escarpments between 40 and 280 m. In addition, three known areas of juvenile pink snapper habitat (two off Oahu: Kaneohe Bay and Kailua Bay and one off southern Molokai: adjacent to Kahanui swamp) have been designated as HAPC. These habitat areas consist of a flat, open bottom of fine, silty sand with little or no relief and close to focused sources of drainage (reef platforms, embayments, and anthropogenic sources) in water depths of 40 to 73 m (Parrish 1989).

4.2.2 PELAGIC MANAGEMENT UNIT SPECIES

Status—Currently, 32 species and one genus are managed as Pelagic Management Unit Species (PMUS) by the WPRFMC through the FMP for the Pelagic Fisheries of the Western Pacific Region (WPRFMC 1986b) and subsequent amendments (WPRFMC 1998). PMUS are divided into the following species complex designations: marketable species, non-marketable species, and sharks (Table 4-1). The marketable species complex has been further divided into temperate and tropical assemblages. The temperate species complex includes those PMUS 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*]). Additionally, a potential squid pelagic management unit consisting of three flying squids (neon flying squid [*Ommastrephes bartramii*], diamondback squid [*Thysanoteuthis rhombus*], and purpleback flying squid [*Sthenoteuthis oualaniensis*]) has been proposed by the WPRFMC for incorporation into the existing PMUS (NMFS 2004b). Currently, no data are available to determine if the PMUS are approaching an over fished situation (NMFS 2004c), except for the bigeye tuna. The NMFS (2004d) determined that over fishing was occurring Pacific wide on this species. In addition, shark species are afforded protection under the Shark Finning Prohibition Act (NMFS 2002b).

The broadbill swordfish, albacore tuna, common thresher shark (*Alopias vulpinus*), and salmon shark (*Lamna ditropis*) have been listed as data deficient on the International Union for Conservation of Nature and Natural Resources (IUCN) Red List due to inadequate information to make a direct, or indirect assessment of its risk of extinction based on its distribution and/or population status (Safina 1996; Uozumi 1996a; Goldman and Human 2000; Goldman et al. 2001). The shortfin mako shark (*Isurus oxyrinchus*), oceanic whitetip shark (*Carcharhinus longimanus*), crocodile shark (*Pseudocarcharius kamoharai*), blacktip shark (*C. limbatus*), and blue shark (*Prionace glauca*) have been listed as near threatened (Compagno and Musick 2000; Shark Specialist Group 2000a; Smale 2000; Stevens 2000a, 2000b). The bigeye tuna and the great white shark (*Carcharadon carcharias*) are listed as vulnerable on the IUCN Red List (Uozumi 1996b; Fergusson et al. 2000).

Distribution—PMUS occur in tropical and temperate waters of the western Pacific Ocean (NMFS 2001). Geographical distribution among the PMUS 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 Preference—PMUS are typically found in epipelagic to pelagic waters; however, shark species can be found in inshore benthic, neritic to epipelagic, and mesopelagic waters (Table 4-

3). Factors such as gradients in temperature, oxygen, or salinity can affect the suitability of a habitat for pelagic fishes. 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 (WPRFMC 1998). Species such as albacore tuna, bigeye tuna, striped marlin, and broadbill swordfish prefer temperate waters associated with higher latitudes and greater depths (WPRFMC 1998). Certain species, such as broadbill swordfish and bigeye tuna, are known to aggregate near the surface at night. However, during the day, broadbill swordfish can be found at depths of 800 m and bigeye tuna around 275 to 550 m (WPRFMC 1998). Juvenile albacore tuna generally concentrate above 90 m with adults found in deeper waters (90 to 275 m) (WPRFMC 1998). Habitat requirements for all life stages of the 32 designated PMUS can be found in Table 4-3.

Life History—Migration and life history patterns of most PMUS are poorly understood in the Pacific Ocean (NMFS 2001). Additionally, very little is known about the distribution and habitat requirements of the juvenile life stage of tuna and billfish prior to recruitment into fisheries (WPRFMC 1998). Seasonal movements of temperate tunas, such as the northern bluefin and albacore, are more predictable and better defined than billfish migrations (NMFS 2001). Tuna and related species tend to move toward the poles during the warmer months and return to the equator during cooler months (WPRFMC 1998). Most pelagic species make daily vertical migrations, inhabiting surface waters at night and deeper waters during the day (NMFS 2001). Spawning for pelagic species generally occurs in tropical waters but may include temperate waters during warmer months. Information is lacking about the life history stages of species that are not targeted by fisheries in the Pacific such as gempylids, sharks (e.g., crocodile), and pomfrets (WPRFMC 1998).

Common Prey Species—Major prey items for the PMUS vary substantially depending upon life stage, region, and season. Adults feed on a variety of small fish (scombrids, gempylids, flying fish), squids, and crustaceans (WPRFMC 1998).

EFH Designations—(WPRFMC 1998; Figure A-7; Table 4-3)

<u>Eggs/Larvae</u>—EFH for these life stages is the (epipelagic zone) water column down to a depth of 200 m from the shoreline to the outer limit of the EEZ.

<u>Juveniles/Adults</u>—For these life stages, EFH is the water column down to a depth of 1,000 m from the shoreline to the outer limit of the EEZ.

HAPC Designations—(WPRFMC 1998; Figure A-7)

HAPC for this group is the entire water column to a depth of 1,000 m above all seamounts and banks with summits shallower than 2,000 m within the EEZ of the Hawaiian archipelago.

4.2.3 CRUSTACEAN MANAGEMENT UNIT SPECIES

Status—Five species and one genus are currently managed as Crustacean Management Unit Species (CMUS) by the WPRFMC through the FMP of the Spiny Lobster Fisheries of the Western Pacific Region and the Final Combined FMP, EIS, Regulatory Analysis, and Draft Regulations for the Spiny Lobster Fisheries of the Western Pacific Region (WPRFMC 1981,

Table 4-3. Pelagic Management Unit Species EFH Designations.

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
PELAGIC											
Marketable Species Complex:											
Temperate Species											
Striped marlin (*Tetrapurus audax*)										A,J.L.E	Depth Distribution: governed by temperature stratification
Broadbill swordfish (*Xiphias gladius*)										A,J.L.E	Depth Distribution: surface to 1,000 m
Northern bluefin tuna (*Thunnus thynnus*)										A,J,L,E	No data
Albacore tuna (*Thunnus alalunga*)										A,J,L	Depth Distribution: surface to 380 m
Bigeye tuna (*Thunnus obesus*)										A,J,L,E	Depth Distribution: surface to 600 m
Mackerel (*Scomber* spp.)										A,J,L,E	No data
Promfet (Bramidae)											
Sickle pomfret (*Tatactichthys steindachneri*)										A,J,L,E	Depth Distribution: surface to 300 m
Lustrous pomfret (*Eumegistus illustris*)										A,J,L,E	Depth Distribution: surface to 549 m
Tropical Species											
Yellowfin tuna (*Thunnus albacares*)										A,J,L,E	Depth Distribution: upper 100 m with marked oxyclines
Kawakawa (*Euthynnus affinis*)										A,J,L,E	Depth Distribution: 36-200 m
Skipjack tuna (*Katsuwonus pelamis*)										A,J,L,E	Depth Distribution: surface to 263 m
Frigate tuna (*Auxis thazard*)										A,J,L,E	No data
Bullet tuna (*Auxis rochei*)										A,J,L,E	No data
Indo-Pacific blue marlin (*Makaira nigricans*)										A,J,L,E	Depth Distribution: 80-100 m
Black marlin (*Makaira indica*)										A,J,L,E	Depth Distribution: 457-914 m
Shortbill spearfish (*Tetrapturus angustirostris*)										A,J,L,E	Depth Distribution: 40-1,830 m
Sailfish (*Istiophorus platypterus*)										A,J,L,E	Depth Distribution: 10-20 to 200-250 m
Dolphinfishes (Coryphaenidae)											
Dolphinfish (*Coryphaena hippurus*)			A,J							A,J,L,E	No data
Pompano dolphinfish (*Coryphaena equiselas*)										A,J,L,E	No data
Wahoo (*Acanthocybium solandri*)										A,J,L,E	Adult depth <200 m
Moonfish (*Lampris guttatus*)										A,J	Depth Distribution: surface to 500 m
Non-marketable Species Complex:											
Snake mackerels/oilfish (Gempylidae)											
Escolar (*Lepidocybium flavobrunneum*)										A,J,L,E	Depth Distribution: surface to 200 m
Oilfish (*Ruvettus pretiosus*)										A,J,L,E	Depth Distribution: surface to 700 m

Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S).

Table 4-3. Pelagic Management Unit Species EFH Designations (continued)

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
Shark Species Complex											
Crocodile shark (*Pseudocarcharias kamoharai*)										A,J	Depth Distribution: surface to 300 m
Common thresher shark (*Alopias vulpinus*)		J								A,J	Depth Distribution: surface to 366 m
Pelagic thresher shark (*Alopias pelagicus*)		A				A				A,J	Depth Distribution: surface to 152 m
Bigeye thresher shark (*Alopias superciliosus*)										A,J	Depth Distribution: surface to 500 m
Shortfin mako shark (*Isurus oxyrinchus*)										A,J	Depth Distribution: surface to 500 m
Longfin mako shark (*Isurus paucus*)										A,J	No data
Salmon shark (*Lamna ditropis*)										A,J	Depth Distribution: surface to 152 m
Silky shark (*Carcharhinus falcirormis*)									A	A,J	Adult depth of 18-500 m
Oceanic whitetip shark (*Carcharhinus longimanus*)										A,J	Adult depth of 37-152 m
Blue shark (*Prionace glauca*)										A,J,L,E	Depth Distribution: surface to 152 m

Source: WPRFMC 1998, 2001a

Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S).

1982) and subsequent amendments (WPRFMC 1998, 2001a). CMUS are divided into the spiny and slipper lobster complex and the Kona crab (*Ranina ranina*) (WPRFMC 1998). Five species are managed in the spiny and slipper lobster complex by the CMUS and the Potentially Harvested Coral Reef Taxa (PHCRT) of the CRE MUS (WPRFMC 1998, 2001a): Hawaiian spiny lobster (*Panulirus marginatus*), spiny lobster (*P. penicillatus* and *Panulirus* spp.), ridgeback spiny lobster (*Scyllarides haani*), and Chinese slipper lobster (*Parribacus antarticus*). The Kona crab is managed as a single species as part of the CMUS and PHCRT (WPRFMC 1998; 2001a). Currently, no data are available to determine if these lobster species or the Kona crab of the CMUS are approaching an over fished situation (NMFS 2004b). None of the species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Members of CMUS occur in the Indo-Pacific region (Holthuis 1991; WPRFMC 1998). There are virtually no complete crustacean studies in the area of the tropical island Pacific; therefore, an assessment of their distribution is difficult (Eldredge 1995). There are 13 species of spiny lobster that occur in the tropical and subtropical Pacific between 35°N and 35°S (Holthuis 1991; WPRFMC 1998).

Habitat Preference—In general, adults of the CMUS favor sheltered areas with rocky substrates and/or sandy bottoms (Table 4-4). There is a lack of published data pertaining to the preferred depth distribution of decapod larvae and juveniles in this region (WPRFMC 2001a). The spiny lobster is restricted mainly to windward surf zones of oceanic reefs (e.g., NWHI; Pitcher 1993). Adult spiny lobsters are typically found on rocky substrate in well-protected areas, such as in crevices and under rocks (Holthuis 1991; Pitcher 1993). Adult and small juvenile spiny lobsters prefer depths less than 10 m (Holthuis 1991; Pitcher 1993) but can be found at depths of around 110 m (WPRFMC 2001a). The ridgeback spiny lobster likely occurs on rocky bottoms; and it is known to occur from depths between 10 and 135 m (Holthuis 1991). The Chinese slipper lobster prefers to live in coral or stone reefs with a sandy bottom (Holthuis 1991). Fishery takes of the Chinese slipper lobster are at depths of 20 to 70 m (Polovina 1993). 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 24 to 115 m (Smith 1993; Poupin 1996; WPRFMC 1998). Habitat requirements for all life stages of the six designated CMUS can be found in Table 4-4.

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 2001a). Both lobsters and crabs are ovigerous (females carry fertilized eggs on the outside of their body). There are limited data available concerning growth rates, reproductive potentials, and natural mortality rates at the various life history stages for members of the CMUS (WPRFMC 1998, 2001a). Spiny lobsters produce eggs in summer and fall. The larvae have a pelagic distribution of about one year and can be transported up to 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 each 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).

Common Prey Species—Spiny lobsters prey upon echinoderms, crustaceans, mollusks (primarily gastropods), algae, and seagrass (Pitcher 1993). Slipper lobsters feed on mollusks,

Table 4-4. Crustaceans Management Unit Species EFH Designations.

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
CRUSTACEANS											
Spiny and Slipper Lobster Complex											
Hawaiian spiny lobster (*Panulirus marginatus*)		All			A, J	All	All		All	L	Depth Distribution: 9 to 183
Spiny lobster (*Panulirus penicillatus, Panulirus* sp.)		All			A,J	All	All		All	L	Depth Distribution: 9 to 183 m
Ridgeback slipper lobster (*Scyllarides haani*)						A					Depth Distribution: 10 to 135 m
Chinese slipper lobster (*Parribacus antarticus*)						A					Depth Distribution: 0 to 20 m
Kona Crab											
Kona crab (*Ranina ranina*)					A						Adult depth of 24 to 115 m

Source: WPRFMC 1998, 2001a
Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S)

other reef invertebrates, and animal carrion (Waikiki Aquarium 1998b); whereas the Kona crab is an opportunistic carnivore ingesting food particles and prey (Hoover 1998; WPRFMC 1998).

EFH Designations—(WPRFMC 1998; Figures A-8, A-9, A-10, A-11, A-12, and A-13; Table 4-4)

Larvae—EFH for this life stage is the water column from the shoreline to the outer limit of the EEZ down to a depth of 150 m.

Juveniles and Adults—For these life stages, EFH is all bottom habitat from the shoreline to a depth of 100 m.

HAPC Designations—(WPRFMC 1998; Figure A-13)

All banks in the NWHI with summits less than or equal to 30 m from the surface have been designated as HAPC.

4.2.4 PRECIOUS CORAL MANAGEMENT UNIT SPECIES

Status—Thirteen species encompassing 11 known precious coral beds occur in the Hawaiian archipelago. Nine of these precious coral beds are currently managed as Precious Corals Management Unit Species (PCMUS) by the WPRFMC through the FMP for the Precious Corals Fisheries (and Associated Non-Precious Corals) of the Western Pacific Region (WPRFMC 1979) and subsequent amendments (WPRFMC 1998, 2001b, 2002; Table 4-1). In the Hawaiian archipelago (NWHI through the MHI), the PCMUS are divided into a shallow-water assemblage and a deep-water assemblage (WPRFMC 2002). Precious coral beds are treated as distinct management units because of their patchy distribution and sessile nature of individual colonies. These distinct management units encompass the deep-water assemblage precious coral beds consisting of pink (or red), *Coralliuim* spp.; gold, *Gerardia* spp., *Callogorgia* spp., *Narella* spp., and *Calyptrophora* spp.; and bamboo, *Lepidisis* spp. and *Acanella* spp. corals. The coral beds are classified as established (Makapu‘u: 3.6 km^2), conditional (Keahole Point: 0.24 km^2, Kaena Point: 0.24 km^2, and 180 Fathom Bank: 0.8 km^2), refugia (Wespac Bank: 0.8 km^2, and Brooks Bank: 1.6 km^2), or exploratory permit areas. The exploratory permit areas include all unexplored coral beds in the EEZ seaward of Hawaii, American Samoa, Guam, and American Flag Pacific Islands [AFPI]) (NOAA 1980; WPRFMC 1998). A fishery for both the shallow-water and deep-water precious coral assemblages has been sustainable for the past 40 years in Hawaii (Grigg 2001; WPRFMC 2002). Currently, no data are available to determine if precious coral stocks of the PCMUS are approaching an over fished situation (NMFS 2004c). Commercial or recreational harvesting of precious corals in the Makapu‘u coral bed has not occurred since 2001 (NMFS 2004b).

Distribution—Precious corals are globally distributed with the richest beds occurring on seamounts in the western Pacific Ocean and within caves and crevices in the western Mediterranean Sea (Grigg 1974a; 1993; Australian Gemmologist 2004). Shallow-water (30 to 100 m) and the deep-water (300 to 1,500 m) precious coral assemblages are known to occur in the EEZ around the NWHI and the MHI (Grigg 2002; WPRFMC 2005ba). Precious coral beds are also very likely to exist in the EEZ around American Samoa (WPRFMC 1998), the Northern Mariana Islands archipelago (Grigg and Eldredge 1975), and the remote U.S. Pacific Island possessions (e.g., Wake Island), but nothing is known of their distribution and abundance in these areas (WPRFMC 2002).

Habitat Preference—In the western Pacific region, precious coral polyps form colonies resembling small trees with the colonies forming aggregations referred to as beds. These precious coral beds inhabit distinct depth zones (shallow-water assemblage: black corals and deep-water assemblages: pink/red, gold, and bamboo corals) but have strikingly similar habitat requirements (WPRFMC 1998). All precious corals are non-reef builders, inhabit regions below the euphotic zone, occur on a variety of solid bottom substrates, and colonize areas that are swept by moderate to strong bottom currents (>25 cm/sec) (Grigg 1974a; WPRFMC 1998). Temperature does not appear to be a significant factor in delimiting suitable habitat for deep-water assemblages (e.g., *Corallium* spp.: 8° to 20°C); whereas the lower depth limit may be determined by temperature in the shallow-water assemblages (e.g., black corals) (Grigg 1993; WPRFMC 2001b). The highest densities for precious corals occur in areas of shell sandstone, limestone, and basaltic or metamorphic rock covered by a limestone veneer (WPRFMC 1998). The shallow-water assemblage of black corals (*Antipathes* spp.) is found in water depths ranging between 30 and 100 m, but may occur at depths ranging from 4,000 to 6,000 m (Waikiki Aquarium 1998c). These colonial corals are generally confined to low light areas, either in deep water or in turbid or shaded areas with vertical or near-vertical substrata and on or below undercut terraces (e.g., Kauai and Maui; Grigg 2004). The deep-water assemblages of precious corals encompass two principal deepwater depth zones: 350 to 450 m and 1,000 to 1,500 m. These two zones comprise 1,700 NM^2 and 5,900 NM^2 of potential habitat and range from 18°N to 35°S in the Hawaiian Islands (WPRFMC 1998).

Life History—Little is known about the biology, ecology, and dispersal of Hawaiian precious coral species (Baco-Taylor 2003). In general, western Pacific precious corals share several characteristics: slow growth, long-lived, low mortality and recruitment rates, ahermatypic, and filter feeders. Many are fan or bushy-shaped to maximize contact surfaces with particles or microplankton in the water column (Grigg 1993; WPRFMC 1998, 2002). Most species are unisexual or dioecious with reproductive maturity occurring between 12 to 13 years (e.g., angel skin coral [*Corallium secundum*] and black coral [*Antipathes dichotoma*]) and fertilization appearing to take place in the water column (WPRFMC 1998, 2002). *Corallium secundum* reproduces annually with spawning occurring during the summer months of June and July (Grigg 1974b, 1993). Asexual reproduction by fragmentation and re-cementation appears rare (WPRFMC 2001b).

Common Prey Species—Precious corals are filter feeders ingesting particulate organic matter (POM) and microzooplankton (Grigg 1993).

EFH Designations—(WPRFMC 1998, 2004a; Figures A-14, A-15, A-16, and A-17; Table 4-5)

<u>Eggs and Larvae</u>—Not applicable.

<u>Juveniles and Adults</u>—For these life stages, EFH for shallow-water black precious corals has been designated in the MHI between Milolii and South Point on the Big Island of Hawaii (at depths between 20 and 100 m), Auau Channel between Maui and Lāna‘i, and the southern border of Kauai (at depths between 20 and 100 m). For the deep-water pink (red), gold, and bamboo precious coral species, EFH is confined to the coral beds located off Keahole Point off

the Main Island of Hawaii, Makapuu and Kaena Point off Oahu, and Wespac Bed (between Necker and Nihoa Islands and east of the French Frigate Shoals), Brooks Bank, and 180 Fathom Bank (around Palmyra Island) in the NWHI.

HAPC Designations—(WPRFMC 1998, 2004a; Figure A-16)

The HAPC for all life stages of the shallow-water black precious coral is Auau Channel in the MHI. These areas for the deep-water precious corals are Makapu‘u off O‘ahu, and Wespac and Brooks Bank Beds in the NWHI.

4.2.5 CORAL REEF ECOSYSTEM MANAGEMENT UNIT SPECIES

4.2.5.1 Introduction to Coral Reef Ecosystem Management Unit Species

The CRE FMP manages coral reef ecosystems surrounding the following U.S. Pacific Island areas: the State of Hawaii, the Territories of American Samoa and Guam, the Commonwealth of the Northern Mariana Islands (CNMI), and the Pacific remote island areas (PRIA) of Johnston Atoll, Kingman Reef, Palmyra and Midway Atolls, and Jarvis, Howland, Baker, and Wake Islands (WPRFMC 2001a; NMFS 2004e). For the purpose of the FMP, these areas make up the Western Pacific Region, and the Currently Harvested Coral Reef Taxa (CHCRT)/PHCRT will only be delineated by specific U.S. Pacific Island areas when information exists. While this EFH focuses on the Hawaiian Islands OPAREA, all family information provided would correspond to the entire western Pacific Region unless otherwise noted.

In addition to EFH, WPRFMC also identifies 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 the CHCRT and PHCRT of the CRE MUS includes all hardbottom substrate between depths of 0 and 100 m in the study area. Within this depth distribution, over 47 HAPC have been identified for the MHI and Nihoa of the NWHI chain. Of these, 9 sites occur within the inshore sections of the study area: 6 on O‘ahu and 3 on Hawaii (WPRFMC 2001a; Moncada et al. 2004; Jokiel and Friedlander n.d.; Figure A-18).

4.2.5.2 Currently Harvested Coral Reef Taxa

The CHCRT are managed under the CRE FMP by the WPRFMC. CHCRT are species that have been identified which: (1) are currently being harvested in state and federal waters and for which some fishery information is available, and (2) are likely to be targeted in the near future based on historical catch data. The WPRFMC has designated EFH for these MUS based on the ecological relationships among the species and their preferred habitat. These species complexes are grouped by the known depth distributions of individual species (WPRFMC 2001a). A complete list of managed species occurring in the study area and their respective fishery management units are found in Table 4-1.

Table 4-5. Precious Corals Management Unit Species EFH Designations.

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Hs	Pr	Sz	DST	Pe	Comments
PRECIOUS CORALS											
Shallow-water Species Assemblage (18-91 m)											
Black coral *(Antipathes dichomata)*					A,J,S	A,J,S			A,J,S	E,L	Depth Distribution: 30-110 m
Pine black coral *(Antipathes grandis)*					A,J,S	A,J,S			A,J,S	E,L	Depth Distribution: 45-110 m
Fern black coral *(Antipathes ulex)*					A,J,S	A,J,S			A,J,S	E,L	Depth Distribution: 40-100 m
Deep-water Species Assemblage (274-1,372 m)											
Angel skin coral (*Corallium secundum*)					A,J,S	A,J,S			A,J,S	E,L	Depth Distribution: 350-475 m
Red coral (*Corallium regale*)					A,J,S	A,J,S			A,J,S	E,L	Depth Distribution: 380-410 m
Pink coral (*Corallium laauense*)					A,J,S	A,J,S			A,J,S	E,L	Depth Distribution: 350-1,500 m
Midway deepsea coral (*Corallium* sp. nov)					A,J,S	A,J,S			A,J,S	E,L	Depth Distribution: 300-1,500 m
Hawaiian gold coral (*Geraddia* sp.)					A,J,S	A,J,S			A,J,S	E,L	Depth Distribution: 300-400 m
Gold coral (*Callogoria gilberti*)					A,J,S	A,J,S			A,J,S	E,L	Depth Distribution: 300-1,500 m
Gold coral (*Narella* sp.)					A,J,S	A,J,S			A,J,S	E,L	Depth Distribution: 300-1,500 m
Gold coral (*Calyprophora* spp.)					A,J,S	A,J,S			A,J,S	E,L	Depth Distribution: 300-1,500 m
Bamboo coral (*Lepidisis olapa*)					A,J,S	A,J,S			A,J,S	E,L	Depth Distribution: 300-400 m
Gold coral (*Acanella* sp.)					A,J,S	A,J,S			A,J,S	E,L	Depth Distribution: 300-1,500 m

Source: WPRFMC 1998

Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Hard Substrate (Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe).

4.2.5.2.1 Fish families

Acanthuridae (Surgeonfish)

Status—Eighteen of the twenty-four species of acanthurids found in the Hawaiian archipelago are managed as part of the CHCRT by the WPRFMC and have EFH designated within the boundaries of the study area (Randall 1996; WPRFMC 2001a). In addition, the remaining 6 species of surgeonfishes have EFH designated under the PHCRT (NMFS 2004e). Currently, no data are available to determine if surgeonfish of the CHCRT are approaching an over fished situation (NMFS 2004c). Acanthurids are not of great commercial importance, but may form a significant part of the catch in insular and coastal regions with coral reefs and are valued in the aquarium trade (Randall 2001a). Aquarium species will be discussed further as part of a separate management unit species assemblage (WPRFMC 2001a). There are no endemic species of surgeonfish found in the Hawaiian archipelago, but the convict surgeonfish (*Acanthurus triostegus sandvicensis*) is recognized as an endemic subspecies, and the yellow tang (*Zebrasoma flavescens*) is abundant only in Hawaii even though its distribution ranges from the north Pacific to southern Japan (WPRFMC 2001a). None of the species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Surgeonfish are found circumtropically around coral reefs with the majority of the species occurring in the Pacific and Indian Oceans (Allen and Steen 1987).

Habitat Preference—Surgeonfish are diurnal herbivores and planktivores seeking shelter on the reef at night. Surgeonfish eggs and larvae have a wide distribution and are found in pelagic waters. The acanthurids of the Hawaiian archipelago can be divided into four major habitat types: mid-water (e.g., Thompson's surgeonfish [*Acanthurus thompsoni*]), sand patch (e.g., eyestripe surgeonfish [*A. dussumieri*]), subsurge reef (e.g., brown surgeonfish [*A. nigrofuscus*]), and seaward reef or surge zone dwellers (e.g., Achilles tang [*A. achilles*]) (WPRFMC 2001a). Larvae are generally found in offshore waters at depths from 0 to 100 m (WPRFMC 2001a). As juveniles, surgeonfish are found in reef areas until they mature. In Hawaii, juveniles have been observed in tide pools (WPRFMC 2001a). Adults are found throughout coral reef habitats and are typically associated with subsurge reef habitats at depths from 0 to 150 m, but are more commonly found between 0 and 30 m deep (WPRFMC 2001a).

Life History—Many species of surgeonfish form large, single-species or mixed-species schools (some numbering in the thousands) often associated with spawning or feeding behavior. In order to feed, the brown surgeonfish (*A. nigrofuscus*) has been known to migrate 500 to 600 m daily in schools numbering in the thousands (WPRFMC 2001a). Spawning activities are often associated with the lunar cycle and occur throughout the year with peak activity during the winter and early spring (Myers 1999). In the Hawaiian Islands, spawning of the convict surgeonfish (*A. triostegus*) occurs primarily from December to June (WPRFMC 2001a). Surgeonfish may spawn during a new moon or full moon depending on species and geography (Kuiter and Debelius 2001). Generally, spawning occurs at dusk involving groups, pairs, or both (Myers 1991). Schooling behavior is common in acanthurids especially associated with spawning events (WPRFMC 2001a).

Common Prey Species—Most acanthurids feed on benthic algae (Randall 1996).

EFH Designations—(WPRFMC 2001a; Figures A-19, A-20, A-21, A-22, A-23, and A-24; Table 4-6)

Eggs/Larvae**—**The water column from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

Adult/Juveniles**—**All bottom habitat and the adjacent water column from 0 to 100 m.

Balistidae (Triggerfishes)

Status—Six of the eleven species of triggerfish found in the Hawaiian archipelago are managed as part of the CHCRT by the WPRFMC and have EFH designated within the boundaries of the study area (Randall 1996; WPRFMC 2001a). Five additional species of triggerfish have EFH designated under the PHCRT (WPRFMC 2001a). Currently, no data are available to determine if triggerfishes of the CHCRT are approaching an over fished situation (NMFS 2004c). Triggerfish are an important food fish in western Pacific, and some of the more colorful species are popular as aquarium fish (Myers 1999). None of the species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Triggerfish are predominately tropical reef dwellers found in the Atlantic, Indian, and Pacific Oceans (Allen and Steene 1987).

Habitat Preference—Most species of triggerfish are benthic with habitat preferences including protected lagoons, high-energy surge zones, ledges and caves of deep drop-offs, sand bottoms, and rocky coral areas. Adults prefer steeply sloping areas with high coral cover, caves, and crevices. Depending on the species, depth preferences may range from shallow subtidal zones to waters deeper than 100 m (Myers 1999). Of the 11 species found in the Hawaiian archipelago, only one, the rough triggerfish (*Canthidermis maculates*), is strictly pelagic (Randall 1998). Balistid larvae are generally pelagic with prejuveniles often being associated with floating algae (WPRFMC 2001a).

Life History—Information is lacking on the spawning and migrational patterns of triggerfish in the western Pacific (WPRFMC 2001a). Triggerfish are generally solitary in habitat but do form pairs during spawning. The rough triggerfish can be found nearshore during spawning events (Randall 1996). Balastid spawning events show some correlation to lunar cycles, and eggs are typically deposited in shallow pits excavated by the parents (WPRFMC 2001a).

Common Prey Species—Most triggerfish feed on a wide variety of invertebrates including hardshell mollusks and echinoderms; however, some species do feed on algae or zooplankton (Froese and Pauly 2005).

EFH Designations—(WPRFMC 2001a; Figures A-19, A-20, A-21, A-22, A-23, and A-24; Table 4-6)

Eggs/Larvae**—**The water column from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

Table 4-6. Coral Reef Ecosystem Management Unit Species EFH Designations.

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
CORAL REEF ECOSYSTEM											
Currently Harvested Coral Reef Taxa											
Surgeonfishes (Acanhturinae)	J	A,J,S	A,J,S	J	A,J,S	A,J,S	A,J,S		A,J	E,L	Adult depth of 0-150 m
Unicornfishes (Nasinae)	J	A,J,S	J		A,S	A,J,S	A,J,S		A,S	All	Adult depth of 0-150 m
Triggerfishes (Balistidae)	J	A,J,S	J	J		A,J,S	A,J,S	A	A,S	E,L	Adult depth of 0-100 m
Jacks (Carangidae)	A,J,S	A,J,S	A,J,S	J	A,J,S	A,J,S	A,J,S		A,J,S	All	Adult depth of 0-350 m
Requiem Sharks (Carcharhinidae)	A,J	A,J	A,J	J	A,J	A,J	A,J		A,J	A,J	Adult depth of 1-300 m
Soldierfishes/Squirrelfishes (Holocentridae)		A,J,S	A,J,S	J		A,J,S	A,J,S		A,S	E,L	Adult depth of 0-235 m
Flagtails (Kuhliidae)	A,J	A,J	A,J	A,J				A		E,L	Adult depth of 3-18 m
Rudderfishes (Kyphosidae)	J	A,J,S	A,J,S		A,J	A,J,S	A,J,S	A,J		All	Adult depth of 1-24 m
Wrasses (Labridae)											
Bodianus and Xyricthys spp.		J	J	J	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Juvenile depth of 2 m; Adult depth of 2-20 m
Cheilinus spp.		A,J	J		A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth of 1-30 m
Oxycheilinus spp.		A,J			A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth of 1-160 m
Cheilio spp.											Adult depth of 1-30 m
Halichoeres spp.		A,J	J		A,J,S	A,J,S		A,J		E,L	Adult depth of 1-30 m
Thalassoma spp.		A,J		J	A,J,S	A,J,S	A,J,S			E,L	Adult depth of 1-30 m
Novaculichthys spp.		A,J			A,J,S	A,J,S		A,J			Adult depth of 1-30 m
Goatfishes (Mullidae)		A,J	A	A,J	A,J	A,J	A,J			E,L	Adult depth of 1-10 m
Mullets (Mugilidae)	J	A,J,S	A,J,S	J		A,J		A		E,L	Adult depth of 0-20 m
Moray Eels (Muraenidae)	A,J,S	A,J,S	A,J,S	A,J	A,J,S	A,J,S	A,J,S	A,J,S	E,L		Adult depth of 0-150 m
Octopuses (Octopodidae)	A,J,S	All	A,J,S	All	All	All	All		All	L	Adult depth of 0-50 m
Threadfins (Polynemidae)	A,J	A,J,S	A,J,S		A,J,S			A,J		E,L	Juvenile depth of 0-100 m; Adult depth of 20-50 m

Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S).

Table 4-6. Coral Reef Ecosystem Management Unit Species EFH Designations.

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
Bigeyes (Priacanthidae)						A,J	A,J		A,J	E,L	Adult depth of 5-400 m
Parrotfishes (Scaridae)	J	A,J,S		A,J		A,J,S	A,J,S			E,L	Adult depth of 1-30 m
Barracudas(Sphyraenidae)	A,J	A,J,S	A,J,S	J		A,J,S	A,J,S		A,S	All	Adult depth of 0-100 m
Aquarium Taxa/Species											
Surgeonfishes (Acanthuridae)	J	A,J,S	A,J,S	J	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth of 1-113 m
Moorish Idols (Zanclidae)		A,J				A,J	A,J			E,L	Adult depth of 3-182 m
Angelfishes (Pomacanthidae)	J	A,J,S	J	J		A,J,S	A,J,S		A,S	E,L	Adult depth of 2-100 m
Hawkfishes (Cirrhitidae)		A,J,S				A,J,S	A,J,S		A,J,S	All	Adult depth of 0-30 m
Butterflyfishes (Chaetodontidae)	J	A,J,S	J	J		A,J,S	A,J,S		A,S	E,L	Adult depth of 0-30 m
Damselfishes (Pomacentirdae)	J	A,J,S	J	J		A,J,S	A,J,S		A,S	E,L	Adult depth of 1-55 m
Scorpionfishes (Scorpaenidae)	J	A,J,S	A,J,S	J		A,J,S	A,J,S			E,L	Adult depth of 10-50 m
Feather-duster Worms (Sabellidae)	A,J,S	A,J,S	A,J,S		A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth of 0-30 m
Potentially Harvested Coral Reef Taxa											
FISH MANAGEMENT UNIT SPECIES											
Hammerhead Sharks (Sphyrnidae)	A,J	A,J	A,J		A,J	A,J	A,J		A,J	A,J	Adult depth of 1-275 m
Whiptail Stingrays, Eagle Rays, and Manta Rays (Dasyatidae, Myliobatidae, and Mobulidae)	A,J	A,J	A,J		A,J	A,J	A,J		A,J	A,J	Adult depth of 0-100 m
Groupers (Serranidae)	J	A,J		J	A,J,S	A,J,S	A,J,S		A,S	E,L	Adult depth of 0-400 m
Emperor Fishes (Lehtrinidae)	J	A,J,S	J	J	A,J,S	A,J,S	A,J,S		A,S	E,L	Adult depth of 0-350 m
False Moray Eels, Conger and Garden Eels, and Snake Eels (Chlopsidae, Congridae, and Ophichthidae)	A,J,S	A,J,S	A,J,S	A,J	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth of 0-105 m
Cardinalfishes (Apogonidae)	A,J,S	A,J,S	A,J,S	A,J,S		A,J,S	A,J,S		A,J,S	E,L	Adult depth of 0-80 m
Blennies (Blenniidae)		A,J,S	A,J,S		A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth of 1-40 m
Sandperches (Pinguipedidae)				A,J	A,J	A,J	A,J		A	E,L	Adult depth of 1-50 m

Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S).

Table 4-6. Coral Reef Ecosystem Management Unit Species EFH Designations. Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S) (continued).

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
Flounders and Soles (Bothidae, Pleuronectidae, and Soleidae)		A,J				A,J	A,J		A,J	L	Adult depth of 1-100 m
Trunkfishes (Ostraciidae)		A	A	J	A,J	A			A	E,L	Adult depth of 1-100 m
Pufferfishes and Porcupinefishes (Tetradontidae and Diodontidae)	A,J	A,J	A,J		A,J	A,J	A,J		A,J	E,L	Adult depth of 0-100 m
Remoras (Echineididae)						A,J,S	A,J,S		A,J,S	E,L	Adult depth of 0-50 m
Tilefishes (Malacanthidae)		A,J,S			A,J,S	A,J,S	A,J,S			E,L	Adult depth of 6-115 m
Coral Crouchers (Caracanthidae)						A,J,S	A,J,S			E,L	Adult depth of 0-10 m
Soapfishes (Grammistidae)						A,J,S	A,J,S			E,L	Adult depth of 0-150 m
Trumpetfishes (Aulostomidae)	J	A,J,S		A,J	A	A,J,S	A,J,S			E,L	Adult depth of 0-122 m
Cornetfishes (Fistularidae)	J	A,J,S		A,J		A,J,S	A,J,S			E,L	Adult depth of 0-122 m
Herrings and Sardines (Clupeidae)	A,J,S	A,J,S	A,J,S			A,J,S	A,J,S		A,S	All	Adult depth of 0-20 m
Anchovies (Engraulidae)	A,J,S	A,J,S	A,J,S			A,J,S	A,J,S		A,S	All	No data
Gobies (Gobiidae)	All	All	All	All	All	All	All		All	All	Adult depth of 1-48 m
Snappers (Lutjanidae)	A,J,S	A,J,S	A,J,S	J		A,J,S	A,J,S		A,S	E,L	Adult depth of 0-400 m
Filefishes (Monocanthidae)	J	A,J,S	J	J		A,J,S	A,J,S		A,S	E,L	Adult depth of 2-200 m
Frogfishes (Antennariidae)		All		All		All	All			L	Adult depth of 0-20 m
Pipefishes and Seahorses (Syngnathidae)	All	All		All		All	All			L	Adult depth of 0-400 m
INVERTEBRATE MANAGEMENT UNIT SPECIES											
Mollusks (Mollusca)											
Gastropods											
Sea Snails (Prosobranchs)	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adut depth of 1-24 m
Sea Slugs (Opisthobranchs)	A,J	A,J,S		A,J,S	A,J,S	A,J,S	A,J,S		A,J	E,L	Adult depth of 2-30 m
Bivalves (Oysters and Clams)											
Black-lipped pearl oyster (*Pinctada margartifera*)	A,J	A,J,S				A,J,S	A,J,S		A,J,S	E,L	Depth Distribution: littoral/sublittoral to 40 m
Other Clams	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Depth Distribution: 1-27 m

Table 4-6. Coral Reef Ecosystem Management Unit Species EFH Designations. Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S) (continued).

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
Squids (Cephalopods)		All	A,J,S	All	All	All	All		All	E,L	Adult depth from surface to 500 m
Octopuses (Octopodidae)	A,J,S	All	A,J,S	All	All	All	All		All	L	Adult depth of 1-1,000 m
Tunicates (Ascidians)	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth of 0-120 m
Moss Animals (Bryozoans)	A,J,S	A,J,S	A,J,S	A,J		A,J,S	A,J,S		A,J,S	E,L	Adult depth of 20-80 m
Crustaceans (Crustacea)											
Lobster: Spiny and Slipper		All			A,J	All	All		All	L	Adult depth of 20-55 m
Shrimps and Mantis Shrimps		All	A,J	A,J	A,J	All	All		All	L	Adult depth of 3-70 m
Crabs: True and Hermit	A,J	All	A,J	A,J	A,J	All	All		All	L	Adult depth of 0-115 m
Sea Cucumbers and Sea Urchins (Echinoderms)	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth of 0-2,000 m
Segmented Worms (Annelids)	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth of 30-70 cm to 20 m
SESSILE BENTHOS MANAGEMENT UNIT SPECIES											
Seaweeds (Algae)	All	All	All	All	All	All	All		All		Distribution: exposed shoreline, lagoon, bommies, inner/outer reef flat, reef crest, outer reef slope
Sponges (Porifera)	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Adult depth from intertidal to 50 m
Corals (Cnidaria)											
Hydrozoans											
Hydroid Fans (Solanderidae)	A,J,S	A,J,S	A,J,S			A,J,S	A,J,S		A,J,S	E,L	Depth Distribution: 0-100 m
Scleractinian Anthozoans											
Stony Corals (Scleractinia)		A,J,S	A,J,S			A,J,S	A,J,S		A,J,S	E,L	Depth Distribution: 0-60 m
Mushroom Corals (Fungiidae)		A,J,S	A,J,S			A,J,S	A,J,S		A,J,S	E,L	Depth Distribution: shallow water
Ahermatypic Corals (Azooxanthellate)		A,J,S	A,J,S		A,J,S	A,J,S	A,J,S		A,J,S	E,L	Depth Distribution: 44-1,761 m
Non-Scleractinian Anthozoans											

Table 4-6. Coral Reef Ecosystem Management Unit Species EFH Designations. Habitat: Mangrove (Ma), Lagoon (La), Estuarine (Es), Seagrass Beds (SB), Soft Substrate (Ss), Coral Reef/Hard Substrate (Cr/Hs), Patch Reefs (Pr), Surge Zone (Sz), Deep-slope Terraces (DST), Pelagic/Open Ocean (Pe). Life History Stage: Egg (E), Larvae (L), Juvenile (J), Adult (A), Spawners (S) (continued).

Management Unit Species/Taxa	Ma	La	Es	SB	Ss	Cr/Hs	Pr	Sz	DST	Pe	Comments
Anemones (Actinaria)	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S	A,J,S		A,J,S	E,L	Depth Distribution: 0-40 m
Colonial Anemones or Soft Zoanthid Corals (Zoanthidae)	A,J,S	A,J,S	A,J,S		A,J,S	A,J,S	A,J,S		A,J,S	E,L	Distribution: lagoon floors, back reef flats, reef crests, shallow sub-littoral zone
Soft Corals and Gorgonians (Alcyonaria)		A,J,S			A,J,S	A,J,S	A,J,S		A,J,S	E,L	Depth Distribution - soft corals: 3-30 m and gorgonians: <30-400 m
Small/Large Polyp Corals (Endemic spp.)		A,J				A,J	A,J		A,J		N/A
Live Rocks		A,J	A,J			A,J	A,J		A,J	E,L	N/A

Source: Colin and Arneson 1995; Sorokin 1995; Myers 1999; WPRFMC 2001a

<u>Adult/Juveniles</u>—All bottom habitat and the adjacent water column from 0 to 100 m.

Carangidae (Jacks)

Status—Two of the six species of scads, the bigeye scad (*Selar crumenophthalmus*) and the mackerel scad (*Decapterus macarellus*), are managed as part of the CHCRT by the WPRFMC and have EFH designated within the boundaries of the study area (Randall 1996; WPRFMC 2001a). In addition, the remaining four species of scads, and eighteen species of jacks, have EFH designated under the PHCRT and/or BMUS (NMFS 2004e). Currently, no data are available to determine if the bigeye and mackerel scads of the CHCRT are approaching an over fished situation (NMFS 2004c). In the MHI, the bigeye and mackerel scads comprise the principal component of nearshore commercial fisheries (WPRFMC 2001a). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Carangids are a large family represented in all tropical and temperate seas with the majority being found in coral reef waters (Allen and Steene 1987; Myers 1999).

The mackerel scad is a circumtropical species and is widespread throughout the Indian Ocean. This species ranges from the Indo-West Pacific to the Marquesas Islands in the east, and from Japan in the north, south to Australia (Smith-Vaniz 1999).

Bigeye scad range from Japan and the Hawaiian Islands in the north, south to New Caledonia and Rapa, and throughout Micronesia (Myers 1999).

Habitat Preference—Carangid eggs are planktonic, and larvae are common in nearshore waters (Miller et al. 1979). Juveniles can be found in nearshore and estuarine waters and occasionally form small schools over sandy inshore reef flats (Myers 1999). Adults are widely distributed in shallow coastal waters, estuaries, shallow reefs, deep reef slopes, banks, and seamounts (WPRFMC 2001a). Adult Carangids can range from reef habitats to deep slope habitats at depths of 0 to 350 m (WPRFMC 2001a).

Mackerel scad are a schooling species that are most often found in open water and frequently in insular habitats. This species can be found near the surface at times but is commonly taken at depths from 40 to 200 m (Froese and Pauly 2005).

Small to large schools of bigeye scad are typically found inshore or in shallow water and occasionally over shallow reefs in turbid water to depths of 170 m (Smith-Vaniz 1999).

The eggs of both the mackerel and bigeye scad are found in pelagic waters and after hatching, larvae and juvenile fish remain in the pelagic environment where they frequently form large aggregating schools. Juvenile aggregations have been identified as far as 145 km offshore (WPRFMC 2001a). Larval and juvenile fish remain in offshore pelagic waters for the first several months of their life, after which they migrate to the nearshore adult habitat (WPRFMC 2001a).

Life History—Carangid species spawn in pairs within larger aggregations associated with the lunar cycle. Information is lacking about the reproduction of these species, but peak spawning occurs between May and August (WPRFMC 2001a). Some species of scad (*Decapterus* spp. and *Selar* spp.) tend to spawn in pelagic environments. Spawning in these species occurs from March to August, peaking from May to July (WPRFMC 2001a).

Common Prey Species—Scads are planktivores, preying upon zooplankton (copepods, amphipods, crab megalops, fish larvae, and pteropods) as well as small fishes (anchovies and holocentrids), small shrimps, benthic invertebrates, and forams (WPRFMC 2001a; Froese and Pauly 2005).

EFH Designations—(WPRFMC 2001a; Figures A-19, A-20, A-21, A-22, A-23, and A-24; Table 4-6)

<u>Eggs/Larvae</u>**—**The water column from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

<u>Adult/Juveniles</u>**—**All bottom habitat and the adjacent water column from 0 to 100 m.

Carcharhinidae (Requiem sharks)

Status—Four of the eleven carcharhinid sharks found in the Hawaiian archipelago (Taylor 1993) are managed as part of the CHCRT by the WPRFMC (WPRFMC 2001a). The remaining seven species of requiem sharks have EFH designated under the PHCRT and/or the PMUS (NMFS 2004e). Currently, no data are available to determine if requiem sharks of the CHCRT are approaching an over fished situation (NMFS 2004c). Each of the CHCRT species has EFH designated within the boundaries of the study area (WPRFMC 2001a) and are listed on the IUCN Red List of threatened species. The grey reef shark (*C. amblyrhynchos*), blacktip reef shark (*C. melanopterus*), whitetip reef shark (*Triaenodon obesus*), and Galapagos shark (*C. galapagensis*) are categorized by the IUCN as near threatened species (Smale 2000b; 2000c; Heupel 2000; Bennett et al. 2003). In addition, the tiger shark (*Galeocerdo cuvier*) and the sandbar shark (*C. plumbeus*) found in the study area are listed as near threatened on the IUCN Red List of threatened species (Simpfendorfer 2000a; Shark Specialist Group 2000b). All of the requiem sharks are afforded protection under the Shark Finning Prohibition Act (NMFS 2002b).

Distribution—The requiem sharks are some of the most common and wide-ranging species found in all warm and temperate seas (WPRFMC 2001a).

In the western central Pacific, the grey reef shark ranges from Sumatra eastward to the Philippines, Australia, New Guinea, Hawaii, and the Tuamotu archipelago (Compagno and Niem 1998).

The Galapagos shark is circumtropical in distribution with a preference for waters surrounding oceanic islands. In the tropical regions of the Pacific, the Galapagos shark can be found around Lord Howe Island, the Tuamoto archipelago, Middleton and Elizabeth Reefs, Hawaii, Revillagigedo, Clipperton, Cocos, and the Galapagos Islands (Compagno 1984).

In the western Pacific, the blacktip reef shark ranges from South Africa, the Red Sea, Pakistan, and India eastward to the western central Pacific (Compagno and Niem 1998).

The whitetip reef shark is common in Polynesia, Melanesia and Micronesia, northward to the Hawaiian Islands, and southwest to the Pitcairns (Compagno 1984).

Habitat Preference—Most species of requiem sharks inhabit tropical, continental, coastal, and offshore waters, but several species prefer coral reefs and oceanic islands (Compagno 1984). Requiem sharks inhabit a wide variety of coral reef habitats, and there seems to be no real preference of any one over the others. Juvenile carcharhinids are often associated with inshore areas such as bays, seagrass beds, and lagoon flats but move into deeper waters as they mature. Adult sharks frequent inshore areas during mating or birthing events and on occasion for foraging (WPRFMC 2001a).

Grey reef sharks prefer open water, associated with coral reefs, particularly along steep outer slopes or drop offs at depths from 1 to 274 m (Myers 1999).

Adult Galapagos sharks can be found over steep outer reef slopes and offshore banks at depths of 30 to 180 m. Juveniles are more commonly found in waters between 2 and 25 m (Myers 1999).

Blacktip reef sharks are common inshore and occasionally offshore on continental and insular shelves. This species is generally associated with reef flats, shallow lagoons, and reef margins (Compagno and Niem 1998; Myers 1999).

The whitetip reef shark is one of the most common sharks in lagoons and over seaward reefs and is frequently found resting on the bottom over sand patches. This species is generally found at depths greater than 3 m and has been observed as deep as 300 m (Compagno and Niem 1998; Myers 1999).

Life History—Carcharhinid sharks reproduce by internal fertilization, and all but one species (tiger shark) in this family are placental viviparous (embryos are nourished by a placenta like organ in the female) (Cahmi et al. 1998; WPRFMC 2001a). Certain species of carcharhinids are demersal, while others range throughout the water column (Grace 2001).

Common Prey Species—Requiem sharks are opportunistic piscivores feeding on fish, elasmobranchs, squids, crustaceans, and mollusks (WPRFMC 2001a; Froese and Pauly 2005).

EFH Designations—(WPRFMC 2001a; Figure A-19; Table 4-6)

<u>Eggs/Larvae</u>**—**Not applicable.

<u>Adult/Juveniles</u>**—**All bottom habitat and the adjacent water column from 0 to 100 m to the outer extent of the EEZ.

Holocentridae (Soldierfishes/Squirrelfishes)

Status—Twelve of the approximately seventeen species of the family Holocentridae (soldierfish/squirrelfish) inhabiting the Hawaiian archipelago are managed as part of the CHCRT by the WPRFMC and have EFH designated within the boundaries of the study area (WPRFMC 2001a). In addition, the remaining four holocentrid species have EFH designated under the PHCRT (NMFS 2004e). Currently, no data are available to determine if soldierfishes/squirrelfishes of the CHCRT are approaching an over fished situation (NMFS 2004c). These fish are commonly sold in fish markets and are popular aquarium fish (Allen and Steene 1987). Holocentrids, particularly the brick soldierfish (*Myripristis amaena),* are commonly caught throughout the Hawaiian archipelago and maintain an important recreational fishery (WPRFMC 2001a). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Squirrelfish and soldierfish are found throughout the tropical Atlantic, Indian, and Pacific Oceans, with most species occurring in the Indo-Pacific region (Allen and Steene 1987).

Habitat Preference—The majority of soldierfish and squirrelfish occupy relatively shallow water over coral reefs or rocky bottoms (Randall and Greenfield 1999). Most holocentrid fish are nocturnally active and occupy the water column above the reef at night (Myers 1999). During the day, they can be found along drop offs, in or near caves and crevices, under rocks or coral overhangs, or among branching corals. Holocentrid fish are found from shallow water down to approximately 40 m, with some species occurring as deep as 235 m (WPRFMC 2001a). Adults are usually demersal, and larvae are planktonic for several weeks (Froese and Pauly 2005).

Life History—Information is lacking on the embryonic development and larval cycles of Holocentrids (WPRFMC 2001a). For one species of Holocentridae, the brick soldierfish, spawning occurs in open water and peaks from early April to early May, with a secondary peak in September. Spawning for this species is roughly correlated to the lunar cycle (WPRFMC 2001a).

Common Prey Species—Soldierfish feed mainly on large zooplankton (brachyuran crab megalops, hermit crab larvae and shrimps), whereas squirrelfish feed on benthic invertebrates and small fishes (WPRFMC 2001a; Froese and Pauly 2005).

EFH Designations—(WPRFMC 2001a; Figures A-19, A-20, A-21, A-22, A-23, and A-24; Table 4-6)

<u>Eggs/Larvae</u>**—**The water column from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

<u>Adult/Juveniles</u>**—**All rocky and coral areas and the adjacent water column from 0 to 100 m.

Kuhliidae (Flagtails)

Status—Two species of the family Kuhliidae are managed as part of the CHCRT by the WPRFMC and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). The Kuhliidae family is comprised of a single genus, *Kuhlia* (Myers 1999). Of the two managed species, the Hawaiian flagtail (*K. sandvicensis*), is the only species found in the study area (Randall 1996). Currently, no data are available to determine if the Hawaiian flagtail of the CHCRT is approaching an over fished situation (NMFS 2004c). The Hawaiian flagtail is a prized food fish and is endemic to the Hawaiian archipelago (WPRFMC 2001a). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Flagtails are distributed throughout the Indo-Pacific region (WPRFMC 2001a). In the Pacific Ocean, the Hawaiian flagtail is widely distributed around oceanic islands (Froese and Pauly 2005).

Habitat Preference—Hawaiian flagtails can be found in waters from 18° to 33°C and 1 to 39 psu. This species may be associated with a variety of habitats: in shallow waters along sandy beaches, tide pools, tidal creeks, around mangrove forests, and in the lower reaches of freshwater streams (Benson and Fitzsimons 2002). Hawaiian flagtails form schools on the outer edge of surge-swept reefs where they aggregate under ledges, in holes, or in caves during the day (WPRFMC 2001a; Froese and Pauly 2005). At night, the schools disperse, and the fish forage independently on plankton in the water column above the reef (Waikiki Aquarium 1999a; WPRFMC 2001a). Juveniles are found individually or in small aggregations in tidal pools or along shallow shoreline areas (Waikiki Aquarium 1999a; Randall and Randall 2001). Hawaiian flagtails can tolerate a wide range of temperatures and salinities and can be found in freshwater, brackish water, or salt water (Waikiki Aquarium 1999a; Benson and Fitzsimons 2002).

Life History—The Hawaiian flagtail is euryhaline throughout its entire life cycle (Benson and Fitzsimons 2002). Spawning for all species of flagtails occurs in marine or estuarine habitats (Benson and Fitzsimons 2002). Overall, information on the life history and habitat requirements of this family is lacking (WPRFMC 2001; Benson and Fitzsimons 2002).

Common Prey Species—The Hawaiian flagtail feeds on fishes, invertebrates, and insects (Froese and Pauly 2005).

EFH Designations—(WPRFMC 2001a; Figures A-19, A-20, A-21, A-22, A-23, and A-24; Table 4-6)

<u>Eggs/Larvae</u>—The water column from the shoreline to the outer limits of the EEZ to a depth of 100 m.

<u>Adult/Juveniles</u>—All bottom habitat and the adjacent water column from 0 to 27 m.

Kyphosidae (Rudderfishes or Sea Chubs)

Status—Three species of the family Kyphosidae (grey sea chub [*Kyphosus bigibbus*], blue sea chub [*K. cinerascens*], and brassy chub [*K. vaigiensis*]) are found in the Hawaiian archipelago (Randall 1998), are managed as part of the CHCRT by the WPRFMC (2001a), and have EFH designated within the boundaries of the study area (NMFS 2004d). Currently, no data are available to determine if rudderfish of the CHCRT are approaching an over fished situation (NMFS 2004c). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Rudderfish are found in the Atlantic, Indian, and Pacific Oceans (Froese and Pauly 2005). In the Indo-Pacific, this family is found throughout the tropical and subtropical waters from Easter Island westward to the Red Sea (WPRFMC 2001a).

Habitat Preference—Rudderfish, or sea chubs, occur near shore over rocky bottoms or associated with coral reefs along exposed coasts (WPRFMC 2001a; Froese and Pauly 2005). Adults are usually found swimming several meters above the bottom. Eggs, larvae, and juveniles are found in the upper layer of pelagic waters. Juveniles are often found far out at sea associated with floating debris or seaweed (Myers 1999; WPRFMC 2001a; Froese and Pauly 2005).

The grey sea chub is found in tropical waters, from 35°N to 28°S, typically associated with reefs (Froese and Pauly 2005). This species is abundant around exposed seaward reefs of isolated high islands (Myers 1999).

The blue sea chub and the brassy chub occur in tropical waters from 30°N to 30°S at depths from 1 to 24 m (Froese and Pauly 2005). These species can be found associated with hard, algal-coated bottoms of exposed, surf-swept outer reef flats, lagoon reefs, and seaward reefs (Myers 1999).

Life History—Information is lacking on the spawning and migration of rudderfish (WPRFMC 2001a). Eggs and larvae are both subject to advection by ocean currents (WPRFMC 2001a). Adults spawn in large numbers in pelagic waters (Froese and Pauly 2005).

Common Prey Species—Most species of the subfamilies Girellinae and Kyphosinae are omnivorus, feeding mainly on seagrass, algae, *Sargassum*, and benthic invertebrates (Froese and Pauly 2005).

EFH Designations—(WPRFMC 2001a; Figures A-19, A-20, A-21, A-22, A-23, and A-24; Table 4-6)

<u>Eggs/Larvae/Juvenile</u>**—**The water column from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

<u>Adult</u>**—**All rocky and coral bottom habitat and the adjacent water column from 0 to 47 m.

Labridae (Wrasses)

Status—Nine of the forty-three labrid species found in the Hawaiian archipelago are managed as part of the CHCRT by the WPRFMC and have EFH designated within the boundaries of the study area (WPRFMC 2001a). In addition, the remaining thirty-four wrasse species have EFH designated under the PHCRT (NMFS 2004e). Fourteen species of wrasse are endemic to Hawaii (Randall 1996). Currently, no data are available to determine if labrids of the CHCRT are approaching an over fished situation (NMFS 2004c). In the Hawaiian archipelago, labrids make up a small percentage of the aquarium and commercial fish trade (WPRFMC 2001a). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Wrasses are found in shallow tropical and temperate seas of the Atlantic, Indian, and Pacific Oceans (Froese and Pauly 2005). This species is distributed throughout the shallow-water areas of the western Pacific (WPRFMC 2001a).

Habitat Preference—Labrids prefer shallow waters closely associated with coral reefs (WPRFMC 2001a). They inhabit steep outer reef slopes, channel slopes, and lagoon reefs. Wrasses can be found in virtually every habitat on tropical reefs, including rubble, sand, algae, seaweeds, rocks, flats, tide pools, crevices, caves, fringing reefs, and patch reefs (Allen and Steene 1987; WPRFMC 2001a). Most wrasses are found in relatively calm waters between about 3 and 20 m; however, some species occur at depths greater than 200 m (Allen and Steene 1987; WPRFMC 2001a) (e.g., cross seamount near Hawaii) (Chave and Mundy 1994). Adults roam the coral reefs during the day keeping close to coral or rocky cover (Froese and Pauly 2005). At night, they may rest in caves or under coral ledges, bury themselves in the sand, or lie motionless on the bottom (WPRFMC 2001a; Froese and Pauly 2005). Labrid eggs and larvae are pelagic and are routinely found in the open ocean (WPRFMC 2001a). Juveniles, like adults, inhabit a wide range of habitats from shallow lagoons to deep reef slopes (WPRFMC 2001a).

Life History—Wrasses are pelagic spawners and schooling behavior is usually associated with reproduction. In tropical waters, spawning occurs year-round along the outer edge of the patch reef or along the outer slope of more extensive reefs. Many labrids migrate to prominent coral or rock outcrops to spawn. Wrasses may spawn in large aggregations or in pairs depending on the maturity of the individuals (WPRFMC 2001a). Labrids exhibit two types of spawning behavior: (1) aggregate spawning of large groups of a dozen to several hundred initial-phase males and females and (2) pair spawning of a terminal-phase male and an initial-phase female (WPRFMC 2001a).

Common Prey Species—Most labrids are carnivores, preying on benthic invertebrates (mollusks, crustaceans, polychaetes, sea urchins, brittle stars, tunicates, and forminiferans), fish, and fish eggs; some are planktivores (copepods, fish eggs, larval fish, and invertebrates), corallivores (live coral polyps), and cleaners, removing ectoparasites from larger fish (WPRFMC 2001a; Froese and Pauly 2005).

EFH Designations—(WPRFMC 2001a; Figure A-19; Table 4-6)

<u>Eggs/Larvae/Juvenile/Adult</u>—The water column and all bottom habitats extending from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

Mullidae (Goatfishes)

Status—Eight of the thirteen species in the family Mullidae found in the Hawaiian archipelago are managed as part of the CHCRT by the WPRFMC and have EFH designated within the boundaries of the study area (WPRFMC 2001). In addition, the remaining five species of goatfish have EFH designated under the PHCRT (NMFS 2004e). There are 10 native, one introduced (yellow-banded goatfish: *Upeneus vittatus*), and two endemic species (whitesaddle goatfish: *Parupeneus porphyreus* and yellowbarbel goatfish: *P. chrysonemus*) of goatfishes known from Hawaiian waters (WPRFMC 2001a). Currently, no data are available to determine if goatfishes of the CHCRT are approaching an over fished situation (NMFS 2004c). A number of goatfish are commercially important in the western Pacific, and most of the catch is marketed fresh (Randall 2001b). None of these are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Goatfish are found in tropical and subtropical regions of the Atlantic, Indian, and Pacific Oceans (Froese and Pauly 2005). The majority of species in this family can be found in the Indo-West Pacific region (Allen and Steene 1987).

Habitat Preference—Generally, goatfish are found over sandy areas in shallow waters adjacent to reefs at depths of about 10 m (Allen and Steene 1987; WPRFMC 2001). However, some species have been reported as deep as 140 m (WPRFMC 2001a). Goatfish eggs and larvae are pelagic, and adults and juveniles are found in demersal habitats associated with coral reefs, rocks, sand, mud, crevices, and ledges (WPRFMC 2001a).

Life History—Goatfish are commonly found schooling and may spawn either in groups or pairs (WPRFMC 2001a). Mullids spawn in pelagic waters with aggregations of 300 to 400 individuals being common for certain species (Allen and Steene 1987). Spawning aggregations are found near channels with heavy tidal flow (WPRFMC 2001a).

Common Prey Species—Goatfish use their chin barbells to probe the sand or holes in the reef for benthic invertebrates such as crabs, shrimps, isopods, amphipods, ostracods, stomatopods, planktonic crab megalops larvae and copepods, gastropods, and foraminiferans; some species consume small fish (WPRFMC 2001a; Froese and Pauly 2005).

EFH Designations—(WPRFMC 2001a; Figures A-19, A-20, A-21, A-22, A-23, and A-24; Table 4-6)

Eggs/Larvae—The water column extending from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

Juvenile/Adult—All rocky/coral and sand-bottom habitat and the adjacent water column from 0 to 100 m.

Mugilidae (Mullets)

Status—Three species of the family Mugilidae, two natives (Engel's mullet [*Moolgarda engeli*] and false mullet [*Neomyxus leuciscus*]) and one introduced form (striped mullet [*Mugil cephalus*]) are managed as part of the CHCRT by the WPRFMC and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if mullets of the CHCRT are approaching an over fished situation (NMFS 2004c). Several species of mullets are of moderate to major importance to fisheries in the western Pacific and small-scale, subsistence fisheries are probably also relatively large (Harrison and Senou 1999). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—The family Mugilidae can be found in all tropical and temperate seas but are most speciose in the Indo-West Pacific region (Harrison and Senou 1999; Foese and Pauly 2005).

The striped mullet is found in the coastal waters of the tropical and subtropical zones of all seas (Froese and Pauly 2005).

The Engel's mullet is found in the Indo-Pacific region from East Africa to the Marquesan and Tuamoto Islands and north to the Yaeyamas (Froese and Pauly 2005).

The false mullet is found in the Pacific Ocean around southern Japan and the Mariana and Bonin Islands east to the Hawaiian, Line, and Ducie Islands (Froeses and Pauly 2005).

Habitat Preference—Most species are capable of tolerating a wide range of salt water concentrations and inhabit marine waters, brackish water lagoons, estuaries, and freshwater (Harrison and Senou 1999). Some species more typically inhabit brackish waters. Mullets are generally found feeding over reefs or sandy bottoms at depths around 20 m (Harrison and Senou 1999; WPRFMC 2001a).

The striped mullet is a coastal species that often enters estuaries and rivers (Froese and Pauly 2005). This species generally aggregates over sandy or muddy bottoms in shallow water (WPRFMC 2001a; Froese and Pauly 2005). The striped mullet is found in subtropical waters between 42°N and 42°S at depths from 0 to 120 m in water temperatures between 8° and 24°C (Froese and Pauly 2005).

The Engel's mullet is found in tropical waters from 25°N to 24°S usually associated with coral reefs. Adults usually inhabit sandy to muddy areas of reef flats and shallow lagoons, while juveniles are generally found in tide pools (Froese and Pauly 2005).

The false mullet is found in tropical waters between 30°N and 30°S at depths from 0 to 4 m. This species inhabits sandy shores, tide pools, and rocky surge areas. The false mullet tends to move inshore to surface waters at night (Froese and Pauly 2005).

Life History—Information is lacking concerning the spawning and migration of these species (WPRFMC 2001a). It is presumed that the eggs and larvae are dispersed by advection (WPRFMC 2001a). The acute-jawed mullet is a schooling species. The striped mullet spawns from July to October (Froese and Pauly 2005).

Common Prey Species—Mullets feed on fine algae, diatoms, and detritus of bottom sediments (Randal 1996).

EFH Designations—(WPRFMC 2001a; Figures A-19, A-20, A-21, A-22, A-23, and A-24; Table 4-6)

<u>Eggs/Larvae</u>**—**The water column from the shoreline to the outer limits of the EEZ to a depth of 100 m.

Juvenile/Adult—All sand and mud bottoms and the adjacent water column from 0 to 27 m.

Muraenidae (Moray Eels)

Status—Three of the thirty-eight members of the family Muraenidae found in the Hawaiian archipelago are managed as part of the CHCRT by the WPRFMC and have EFH designated within the boundaries of the study area (WPRFMC 2001a). The remaining thirty-five moray eels, excluding the dragon moray (*Enchelycore paradilis*), which is an aquarium taxa, have EFH designated under the PHCRT (NMFS 2004e). One species, Steindachner's moray (*Gymnothorax steindachneri*), is endemic to Hawaii (WPRFMC 2001a). Currently, no data are available to determine if moray eels of the CHCRT are approaching an over fished situation (NMFS 2004b). Although there is no commercial fishery for morays, most are taken as incidental catch, sold in fish markets, and readily eaten in the western Pacific (Bohlke et al. 1999). These species are also targets of the aquarium trade. None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Moray eels are found worldwide in tropical and subtropical waters (Froese and Pauly 2005).

The yellowmargin moray eel (*G. flavimarginatus*) ranges throughout the Indo-Pacific from the Red Sea and South Africa eastward to the Tuamoto and Austral Islands, north to the Ryukyu and Hawaiian Islands, and south to New Caledonia (Froese and Pauly 2005).

The giant moray (*G. javanicus*) is found in the Indo-Pacific from the Red Sea and East Africa to the Marquesas and Oeno Atoll (Pitcairn Group), north to the Ryukyu and Hawaiian Islands, south to New Caledonia and the Austral Islands; throughout Micronesia (Froese and Pauly 2005).

The undulated moray (*G. undulatus*) is distributed throughout the Indo-Pacific from the Red Sea and East Africa, including Walter Shoal, to French Polynesia, north to southern Japan and the Hawaiian Islands, south to the southern Great Barrier Reef (Froese and Pauly 2005).

Habitat Preference—Most species of moray eels are benthic and can be found in shallow waters around rocks or reefs. Some species are associated with sand or mud bottoms, and morays have been caught as deep as 500 m. (Bohlke et al. 1999). Moray eel juveniles and adults lurk in holes and crevices during the day and emerge at night to search the reef for food (Waikiki Aquarium 1999b). Moray eggs are pelagic, and the leptocephalic larvae are epipelagic (WPRFMC 2001a; Froese and Pauly 2005).

The yellow-edged moray inhabits tropical waters between 30°N and 24°S at depths from 1 to 150 m. This species can be found along drop-offs and in coral or rocky areas of reef flats and protected shorelines to seaward reefs (Froese and Pauly 2005).

The giant moray inhabits tropical waters from 30°N to 25°S at depths from 0 to 50 m. This species is usually found in lagoons and along seaward reefs (Froese and Pauly 2005).

The undulated moray inhabits tropical waters from 32°N to 28°S at depths from 0 to 30 m. This species is common on reef flats among rocks, rubble, or debris and in lagoons and seaward reefs to depths greater than 26 m (Froese and Pauly 2005).

Life History—Information is lacking on the life history of this family (WPRFMC 2001a). Migration has been observed in some species of morays, but most tropical species remain in their home territories or congregate in small groups in certain areas (Debelius 2002).

Common Prey Species—Moray eels mainly feed on crustaceans, cephalopods, and small fishes (Froese and Pauly 2005).

EFH Designations—(WPRFMC 2001a; Figures A-19, A-20, A-21, A-22, A-23, and A-24; Table 4-6)

Eggs/Larvae—The water column from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

Juvenile/Adult—All rocky coral areas and the adjacent water column and the adjacent water column from 0 to 100 m.

Octopodidae (Octopuses)

Status—Two of the species of the family Octopodidae, the day squid (*Octopus cyanea*) and the night squid (*O. ornatus*), are managed as part of the CHCRT by the WPRFMC and have EFH designated within the boundaries of the study area (WPRFMC 2001). In addition, the remaining six species of octopuses found in the study area have designated EFH under the PHCRT (NMFS 2004d). Currently, no data are available to determine if octopuses of the CHCRT are approaching an over fished situation (NMFS 2004b). These species are primarily harvested for human consumption but are also used as bait in other fisheries (Norman 1998). Octopuses are a component of the incidental catch of the lobster-trap fishery in the NWHI (WPRFMC 2001a). None of the species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Members of the family Octopodidae occur in all the oceans of the world from the equator to polar latitudes (Norman 1998; Waikki Aquarium 1998d).

The day squid and the night squid are found widely throughout the shallow waters of the Indo-West Pacific from Hawaii in the east to the east African coast in the west. These species have been reported as far north as Japan and as far south as New South Wales, Australia (Norman 1998).

Habitat Preference—Reef-associated octopuses are bottom-dwelling species that usually occupy holes and crevices or coral areas. These species are found from the shallowest part of the reef down to approximately 50 m (WPRFMC 2001a). Octopuses occur on a wide range of substrates including coral and rock reefs, seagrass beds, sand, and mud. Octopus eggs are demersal and typically attached in clusters within the rocky depths of the reef (WPRFMC 2001a).

The day squid and night squid are found from intertidal reefs, shallow reef flats and reef slopes to depths of at least 25 m and are associated with both live and dead corals. As the name implies the day squid is more active throughout the day with peak activities at dusk and dawn (Norman 1998). The night squid is nocturnal, resting by day and foraging at night (Waikiki Aquarium 1998d).

Life History—Life history information is lacking for these species of octopus (Norman 1998; Waikki Aquarium 1998d; WPRFMC 2001a).

Common Prey Species—Octopuses feed on fishes, isopods, stomatopods, eels, and crabs (Wood 2005)

EFH Designations—(WPRFMC 2001a; Figures A-19, A-20, A-21, A-22, A-23, and A-24; Table 4-6)

<u>Eggs/Juvenile/Adult</u>—EFH for the adult, juvenile, and demersal egg phases are defined as all coral, rocky, and sand-bottom areas from 0 to 100 m.

<u>Larvae</u>—The water column extending from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

Polynemidae (Threadfin)

Status—One species, the sixfeeler threadfin (*Polydactylus sexfilis)*, of the family Polynemidae is managed as part of the CHCRT by the WPRFMC and has EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004d). Currently, no data are available to determine if the sixfeeler threadfin of the CHCRT is approaching an over fished situation (NMFS 2004b). This species is highly valued as food fish in Hawaii (WPRFMC 2001a). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—The sixfeeler threadfin is found throughout the tropical waters of the Atlantic and Indo-Pacific Oceans from 30°N to 0°N (WPRFMC 2001a; Froese and Pauly 2005). In the Indo-Pacific, this species ranges from India to the Hawaiian, Marquesan, and Pitcairn Islands, north to the Yaeyama and Bonin Island, and throughout Micronesia (Myers 1999).

Habitat Preference—Adult sixfeeler threadfin are found near reef areas and inhabits turbid waters along sandy shorelines and over sandy lagoon bottoms usually associated with high-energy surf zones (Meyers 1999; Feltes 2001; WPRFMC 2001a). This species is most common at depths from 20 to 50 m (Feltes 2001). Sixfeeler threadfin eggs and larvae are pelagic; but after larval metamorphosis, they enter nearshore habitats such as surf zones, reefs, and stream entrances (WPRFMC 2001a). Juvenile sixfeeler threadfin are found from the shoreline breaker to 100 m depth (WPRFMC 2001a). In Kaneohe Bay, adults can be found on reef faces, in depths of the inner bay, and in shallow (2 to 4 m) areas with muddy sand bottoms (WPRFMC 2001a).

Life History—Spawning occurs close to shore for three to six days per month and is associated with the lunar cycle (Meyers 1999; WPRFMC 2001a). In Hawaii, the sixfeeler threadfin spawns from June to September, with a peak in July and August (WPRFMC 2001a). Spawning may occur year round in tropical locations (WPRFMC 2001). Both eggs and larvae are subject to advection by ocean currents (WPRFMC 2001a).

Common Prey Species—Threadfins mainly feed on benthic invertebrates such as penaeid and caridean shrimps and fish (Froese and Pauly 2005).

EFH Designations—(WPRFMC 2001a; Figures A-19, A-20, A-21, A-22, A-23, and A-24; Table 4-6)

Eggs/Larvae—The water column extending from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

Juvenile/Adult—All rocky/coral and sand-bottom habitat and the adjacent water column from 0 to 100 m.

Priacanthidae (Bigeyes)

Status—One of the two species of the family Priacanthidae is managed as part of the CHCRT by the WPRFMC (2001a) and is found in the Hawaiian Islands OPAREA (Randall 1998). The glasseye (*Heteropriacanthus cruentatus*) has EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if the glasseye is approaching an over fished situation (NMFS 2004c). Priacanthids are excellent food fish but are not important in most fishery areas (Starnes 1999). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Priacanthids can be found in the tropical and subtropical waters of the Atlantic, Indian, and Pacific Oceans (Froese and Pauly 2005).

The glasseye is located circumtropically north to Ryukyu, Bonin, and Hawaiian Islands, and south to Lord Howe and Easter Island (Myers 1999).

Habitat Preference—Bigeyes are typically epibenthic and are usually associated with rock formations or coral reefs. This family prefers shaded overhangs, caves, and crevices near the reef during the daytime (WPRFMC 2001a). Occasionally, bigeyes may be associated with more open areas at depths of 5 to 400 m (Starnes 1999). Eggs, larvae, and early juvenile stages are pelagic (Froese and Pauly 2005).

The glasseye is a subtropical species that ranges from 33°N to 32°S at depths from 3 to 300 m (Froese and Pauly 2005). This species is commonly associated with lagoons or seaward reefs below the surge zone, generally around islands (Myers 1999; Froese and Pauly 2005). Glasseyes are found singly or in small groups under or near ledges during the day forming larger groups at dusk to forage. Juveniles of this species are pelagic (Froese and Pauly 2005).

Life History—Spawning has not been observed for this species (WPRFMC 2001a). Daily migrations usually occur above and away from the reef in search of food (Myers 1999).

Common Prey Species—Glasseyes are nocturnal zooplanktivores feeding on the larvae of crabs, fishes, crustaceans, polychaete worms and cephalopods, and soft-bodied invertebrates (WPRFMC 2001a; Froese and Pauly 2005).

EFH Designations—(WPRFMC 2001a; Figures A-19, A-20, A-21, A-22, A-23, and A-24; Table 4-6)

Eggs/Larvae—The water column extending from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

Juvenile/Adult—All rocky/coral and sand-bottom habitat and the adjacent water column from 0 to 100 m.

Scaridae (Parrotfishes)

Status—One species, the stareye parrotfish (*Catolomus carolinus*), and one genus, *Scarus* spp., of the family Scaridae is managed as part of the CHCRT by the WPRFMC and have EFH designated within the boundaries of the study area (WPRFMC 2001a). In addition, the remaining five species of parrotfishes found in the study area have EFH designated under the PHCRT (WPRFMC 2001a). Three of these species are endemic to the Hawaiian Islands: yellowbar parrotfish (*C. zonarchus*), spectacled parrotfish *(Chlorurus perspicillatus),* and regal parrotfish *(Scarus dubius*) (WPRFMC 2001a). Currently, no data are available to determine if parrotfishes of the CHCRT are approaching an over fished situation (NMFS 2004c). Parrotfish are not a major commercial catch but they are an important food-fish and are frequently found in fish markets (Westneat 2001; Froese and Pauly 2005). There are no species of parrotfish found in the study area listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Parrotfish are mainly a tropical species occurring in the Atlantic, Indian, and Pacific Oceans (Froese and Pauly 2005). The majority of these species are found inhabiting the coral reefs of the Indian and western Pacific Oceans (WPRFMC 2001a).

Habitat Preference—Parrotfish are commonly found around coral reefs and are usually most abundant in shallow waters to a depth of 30 m (Bellwood 2001). This family 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).

Life History—Parrotfish spawn in pairs and groups with group spawning frequently occurring on reef slopes associated with high current speeds. Pair 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 attached and practice haremic, pair spawning. The eggs and larvae of these species are pelagic, and both are subject to dispersal by ocean currents (WPRFMC 2001a).

Common Prey Species—Parrotfish are herbivorous and scrape algae from dead coral substrates (Froese and Pauly 2005).

EFH Designations—(WPRFMC 2001a; Figures A-19, A-20, A-21, A-22, A-23, and A-24; Table 4-6)

Eggs/Larvae—The water column from the shoreline to the outer limit of the EEZ to a depth of 100 m.

Juvenile/Adult—All bottom habitat and the adjacent water column from 0 to 100 m.

Sphyraenidae (Barracudas)

Status—Two species (Heller's barracuda [*Sphyraena helleri*] and the great barracuda [*S. barracuda])* of the family Sphyraenidae are managed as part of the CHCRT by the WPRFMC and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if barracudas of the CHCRT are approaching an over fished situation (NMFS 2004c). These two species of barracuda are not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Barracudas can be found in tropical and subtropical waters in the Atlantic, Indian, and Pacific Oceans (Froese and Pauly 2005). Heller's barracuda and the great barracuda are the only two species positively recorded from Hawaiian waters (WPRFMC 2001).

Heller's barracuda can be found from southern Japan south to the Coral Sea and east to French Polynesia. This species is common around the oceanic islands of the Pacific (Froese and Pauly 2005).

The great barracuda is common in the Indo-Pacific from the Red Sea and east coast of Africa to the Hawaiian, Marquesan, and Tuamoto Islands (Froese and Pauly 2005).

Habitat Preference—Barracudas are both pelagic and demersal fish and inhabit shallow coastal waters such as bays, estuaries, or the vicinity of coral reefs. This species may also be found at the surface of open oceans down to depths greater than 100 m (Senou 2001). Barracudas may be found within lagoons and mangrove areas, over coral reefs or sand or mud bottoms, or off of deep outer reef slopes. Eggs and larvae for these species are pelagic (WPRFMC 2001a).

Heller's barracuda is a subtropical species found from 30°N to 25°S at depths from 15 to 60 m (Froese and Pauly 2005). This species occurs in lagoons and over seaward reefs (Myers 1999).

The great barracuda is a subtropical species found from 30°N to 30°S at depths from 0 to 100 m. Adults occur from murky inner harbors to open seas, usually at or near the surface (Froese and Pauly 2005). Juveniles occur among mangroves and in shallow sheltered inner reefs (WPRFMC 2001a).

Life History—Barracuda migrate in very large numbers to specific spawning areas at reef edges or in deeper water. Eggs and juveniles may be carried long distances by ocean currents

(WPRFMC 2001a). Heller's barracuda can be found in large school during the day; whereas, the great barracuda is diurnal and solitary (Froese and Pauly 2005).

Common Prey Species—Barracudas are piscivorous feeding on a variety of fishes including, but not limited to, jacks, groupers, snappers, small tunas, mullets, herrings, and anchovies (Bester 2005).

EFH Designations—(WPRFMC 2001a; Figure A-19; Table 4-6)

Eggs/Larvae/Juvenile/Adult—The water column from the shoreline to the outer boundary of the EEZ to a depth of 100 m.

4.2.5.2.2 Aquarium species/taxa

Fish species harvested for aquarium trade are managed as part of the CHCRT by the WPRFMC (2001a) and have EFH designated within the boundaries of the study area (NMFS 2004e). All aquarium taxa are managed as a unit, and EFH designation for the life stages of each species are identical. The EFH designations for all species of aquarium taxa can be found below and will therefore not be listed for individual species. Within the jurisdictional waters of the WPRFMC, Hawaii is the main site where commercial collection and sale of coral reef fishes and invertebrates for the aquarium trade is occurring (WPRFMC 2001). As a result, the aquarium MUS complex is based primarily on those species known from Hawaiian waters. The species found within the Aquarium Species/Taxa category do not represent a taxonomically related group; however, from an ecological standpoint, these species are generally associated with shallow coral areas (WPRFMC 2001a).

EFH Designations—(WPRFMC 2001a; Figures A-19, A-20, A-21, A-22, A-23, and A-24; Table 4-6)

Eggs/Larvae—All waters from 0 to 100 m from the shoreline to the limits of the EEZ.

Juvenile/Adult—All coral, rubble, or other hard bottom features and the adjacent water column from 0 to 100 m.

Acanthuridae (Surgeonfishes)

A complete summary of the family Acanthuridae including EFH designations is provided earlier in the CHCRT section 4.2.5.2.1.

Zebrasoma flavescens (Yellow tang)

Status—The yellow tang is managed as part of the CHCRT by the WPRFMC and has EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if the yellow tang is approaching an over fished situation (NMFS 2004b). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—The yellow tang can be found in the Pacific Ocean associated with Ryukyu, Mariana, Marshall, Marcus, Wake, and Hawaiian Islands (Froese and Pauly 2005).

Habitat Preference—Yellow tangs inhabit coral-rich areas of lagoons and seaward reefs from below the surge to approximately 46 m. This species can be found in tropical waters from 30°N to 15°N in water temperatures ranging from 24° to 28°C at depths between 2 and 46 m (Froese and Pauly 2005).

Life History—The yellow tang may spawn in groups or pairs (Myers 1999).

Common Prey Species—The yellow tang is herbivorous, generally feeding on filamentous algae growing exposed on basalt and dead coral heads (Froese and Pauly 2005).

Ctenochaetus strigosus (Yellow-eyed surgeonfish)

Status—The yellow-eyed surgeonfish is managed as part of the CHCRT by the WPRFMC and has EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if the yellow-eyed surgeonfish is approaching an over fished situation (NMFS 2004c). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—The yellow-eyed surgeonfish can be found in the Indo-Pacific region from east Africa to the Hawaiian, Marquesan, and Ducie Islands. Its range is bounded to the north by the Bonin Islands and to the south by the Great Barrier Reef and New Caledonia (Myers 1999).

Habitat Preference—The yellow-eyed surgeonfish inhabits coral-rich areas of lagoons and seaward reefs. This species can be found in tropical waters from 30°N to 30°S in water temperatures ranging from 21° to 27°C at depths between 1 and 113 m (Froese and Pauly 2005).

Life History—The yellow-eyed surgeonfish has been observed spawning in pairs (Myers 1999).

Common Prey Species—The yellow-eyed surgeonfish feeds mainly on detritus (Froese and Pauly 2005).

Acanthurus achilles (Achilles tang)

Status—The achilles tang is managed as part of the CHCRT by the WPRFMC and has EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if the achilles tang is approaching an over fished situation (NMFS 2004c). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—The achilles tang can be found distributed throughout the tropical Indo-Pacific from the western Caroline Islands, Parece Vela, and the Torres Strait east to the Hawaiian, Marquesan, and Ducie Islands. This species ranges as far north as the Marcus Islands and south to New Caledonia (Myers 1999).

Habitat Preference—The achilles tang inhabits clear seaward reefs from the surge zone to a depth of 4 m (Myers 1999). This species can be found in tropical waters from 28°N to 26°S in water temperatures ranging from 26° to 28°C at depths between 0 and 10 m (Froese and Pauly 2005).

Life History—Information is lacking on the life history of the achilles tang (WPRFMC 2001a).

Common Prey Species—The achilles tang feeds on filamentous and small fleshy algae (Froese and Pauly 2005).

Zanclidae (Moorish Idol)

Status—The Moorish idol (*Zanclus cornutus*), the sole member of this monotypic family, is an aquarium taxa that is managed in the Hawaiian archipelago as part of the CHCRT by the WPRFMC (2001a) and has EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if the Moorish idol is approaching an over fished situation (NMFS 2004c). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—The Moorish idol can be found distributed throughout the Indo-pan-Pacific from the Gulf of Aden and eastern Africa east to Mexico. This species ranges as far north as southern Japan and the Hawaiian Islands and south to Lord Howe, the Kermadecs, Rapa, and Ducie Islands (Myers 1999).

Habitat Preference—The Moorish idol inhabits areas of hard substrates from turbid inner harbors and reef flats to clear seaward reefs as deep as 182 m (Myers 1999; WPRFMC 2001a). This species can be found in tropical waters from 30°N to 35°S in water temperatures ranging from 24° to 28°C at depths between 3 and 182 m (Froese and Pauly 2005).

Life History—The Moorish idol is usually found in small groups, but may occur in schools numbering over 100 individuals (Myers 1999; WPRFMC 2001a).

Common Prey Species—The Moorish idol feeds on small encrusting animals (sponges) and occasionally on benthic crustaceans and algae (Randall 1996; Froese and Pauly 2005).

Pomacanthidae (Angelfish)

Status—Aquarium species in the family Pomacanthidae are managed in the Hawaiian archipelago as part of the CHCRT by the WPRFMC (2001a). Six angelfish species occur in Hawaii and have EFH designated within the boundaries of the study area (NMFS 2004e). Four of these species are endemic: Fisher's angelfish (*Centropyge fisheri*), Potter's angelfish (*C. potteri*), bandit angelfish (*Desmoholacantus arcuatus*), and masked angelfish (*Genicanthus personatus*) (WPRFMC 2001a). The masked angelfish is highly valued for the aquarium trade

(WPRFMC 2001a). Currently, no data are available to determine if angelfishes of the CHCRT are approaching an over fished situation (NMFS 2004c). Although harvested as food-fish, the primary value of angelfish is through the ornamental marine aquarium trade, where they are the second most-frequently exported fish by number and highest in total value of all families of aquarium fishes in trade (Pyle 2001a). These species are not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Angelfish are circumtropical with the greatest numbers of species distributed throughout the Indo-Pacific (Myers 1999).

Habitat Preference—Angelfish require suitable shelter in the form of boulders, caves, and coral crevices and occur from 2 to 30 m depth (WPRFMC 2001a). A few species have been known to occur at depths greater than 100 m (WPRFMC 2001a).

Life History—Angelfish spawn in pairs, typically around sunset (Myers 1999).

Common Prey Species—Most large angelfish (e.g., *Pomacanthus* spp.) feed primarily on sponges, whereas small species (e.g., *Centropyge* spp.) feed on benthic algae and detritus (Randall 1996). All species take small amounts of soft-bodied invertebrates (tunicates), zooantharians, gorgonians, fish and invertebrate eggs, hydroids, algae, and seagrasses (Myers 1999; WPRFMC 2001a). The masked angelfish is zooplanktivores, but may consume algae, copepods, diatoms, fish eggs, and sponge spicules (WPRFMC 2001a).

Muraenidae (Moray Eels)

Status—The dragon moray (*Enchelycore pardalis*) is the only aquarium species in the family Muraenidae that is managed as a part of the CHCRT by the WPRFMC and has EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if the dragon moray eel of the CHCRT is approaching an over fished situation (NMFS 2004c). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—The dragon moray can be found from Reunion Island in the east to the Hawaiian, Line, and Society Islands in the west and ranges from southern Japan and southern Korea in the north to New Caledonia in the south (Froese and Pauly 2005). This species is more common around NWHI than in the MHI (WPRFMC 2001a).

Habitat Preference—The dragon moray is found in tropical waters and typically inhabits coral and rocky reefs at depths from 8 to 60 m (Froese and Pauly 2005).

Life History—Information is lacking on the life history of the dragon moray (WPRFMC 2001a).

Common Prey Species—The dragon moray is an opportunistic piscivore, feeding on sponges, invertebrates, and algae (Froese and Pauly 2005).

Cirrhitidae (Hawkfishes)

Status—The longnose hawkfish (*Oxycirrhites typus*) is the sole species of aquarium taxa in the family Cirrhitidae that is managed in the Hawaiian archipelago as part of the CHCRT by the WPRFMC (2001a) and has EFH designated within the boundaries of the study area (NMFS 2004e). However, the remaining five species of hawkfishes found in the study area have designated EFH under the PHCRT (NMFS 2004e). Currently, no data are available to determine if hawkfishes of the CHCRT are approaching an over fished situation (NMFS 2004c). Some hawkfishes are occasionally used as food and are valued aquarium fishes (Randall 2001c). These species found are not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Hawkfishes can be found from the tropical western and eastern Atlantic, Indian, and Pacific Oceans (Froese and Pauly 2005).

The longnose hawkfish can be found from the Red Sea in the west to Panama in the east and from southern Japan and Hawaii in the north to New Caledonia in the south (Myers 1999).

Habitat Preference—Cirritids are bottom-dwelling species associated with coral reefs, rocky substrate, or rubble in the surge zone (Randall 2001c). Hawkfishes typically can be found around seaward reefs, lagoons, channels, rocky shorelines, and submarines terraces. Some are found on heads of small branching corals (Randall 2001c; WPRFMC 2001a). Both the egg and larval stages for most hawkfishes are pelagic with the larval stage being prolonged allowing for the potential of wide dispersal (WPRFMC 2001a).

The longnose hawkfish can be found perched on the branches of black corals and gorgonian sea fans of steep outer reef slopes exposed to strong currents (Myers 1999; WPRFMC 2001; Allen et al. 2003). The longnose hawkfish also lays demersal eggs, unlike many other Cirrhitids (Froese and Pauly 2005).

Life History—Spawning occurs throughout the year in tropical waters and only during warmer months in temperate areas. These species usually spawn at dusk or during early nighttime (Myers 1999).

Common Prey Species—Hawkfish feed on small crustaceans (primarily zooplankton and crabs), sea urchins, brittle stars, and fish (Randall 1996; Froese and Pauly 2005).

Chaetodontidae (Butterflyfishes)

Status—Three aquarium species in the family Chaetodontidae are managed in the Hawaiian archipelago as part of the CHCRT by the WPRFMC (2001a) and have EFH designated within the boundaries of the study area (NMFS 2004e). These species include the threadfin butterflyfish (*Chaetodon auriga*), the raccoon butterflyfish (*C. lunula*), and the saddled butterflyfish (*C. ephippium*). In addition, the remaining twenty-one species of butterflyfishes found in the study area have EFH designated under the PHCRT (NMFS 2004e). Four of these species are endemic to Hawaii: bluestripe butterflyfish (*Chaetodon fremblii*), milletseed butterflyfish (*C. miliaris*), multiband butterflyfish (*C. multicinctus*), and Tinker's butterflyfish (*C. tinkeri*) (WPRFMC 2001a). Currently, no data are available to determine if butterflyfishes of the CHCRT are approaching an over fished situation (NMFS 2004c). Although harvested as food-fish, the primary value of the butterflyfish is through the ornamental marine aquarium trade, where they are the third most-frequently exported fish by number and second highest in total value of all families of aquarium fishes in trade (Pyle 2001b). None of the three aquarium species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Chaetodontids can be found in the tropical to temperate waters of the Atlantic, Indian, and Pacific Oceans but are most abundant in the Indo-West Pacific region (Froese and Pauly 2005).

The threadfin butterflyfish can be found from the western Red Sea and off the east coast of Africa to the Hawaiian, Marquesan, and Ducie Islands in the west. This species ranges from southern Japan in the north to Lord Howe and Rapa Islands in the south (Froese and Pauly 2005).

The raccoon butterflyfish can be found in the Indo-Pacific from the east coast of Africa in the west to the Hawaiian, Marquesan, and Ducie Islands in the east. This species ranges from southern Japan south to Lord Howe and Rapa Islands (Froese and Pauly 2005).

The saddled butterflyfish can be found distributed throughout the tropical Indo-Pacific from the Cocos-Keeling Islands in the west to the Hawaiian, Marquesan, and Tuamoto Islands in the east. This species ranges as far north as southern Japan and south to Rowley Shoals and New South Wales, Australia (Froese and Pauly 2005).

Habitat Preference—Butterflyfish are diurnal species that are generally found near coral reefs (Froese and Pauly 2005). Juveniles tend to occupy shallower, more sheltered habitats than adults. Butterflyfish eggs are planktonic (WPRFMC 2001a).

The threadfin butterflyfish can be found in a variety of habitats including mixed sand, rubble, and coral (WPRFMC 2001). This species inhabits tropical waters at depths between 1 and 35 m (Froese and Pauly 2005) and may be found on seaward reefs at depths greater than 30 m (Myers 1999). The threadfin butterflyfish ranges from 30°N to 20°S at depths between 1 and 35 m (Froese and Pauly 2005).

The raccoon butterflyfish inhabits shallow reef flats of lagoons and seaward reefs to depths of over 30 m (Froese and Pauly 2005). This species is common in exposed rocky areas of high vertical relief (Myers 1999). The raccoon butterflyfish can be found in tropical waters from 30°N to 32°S at depths between 0 and 30 m (Froese and Pauly 2005). Juveniles prefer rocks of inner reef flats and tide pools (Froese and Pauly 2005). This is the only nocturnally active butterflyfish, spending its days hovering inactively in aggregations between boulders (Myers 1999).

The saddled butterflyfish inhabits lagoons and seaward reefs to a depth of 30 m and prefers areas of rich coral growth and clear water (Myers 1999). This species can be found in tropical waters from 30°N to 30°S at depths between 0 and 30 m (Froese and Pauly 2005).

Life History—The threadfin butterflyfish may be found singly or in pairs and forms aggregations that roam long distances in search of food (Froese and Pauly 2005). Information is lacking about the spawning and migration of the raccoon and saddled butterflyfishes (Myers 1999; WPRFMC 2001a; Froese and Pauly 2005).

Common Prey Species—The threadfin butterflyfish feeds mainly by tearing pieces from polychaetes, sea anemones, coral polyps, and algae (Froese and Pauly 2005). Adult raccoon butterflyfish feed mainly on nudibranchs, tubeworm tentacles, and other benthic invertebrates but may also feed on algae and coral polyps (Froese and Pauly 2005). The saddled butterflyfish feeds on filamentous algae, small invertebrates, coral polyps, and fish eggs (Froese and Pauly 2005).

Pomacentridae (Damselfishes)

Status—Aquarium species in the family Pomacentridae are managed in the Hawaiian archipelago as part of the CHCRT by the WPRFMC (2001a). Seventeen damselfish species occur in Hawaii, of which six are endemic: Hawaiian sergeant (*Abudefduf abdominalis*), chocolate-dip chromis (*Chromis hanui*), oval chromis (*C. ovalis*), threespot chromis (*C.verater*), Hawaiian dascyllus (*Dascyllus albisella*), and rock damselfish (*Plectoglyphidodon sindonis*) (WPRFMC 2001a). All of these species have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if damselfishes of the CHCRT are approaching an over fished situation (NMFS 2004c). Damselfish's most important commercial use is as aquarium fishes (Allen 2001). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Damselfish can be found in all tropical seas but are most abundant in the Indo-West Pacific region (Froese and Pauly 2005).

Habitat Preference—Damselfish typically occur in shallow water or coral or rock substrata associated with shelter (Froese and Pauly 2005). Damselfish eggs are demersal and laid in nests which are guarded by the male (WPRFMC 2001a). Upon hatching, the larval stage is planktonic (WPRFMC 2001a).

Life History—Spawning for damselfish typically occurs in the morning (Myers 1999) throughout most of the year in tropical waters (Allen 2001). In many species, spawning exhibits lunar periodicity (Myers 1999).

Common Prey Species—Damselfish may be planktivores (e.g., *Chromis* spp.*, Dascyllus* spp.,—zooplankton), omnivores (e.g., *Abudefduf* spp.—benthic algae, small invertebrates, zooplankton), or herbivores (e.g., *Stegastes* spp.*, Plectroglyphidodon* spp.—algal mats), except for blue-eye damselfish (*P. johnstonianus*), which feed on coral polyps (Myers 1999).

Scorpaenidae (Scorpionfishes)

Status—Twenty-five species of the family Scorpaenidae are managed as aquarium taxa in the Hawaiian archipelago as part of the CHCRT by the WPRFMC (2001) and have EFH designated within the boundaries of the study area (NMFS 2004e). Three of these species are endemic: Hawaiian lionfish (*Dendrochirus barberi*), Hawaiian turkeyfish (*Pterois sphex*), and titan scorpionfish (*Scorpaenopsis cacopsis*) (WPRFMC 2001a). Currently, no data are available to determine if scorpionfishes of CHCRT are approaching an over fished situation (NMFS 2004c). Most species in the western central Pacific are small and dangerous to handle and do not form the basis of large fisheries (Poss 1999a). These species are not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Scorpaenids can be found in all tropical and temperate seas (Froese and Pauly 2005).

Habitat Preference—Turkeyfishes and lionfishes may be found swimming well above the bottom; but smaller, more cryptic species of the subfamily Scorpaeninae are typically found on the bottom usually associated with rubble areas in shallow water. Scorpaenids are commonly found in shallow waters but may be found at depths greater than 50 m (WPRFMC 2001a). The eggs are pelagic, and larvae of these species are planktonic (Froese and Pauly 2005).

Life History—Most scorpaenids are ovoviparous, producing between a few hundred and a few thousand eggs; although, some species are viviparous (Poss 1999a).

Common Prey Species—Scorpaenids feed on shrimps, crabs, and other crustaceans (Froese and Pauly 2005).

Sabellidae (Feather-duster Worms)

Status—The family Sabellidae is managed as aquarium taxa in the Hawaiian archipelago as part of the CHCRT by the WPRFMC (2001a) and have EFH designated within the boundaries of the study area (NMFS 2004e). This family has no species found in the study area listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Feather-duster worms are common throughout the world in shallow water (Waikiki Aquarium 1998e).

Habitat Preference—In the western Pacific, feather-duster worms are common on reef flats and in quiet bays and harbors (e.g., Kaneohe Bay, O‘ahu) (Hoover 1998) where they are associated with hard surfaces to which they attach (Waikiki Aquarium 1998e). They are occasionally found in clear water, usually at depths greater than 30 m (WPRFMC 2001a).

Life History—Information is lacking on the life history of feather-duster worms (WPRFMC 2001a).

Common Prey Species—Feather-duster worms feed on plankton and organic detritus (Waikiki Aquarium 1998e).

4.2.5.3 Potentially Harvested Coral Reef Taxa

The Potentially Harvested Coral Reef Taxa (PHCRT) are managed as part of the CRE FMP by the WPRFMC (2001a). Taxa included under PHCRT consist of thousands of coral reef associated species, families, or subfamilies that encompass fish, invertebrate, and sessile benthos MUS (WPRFMC 2001a). These MUS are limited to those families/species known or believed to occur in association with coral reefs during some phase of their life cycle (WPRFMC 2001a). Since little information is available about life histories and habitats of this biota beyond general taxonomic and distributional descriptions, WPRFMC (2001a) has adopted a precautionary approach in designating EFH for PHCRT. EFH for all life stages of PHCRT is designated as the water column and bottom habitat from the shoreline to the outer boundary of the EEZ to a depth of 100 m (WPRFMC 2001a; Figure A-25).

In addition to EFH, the 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 the PHCRT include all hard bottom substrate between 0 and 100 m depth in the study area. Over 47 HAPC have been identified for the MHI and Nihoa of the NWHI chain, of which nine sites occur within the inshore sections of the study area: six on O‘ahu and three on the main island of Hawaii (WPRFMC 2001a; Moncada et al. 2004; Jokiel and Friedlander n.d.; Figure A-18).

A complete list of the PHCRT and habitat requirements of all life stages occurring in the study area can be found in Tables 4-1 and 4-6, respectively. All other CRE MUS that are marine plants, invertebrates, and fish not listed in the CHCRT or as MUS are included in the PHCRT. Descriptions of these taxa will be presented only in the CHCRT section. Descriptions of the individual families, subfamilies, or species comprising the fish, invertebrate, and sessile benthos are described in the following paragraphs.

<u>Fish Management Unit Species</u>

Sphyrnidae (Hammerhead Sharks)

Status—Two species of hammerhead sharks, the scalloped hammerhead (*Sphyrna lewini*) and the smooth hammerhead (*S. zygaena*), are managed in the Hawaiian archipelago as part of the PHCRT by the WPRFMC (2001a). Of the nine different species of hammerheads, only the scalloped hammerhead has been positively recorded from along the tropical coasts of the MHI and NWHI (Randall 1996). The smoothed hammerhead is a significant element in the offshore longline catch (Taylor 1993). Both species have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if these hammerheads of the PHCRT are approaching an over fished situation (NMFS 2004c). Hammerhead sharks are generally caught in low numbers as part of long line fishery (NMFS 2001) and are readily available to inshore artisanal and small commercial fisheries (Compagno 1998). Both hammerhead species are listed on the IUCN Red List of threatened species as near threatened (Kotas 2000; Simpfendorfer 2000b). In addition, both species are afforded protected under the *Shark Finning Prohibition Act* (NMFS 2002b).

Distribution—Hammerheads are wide-ranging, coastal-pelagic, and semi-oceanic sharks that inhabit tropical and warm temperate waters over continental and insular shelves (Compagno 1984, 1998).

Habitat Preference—Hammerhead sharks are found in a wide variety of coral reef habitats (Hennemann 2001). They are very active swimmers occurring in pairs, schools, or solitary, and range from the surface, surf line, and intertidal region down at least 275 m depth (Compagno 1984). Juveniles often occur in schools frequently inhabiting inshore areas such as bays, seagrass beds, and lagoon flats before moving into deeper waters as adults (WPRFMC 2001a).

Adults (e.g., scalloped hammerhead) can be found in shallow inshore areas during mating or birthing events (Compagno 1984).

Life History—Hammerhead sharks (e.g., smooth hammerhead) make long, seasonal, north-south migrations to warmer waters in the winter and cooler waters in the summer (Hennemann 2001). They are viviparous, having a gestation period of about 12 months (WPRFMC 2001a). The scalloped hammerhead produces offspring of 15 to 31 pups per liter and utilizes shallow, turbid coastal waters (e.g., Kaneohe Bay, Waimea Bay, Honolulu Harbor, Pearl Harbor, and Keehi Lagoon on O'ahu and Hilo Bay on Hawaii) as a nursery area (Compagno 1984; Taylor 1993; WPRFMC 2001a). The southern part of Kaneohe Bay is a major breeding and pupping ground for this species (WPRFMC 2001a). The smooth hammerhead has a gestation period of about eight months, with a litter size of 29 to 32 pups (Hennemann 2001).

Common Prey Species—Hammerhead sharks feed on a wide variety of organisms including eels, halfbeaks, lizardfish, jacks, goatfish, damselfish, wrasses, butterflyfish, surgeonfish, blacktip reef sharks, squids, octopuses, mantis shrimp, crabs, and lobsters (Compagno 1984; Taylor 1993; Randall 1996).

Dasyatididae, Myliobatidae, and Mobulidae (Whiptail Stingrays, Eagle Rays, and Manta Rays)

Status—Six species of rays (three stingrays of the genus *Dasyatis*, the spotted eagle ray [*Aetobatis narinari*], manta ray [*Manta birostris*], and the Japanese devil ray [*Mobula japanica*]) occur in the Hawaiian archipelago (Randall 1996), are managed as part of the PHCRT by the WPRFMC (2001a) and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if rays of the PHCRT are approaching an over fished situation (NMFS 2004c). The white-spotted eagle ray and the Japanese devil ray are taken as a by-catch, while the manta ray is neither a fisheries nor a by-catch species (Cavanagh et al. 2003). Eagle rays and devil rays are attractive and desirable as captives in large aquaria and oceanaria (Compagno and Last 1999a, 1999b). Both the spotted eagle ray and the manta ray are listed on the IUCN Red List of threatened species as data deficient (Ishihara 2000; Ishihara et al. 2002), whereas the Japanese devil ray is listed as near threatened (White 2003).

Distribution—Stingrays range throughout the Indo-Pacific region, while the spotted eagle, manta, and devil rays are circumglobal occurring in tropical and subtropical seas and warm temperate and tropical oceans (G. Nelson 1994; Myers 1999; Hennemann 2001).

Habitat Preference—Habitat preferences for most rays include sand and mud bottoms of continental shelves with a few species occurring on coral reefs (Myers 1999). Juveniles inhabit a variety of habitats from shallow clear lagoons to outer reef slopes and nursery areas in seagrass beds, mangroves, and shallow sand flats (WPRFMC 2001a). Adults utilize shallow clear lagoons to outer reef slopes at depths ranging from the shoreline out to a depth of 100 m (Myers 1999) or deeper (e.g., eagle rays: 527 m, sting rays: 480 m) (Compagno and Last 1999a; Last and Compagno 1999).

Life History—Stingrays are viviparous (Last and Compagno 1999), whereas eagle, manta, and devil rays are ovoviviparous (WPRFMC 2001a; White 2003). Stingrays produce a litter with two to six young with a 12-month gestation period (Last and Compagno 1999). The spotted eagle ray produces an average of four pups per liter after a gestation period of about 12 months (Bester n.d.), while both the manta and devil rays may give birth to one pup during a breeding season (White 2003; Passarelli and Piercy n.d.). During the winter, manta rays migrate to warmer areas, deeper waters, or disperse offshore (Passarelli and Piercy n.d.). Some species of eagle rays breed in shallow bays and lagoons (Compagno and Last 1999a).

Common Prey Species—Stingrays feed on sand-dwelling and reef-dwelling invertebrates and fish, whereas the spotted eagle ray feed mainly on hard-shelled mollusks and crustaceans and the manta and devil rays consume zooplankton and small fishes (Randall 1996; Hennemann 2001; WPRFMC 2001a).

Serranidae (Groupers)

Status—Three species of groupers occur in the Hawaiian archipelago (Randall 1996). The endemic Hawaiian grouper (*Epinephelus quernus*), which is native to the Hawaiian Islands and Johnston Atoll, is managed as part of BMUS by the WPRFMC (1998). The other native giant grouper (*E. lanceolatus*) and introduced peacock grouper (*Cephalopholis argus*) are managed as part of the PHCRT by the WPRFMC (2001a) and have EFH designated within the boundaries of the study area (NMFS 2004e). Currently, no data are available to determine if the giant and peacock groupers of the PHCRT are approaching an over fished situation (NMFS 2004c). Groupers are most highly prized food fishes and are actively caught by commercial and sport fishermen (Heemstra and Randall 1999). Two of the groupers are listed on the IUCN Red List of threatened species: Hawaiian grouper as near threatened (Cornish 2004) and the giant grouper as vulnerable (Sadovy 1996)

Distribution—Groupers have a worldwide distribution occurring in tropical and semitropical seas of the Indo-Pacific region (G. Nelson 1994; Debelius 2002). Their wide geographic distribution is thought to be due to the relatively long pelagic phase as larvae (Allen et al. 2003).

Habitat Preference—Serranids inhabit a wide variety of habitats (Myers 1999). Larvae tend to be more abundant over the continental shelf than oceanic waters, avoiding surface waters during the day, are evenly distributed vertically in the surface water column at night, and may be influenced by oceanic currents (Leis et al. 1987; Rivera et al. 2004). Juveniles are found in shallow-water reef areas (seagrass beds and tide pools) and estuarine habitats (WPRFMC 2001a). Adults utilize shallow coastal coral reef areas to deep slope rocky habitats from the shoreline to a depth of at least 400 m (Heemstra and Randall 1993). The Hawaiian grouper is found at depths of 20 to 380 m on rocky bottom substrate (WPRFMC 1999), the giant grouper is a solitary inhabitant of lagoon and seaward reefs at depths of a few to at least 50 m, and the introduced peacock grouper occurs in areas of rich coral growth in clear water lagoons and seaward reefs at depths ranging from 1 to 40 m (Myers 1999). Regardless of size, groupers are typically ambush predators, hiding in crevices and among coral and rocks (WPRFMC 2001a).

Life History—Spawning in groupers is typically seasonal (e.g., Hawaiian Grouper: January through June, peaking in April and again in June) (Cornish 2004) and synchronized by lunar phase (Grimes 1987) with some species of groupers migrating several kilometers to spawn (Heemstra and Randall 1993). Groupers tend to spawn in predictable, dense aggregations (some species spawn in pairs) with individual males spawning multiple times during the breeding season (Myers 1999; Rivera et al. 2004). Most species of groupers are solitary fishes with a limited home range (Heemstra and Randall 1993).

Common Prey Species—Groupers prey upon brachyuran crabs, fishes, shrimps, galatheid crabs, octopus, stomatopods, fishes, and ophiuroids (Heemstra and Randall 1993; Randall 1996).

Lethrinidae (Emperor Fishes)

Status—Emperor fishes occur in the Hawaiian archipelago and are managed as part of the PHCRT by the WPRFMC (2001a). The only Hawaiian representative is the bigeye emperor (*Monotaxis grandoculis*) (Randall 1996) which has EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Emperors are commonly taken by bottom handline fishing and are of moderate to significant importance in commercial, recreational, and artisanal fisheries throughout the tropical Pacific (WPRFMC 1996). Currently, no data are available to determine if the bigeye emperor of the PHCRT is approaching an over fished situation (NMFS 2004c). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Emperor fishes are widely distributed over the Indo-Pacific in tropical and subtropical waters with a few species ranging into warm-temperate waters (Debelius 2002).

Habitat Preference—Little is known about the biology of the emperor fish (WPRFMC 2001a). Emperors are known to occur in the deeper waters of coral reefs and adjacent sandy coastal areas from 0 to 350 m (WPRFMC 2001a). Some lethrinid species are found inhabiting coastal waters, including coral and rocky reefs, sand flats, seagrass beds, and mangrove swamps (Debelius 2002). Most species occur either singly or in schools and feed primarily at night on or near reefs (Myers 1999). The bigeye emperor is relatively common over sandy patches and channels of both lagoon and seaward reefs from depths of one to at least 100 m (Myers 1999; Debelius 2001).

Life History—Spawning behavior of lethrinid species is poorly documented (WPRFMC 1998). Based on available data, spawning occurs throughout the year and is preceded by localized migrations during crepuscular periods (Carpenter 2001). Peak spawning events occur on or near the new moon. Spawning occurs near the surface as well as near the bottom of reef slopes (WPRFMC 2001a).

Common Prey Species—The bigeye emperor feeds mainly on hermit crabs, sea and heart urchins, and mollusks (Randall 1996).

Chlopsidae, Congridae, and Ophichthidae (False Moray Eels, Conger Eels, Garden Eels, and Snake Eels)

Status—Twenty-two species of eels occur in the Hawaiian archipelago (Randall 1996), are managed as part of the PHCRT by the WPRFMC (2001a), and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if eels of the PHCRT are approaching an over fished situation (NMFS 2004c). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Eels are distributed worldwide in tropical and temperate seas (Allen and Steene 1987).

Habitat Preference—Both juvenile and adult eels inhabit cryptic locations in the framework of coral reefs (e.g., false moray) or soft bottom habitats (e.g., snake and conger/garden eels) (Myers 1999). Habitats vary between the different families. False moray eels are secretive indwellers of coral heads, seaward reefs, and seagrass beds at depths of 0 to 56 m. Conger and garden eels tend to be solitary or exist in large colonies on sand patches/flats or slopes away from reefs at depths of 7 to 53 m with strong currents. Snake eels are indwellers that stay buried in the sand or mud with a few occasionally emerging to traverse sand, rubble, or seagrass habitats at depths of 16 to 68 m (Myers 1999; Smith 1999; Debelius 2002; Allen et al. 2003).

Life History—Most eel species are known to migrate to spawn (WPRFMC 2001a). Individual spawning characteristics vary among the different families. False moray eels are known to migrate off the reef to spawn (Myers 1999). Snake eels appear to be nocturnal with some species also coming to the surface to spawn (Myers 1999). Group spawning of eels has also been documented with large numbers of adults congregating at the water surface at night (WPRFMC 2001a).

Common Prey Species—False moray eels feed on crustaceans, whereas conger and garden eels are planktivores, and snake eels feed on small fish and crustaceans (Allen and Steene 1987; WPRFMC 2001a; Debelius 2002).

Apogonidae (Cardinalfishes)

Status—Ten cardinalfish species occur in the Hawaiian archipelago (Randall 1996), are managed as PHCRT by the WPRFMC (2001a), and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if cardinalfish of the PHCRT are approaching an over fished situation (NMFS 2004c). Generally, not important economically, a few species are seen in the aquarium trade or as tuna bait (Allen 1999). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Apogonids are a very large family of small reef fishes that are distributed in shallow coastal waters of the Atlantic, Pacific, and Indian Oceans (Debelius 2002).

Habitat Preference—Cardinalfish are found in water depths ranging from 1 to 80 m and are typically nocturnal, remaining hidden under coral reef ledges, holes, flats, and rubble even among the spines of sea urchins (*Diadema* spp.) or crown-of-thorns starfish (*Acanthaster* spp.) during the day, then emerging at night to feed on the reef (Allen 1999; Debelius 2002). Although typically solitary, in pairs, or loose clusters, a few species form dense aggregations immediately above mounds of branching corals (Allen et al. 2003). Members of the genera

Apogonichthys spp. and *Foa* spp. are typically secretive, cryptic inhabitants of seagrasses, algal beds, or rubble of sheltered reefs and reef flats (WPRFMC 2001a).

Life History—Apogonid species display a variety of different spawning patterns including year-round, spring and fall peaks, and in conjunction with phases of the moon (WPRFMC 2001a). Courtship and spawning in cardinalfishes are always paired rather than group activities (Debelius 2002). Cardinalfish are also among the few marine fishes with oral brooding, with the male carrying the eggs in his mouth until they hatch (Allen et al. 2003).

Common Prey Species—Cardinalfish prey mainly on large zooplankton with some species eating primarily small benthic crustaceans (Randall 1996; WPRFMC 2001a).

Blenniidae (Blennies)

Status—Fourteen species of blennies occur in the Hawaiian archipelago (Randall 1996), are managed as part of the PHCRT by the WPRFMC (2001a), and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if blennies of the PHCRT are approaching an over fished situation (NMFS 2004c). Blennies have very little commercial importance due to their small size (Springer 2001). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Blennies have a worldwide distribution occurring in tropical and temperate seas. The Indo-Pacific population consists of two subfamilies: sabretooth (Salariinae) and combtooth (Blenniinae) blennies based on dentition and diet (Myers 1999).

Habitat Preference—Blennies are bottom-dwelling fishes that tend to shelter in small holes in the rocky, oyster, or coral reefs or sand substrate in tidepools (Springer 2001; Debelius 2002). This group exhibits complex color patterns that enable them to be well camouflaged to the surrounding habitat (WPRFMC 2001a). Most of the combtooth blennies are sedentary inhabitants of rocky shorelines, reef flats, or shallow seaward reefs from one to 30 m depths (Myers 1999). Some combtooth blennies (e.g., *Istiblennius* spp. and *Entomacrodus* spp.), called rockskippers, inhabit tidal zones where they are able to leap between tide pools. Others in the genus *Escenius* spp. generally occupy coral-rich areas (Allen et al. 2003). Sabretooth blennies (e.g., *Plagiotremus* spp. and *Omobranchus* spp.) utilize empty worm tubes or shells when they are not actively swimming above the seafloor, mimicking (e.g., bluestreak cleaner wrasse, *Labroides dimidiatus*), or pursuing other fishes (Allen et al. 2003).

Life History—The reproductive biology of blennies has been studied extensively. Although there are many variations, most are demersal territorial fishes that deposit adhesive eggs in or near a shelter hole that are guarded by the male (Randall 1996). Spawning occurs throughout the year with a peak from January to April (WPRFMC 2001a).

Common Prey Species—Sabretooth blennies feed on scales, skin, or mucus of larger fish; and combtooth blennies feed primarily on benthic algae, although a few also feed on coral polyps (e.g., leopard blenny, *Exalias brevis*) (Randall 1996; WPRFMC 2001a).

Pinguipedidae (Sandperches)

Status—Two sandperch species occur in the Hawaiian archipelago (Randall 1996), are managed as part of the PHCRT by the WPRFMC (2001a), and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if sandperch of the PHCRT are approaching an over fished situation (NMFS 2004c). A few species of sandperch are large enough to be of commercial importance as food, but only of limited value (Randall 2001d). Neither of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Only species of the genus, *Parapercis,* occur in the Indo-Pacific region (Myers 1999).

Habitat Preference—Species of the genus, *Parapercis*, typically occur on sandy bottoms near rubble, rock, or coral reefs where they can be found resting using well-separated pectoral fins (WPRFMC 2001a). Adults are found at depths ranging from 10 to 50 m (e.g., redspotted sandperch, *P. schauinslandii*) (Randall 1996) with some species occurring in deeper waters (100 to 300 m) (Myers 1999).

Life History—Sandperch live in small harems with a single dominant, territorial male (Allen et al. 2003). Some sandperch are unisexual (Randall 2001d). Courtship and spawning occur just before sunset year round (Myers 1999). There is no evidence of spawning migrations (WPRFMC 2001a).

Common Prey Species—Sandperch feed on benthic crustaceans and small fishes (Randall 1996).

Bothidae, Pleuronectidae, and Soleidae (Flounders and Soles)

Status—Seventeen flatfish species occur in the Hawaiian archipelago and are managed as part of the PHCRT by the WPRFMC (2001a). Thirteen left-eyed flounders including two common shallow-water species, two tropical right-eyed flounders of the subfamily Samaridae, and two soles of the native genus *Aseraggodes* spp. (Randall 1996) have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Although flatfish are among the world's important food fishes, there are currently no data available to determine if flatfish of the PHCRT are approaching an over fished situation (NMFS 2004c). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Flatfish are distributed on tropical and temperate continental shelves worldwide. Some species are associated with coral reefs in the Indo-Pacific (Myers 1999).

Habitat Preference—Habitats for most flatfish consist of soft bottoms such as sand, mud, silt, or gravel that are often associated with coral reefs (Myers 1999). Some species occur directly on the reef or within the reef framework (WPRFMC 2001a). Juveniles and adults are often found in lagoons, caves, flats, and reefs (WPRFMC 2001a). Flatfishes exhibit adaptive camouflage to closely match the surrounding bottom habitat (Allen et al. 2003). Some flatfishes are found in water deeper than 100 m (e.g., panther flounder, [*Bothus pantheinus*]), with some species being common in shallower habitats (flowery flounder, [*B. mancus*]: 1 to 73 m) (Myers

1999). Eggs of the flounder and sole are pelagic. As larvae metamorphose into juveniles and adults, they become demersal (WPRFMC 2001a).

Life History—Information on the reproductive process and the extent of spawning aggregations are lacking on these Indo-Pacific species (WPRFMC 2001a).

Common Prey Species—Flatfish prey upon small fishes and crustaceans (Randall 1996; WPRFMC 2001a).

Ostraciidae (Trunkfishes)

Status—Six trunkfish species occur in the Hawaiian archipelago (Randall 1996), are managed as part of the PHCRT by the WPRFMC (2001a), and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if trunkfish of the PHCRT are approaching an over fished situation (NMFS 2004c). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Trunkfish, also known as boxfish, are distributed in marine and tropical waters in the Pacific, Indian, and Atlantic Oceans (G. Nelson 1994; Randall 1996; Myers 1999).

Habitat Preference—Ostraciids are solitary, slow-swimming, diurnal predators that inhabit a variety of sand and rubble bottom areas (e.g., subtidal reef flats, lagoons, bays, channels, seaward reefs) covered with moderate to heavy algae or coral growth (Myers 1999; Matsuura 2001a). These fish have been reported at depths from one to 100 m (Matsuura 2001a). Postlarvae and juveniles are commonly collected in grass beds and other shallow areas (WPRFMC 2001a).

Life History—Trunkfish are sexually dimorphic. The species of trunkfish studied to date are haremic with males defending a large territory with non-territorial females and subordinate males. Trunkfish spawning occurs in pairs at dusk, usually above a structure (WPRFMC 2001a).

Common Prey Species—Trunkfish feed on a wide variety of small sessile invertebrates, especially didemnid tunicates and sponges, but also polychaetes, algae, mollusks, and copepods (Randall 1996; WPRFMC 2001a).

Tetradontidae and Diodontidae (Pufferfishes and Porcupinefishes)

Status—Fourteen pufferfish and three porcupinefish species are managed in the Hawaiian archipelago as part of the PHCRT by the WPRFMC (2001a). Nine of the pufferfish and all three porcupinefish have been reported from the Hawaiian Island's inshore waters (Randall 1996) and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if pufferfish or porcupinefish of the PHCRT are approaching an over fished situation (NMFS 2004c). Some porcupinefish are inflated, dried, and sold as curios (Leis 2001). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Pufferfish and porcupinefish are distributed worldwide throughout tropical and temperate waters including brackish and some freshwater habitats (Waikiki Aquarium 1999c; Matsuura 2001b).

Habitat Preference—Both families have reef-associated and pelagic species utilizing bottom types of sand, rubble, silt, coral, or rock in estuarine, mangrove, lagoon, and coral reef (e.g., reef flats, seaward reefs, and patch reefs) habitats from the shoreline to 100 m (Myers 1999; WPRFMC 2001a). Pufferfish feed in the quiet shallow waters of the reef during the day and rest in caves or crevices at night. Porcupinefish also occur close to the reef in quiet waters during the day, often in caves or under ledges, but emerge at night to feed (Waikiki Aquarium 1999c). Most puffers are solitary but a few form small aggregations (WPRFMC 2001a). Larval forms are pelagic, occurring from 0 to 100 m (WPRFMC 2001a).

Life History—Most information on pufferfish reproduction has been collected in temperate locations; however, some assumptions can be made about tropical species (WPRFMC 2001a). All species lay demersal adhesive eggs, although the courtship often occurs near the surface (Myers 1999). At least one genus (*Canthigaster* spp.), is haremic with males spawning at mid-morning with a different female each day. Females then deposit the eggs in tufts of algae (Myers 1999). Porcupinefish may spawn pelagic or demersal eggs depending on species. As observed in one species, the spiny balloonfish (*Diodon holcanthus*), spawning takes place at the surface near dawn or dusk as pairs or groups of males with a single female. In Hawaii, porcupinefish have a peak spawning in late spring with some spawning also occurring from January to September (WPRFMC 2001a).

Common Prey Species—Puffers feed on a wide variety of algae and benthic invertebrates including fleshy, calcareous, or coralline algae and detritus, sponges, mollusks, tunicates, corals, zoanthid anemones, crabs, hermit crabs, tube worms, sea urchins, brittle stars, starfishes, hydroids, bryozoans, and foraminifera (WPRFMC 2001a). Porcupinefish consume hard tests of sea urchins, shells of mollusks and hermit crabs, and exoskeletons of crabs (Randall 1996).

Echineididae (Remoras)

Status—Three remora species (sharpsucker {*Echeneis naucrates*], common remora [*Remora remora*], and white suckerfish [*Remorina albescens*]) occur in the Hawaiian archipelago (Randall 1996), are managed as part of the PHCRT by the WPRFMC (2001a), and have EFH designated within the boundaries of the study area (NMFS 2004e). Currently, no data are available to determine if remoras of the PHCRT are approaching an over fished situation (NMFS 2004c). Remoras are not considered to be of any commercial importance (Collette 1999). None of these three species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Remoras are circumglobal in their distribution and are found throughout the Pacific, Indian, and Atlantic Oceans (G. Nelson 1994).

Habitat Preference—Remoras occur in coastal and pelagic waters either as free swimming species, host specific species (large reef-associated inhabitants: sharks, rays, large bony fishes, sea turtles, or marine mammals), or utilize a variety of hosts (e.g., ships, drivers, etc.) (Myers 1999; Debelius 2001). Species associated with coral reef dwellers are found near reefs down to

50 m (Allen et al. 2003). Eggs of the sharpsucker and common remora are pelagic (Leis and Trnski 1989).

Life History—Information is lacking on the spawning techniques and/or locations of remoras (WPRFMC 2001a).

Common Prey Species—Remoras pick parasites and diseased tissues from their hosts and make short forays from their capture host to feed on zooplankton (copepods and isopods) or zoobenthos such as small crustaceans, detritus, and small fish (Moyle and Cech 2000; WPRFMC 2001).

Malacanthidae (Tilefishes)

Status—One tilefish species is managed in Hawaiian archipelago as part of the PHCRT by the WPRFMC (2001a). The flagtail tilefish (*Malacanthus brevirostris*) has been reported as occurring in Hawaii (Randall 1996) and has EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if the flagtail tilefish of the PHCRT is approaching an over fished situation (NMFS 2004c). Tilefishes are very high-quality food fishes with several species being commercially important (Dooley 1999). The flagtail tilefish is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Tilefishes are distributed worldwide in tropical and temperate seas (WPRFMC 2001a). The flagtail tilefish ranges from the Red Sea to Panama, north to south Japan and Hawaiian Islands, south to north New Zealand and Lord Howe and Austral Islands, and throughout Micronesia (Myers 1999).

Habitat Preference—Tilefish usually occur singly or in pairs on outer slope reefs (Myers 1999). They can be found in depths ranging from 6 to 115 m in mud, sand, rubble or talus areas of barren seaward slopes (WPRFMC 2001a). Tilefish frequently build mounds under rocks in the sand or excavate burrows when facing a potential threat (Debelius 2002). The flagtail tilefish is an uncommon inhabitant of barren, open areas of sand and rubble on outer reef slopes at depths of 14 to 45 m (Myers 1999; Allen et al. 2003).

Life History—Few accounts of spawning are known, but it appears that adult pairs of tilefish make a short spawning ascent, releasing gametes into the water column (Leis and Trnski 1989).

Common Prey Species—Tilefish feed on benthic invertebrates and plankton (WPRFMC 2001a).

Caracanthidae (Coral Crouchers)

Status—One coral croucher or orbicular velvetfish species is managed in the Hawaiian archipelago as part of the PHCRT by the WPRFMC (2001a). The Hawaiian orbicular velvetfish (*Caracanthus typicus*) has been reported as occurring in Hawaii (Randall 1996) and has EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if the Hawaiian orbicular velvetfish of the PHCRT is approaching an over fished situation (NMFS 2004c). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Coral crouchers are distributed in the Pacific and Indian Oceans and are represented by a single species, the Hawaiian orbicular velvetfish, in the Hawaiian Islands (G. Nelson 1994; Froese and Pauly 2005).

Habitat Preference—Coral crouchers inhabit branches of certain *Stylophora* spp., *Pocillopora* spp., and *Acropora* spp. corals at depths from 3 to 15 m where they tightly wedge themselves into the coral branched when disturbed (Myers 1999). Other than their close association with corals, little is known of their biology (Poss 1999b).

Life History—Information is lacking on the life history of the coral croucher (WPRFMC 2001a).

Common Prey Species—Coral crouchers feed on alpheid shrimps and other small crustaceans (WPRFMC 2001a).

Grammistidae (Soapfishes)

Status—Five species of soapfish occur in the Hawaiian archipelago (Randall 1996), are managed as part of the PHCRT by the WPRFMC (2001a), and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if soapfish of the PHCRT are approaching an over fished situation (NMFS 2004c). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Soapfishes are distributed in the Atlantic, Pacific, and Indian Oceans and are represented by two genera (*Liopropoma* spp. and *Pseudogramma* spp.) in Hawaii within the Indo-Pacific region (WPRFMC 2001a).

Habitat Preference—Soapfishes are small, grouper-like, secretive fishes that occur on reef flats, shallow lagoons, outer reef slopes, and wave-washed seaward reefs (WPRFMC 2001a). They often hide in small caves, under ledges, or in holes at depths up to 150 m (Myers 1999). *Liopropoma* spp. has pelagic eggs, whereas *Pseudogramma* spp. has large demersal eggs (WPRFMC 2001a).

Life History—The soapfish, like the grouper, are generally unisex. All species are solitary and territorial. *Liopropoma* has pelagic eggs, whereas *Pseudogramma* has large demersal eggs (WPRFMC 2001a).

Common Prey Species—Soapfishes prey upon fishes, crustaceans, and a variety of invertebrates (WPRFMC 2001a).

Aulostomidae (Trumpetfishes)

Status—A single trumpetfish species, the Chinese trumpetfish (*Aulostomus chinensis*), is managed in the Hawaiian archipelago as part of the PHCRT by the WPRFMC (2001a). This species has been reported as occurring in Hawaii (Randall 1996) and has EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if the trumpetfish of the PHCRT is approaching an over fished situation (NMFS 2004c). Trumpetfish have no commercial importance, but are occasionally taken as by-catch in artisanal fisheries (Fritzsche and Thiesfeld 1999a). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Trumpetfishes are distributed in the tropical Atlantic and Indo-Pacific regions occurring in Hawaii, Micronesia, and American Soma (G. Nelson 1994; WPRFMC 2001a).

Habitat Preference—Trumpetfishes occur in virtually all reef habitats except areas of heavy surge to a depth of 122 m (Myers 1999). These fishes are solitary ambush predators which hover vertically among branches of corals and seagrasses, hide within schools of surgeonfishes, or use the body of a large parrotfish as cover to approach unsuspecting prey (Waikiki Aquarium 1999c).

Life History—Spawning of trumpetfishes has been reported to occur at dusk when individual males and females ascend to a depth of 5 to 8 m to release gametes before returning to the bottom (WPRFMC 2001a).

Common Prey Species—Trumpetfishes feed mainly on small fishes and shrimps (Randall 1996; Myers 1999; WPRFMC 2001a).

Fistularidae (Cornetfishes)

Status—A single cornetfish species, the reef cornetfish (*Fistularia commersonnii*), is managed in the Hawaiian archipelago as part of the PHCRT by the WPRFMC (2001a). This species has been reported as occurring in Hawaii (Randall 1996) and has EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if the cornetfish of the PHCRT is approaching an over fished situation (NMFS 2004c). Although not important in commercial fisheries, cornetfish are frequently taken in trawls and by various types of artisanal gear and may appear in local food markets (Fritzsche and Thiesfeld 1999b). This species is not listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—The cornetfishes are distributed in the tropical Atlantic, Pacific, and Indian Oceans and is represented by a shallow-water and deepwater species in the Indo-Pacific region (G. Nelson 1994; WPRFMC 2001a).

Habitat Preference—The shallow-water cornetfish species occur in virtually all reef habitats except in areas of heavy surge to a depth of 122 m (Myers 1999; Allen et al. 2003). It is usually seen in relatively open sandy areas within schools of similarly sized individuals (WPRFMC 2001a) and occasionally occurs in mid-water, above steep drop offs (Myers 1999).

Life History—Cornetfish eggs are large, pelagic, and subject to advection by ocean currents (WPRFMC 2001a).

Life History—Information is lacking on the life history of cornetfishes (WPRFMC 2001a).

Common Prey Species—Cornetfishes feed on small fishes, including the lionfish (*Pterois miles*), crustaceans, and squids (Randall 1996; Myers 1999; WPRFMC 2001a).

Clupeidae (Herrings and Sardines)

Status—Four clupeid species are managed in the Hawaiian archipelago as part of the PHCRT by the WPRFMC (2001). Two species of introduced sardines (Marquesan [*Sardinella marquesensis*] and goldspot [*Herkotsichthys quadrimaculatus*]) and two species of round herrings (redeye [*Etrumeus teres*] and delicate [*Spratelloides delicatulus*]) have been reported as occurring in Hawaii (Randall 1996) and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if sardines and round herrings of the PHCRT are approaching an over fished situation (NMFS 2004c). In Hawaii, the goldspot sardine is an important food and baitfish in many areas (Myers 1999). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Clupeids are distributed worldwide in freshwater and marine systems and are represented by four genera in Hawaii and the Indo-Pacific region (J. Nelson 1994; Myers 1999).

Habitat Preference—Both the sardine and round herring species occur in coastal water habitats over sand, mud, rock, and coral reefs from the surface down to 20 m (WPRFMC 2001a). Round herrings occur in large schools near the surface in relatively clear coastal waters, lagoons, and along reef margins during feeding. Sardines school near mangroves and above sandy shallows of coastal bays and lagoons during the day moving into deeper water at night to feed (Myers 1999).

Life History—Tropical round herrings and sardines spawn throughout the year (Myers 1999). The goldspot sardine is known to migrate to tidal creeks to spawn from November to April (WPRFMC 2001a).

Common Prey Species—Sardines and round herrings feed on plankton, mainly crustaceans and their larvae (G. Nelson 1994; Randall 1996; Myers 1999).

Engraulidae (Anchovies)

Status—Two anchovy species are managed in the Hawaiian archipelago as part of the PHCRT by the WPRFMC (2001a). Both species (endemic Hawaiian anchovy [*Encrasicholina purpurea*] and oceanic or buccaneer anchovy [*E. punctifer*]) have been reported as occurring in Hawaii (Randall 1996) and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if anchovies of the PHCRT are approaching an over fished situation (NMFS 2004c). Anchovies are commercially important being utilized as live bait for pole and line tuna fisheries (Myers 1999; Wongratana et al. 1999). Neither of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Anchovies are distributed in the Atlantic, Indian, and Pacific Oceans and represented by one genus (*Enchasicholina* spp.) in Hawaii and the Indo-Pacific region (J. Nelson 1994; Myers 1999).

Habitat Preference—Anchovies typically inhabit estuaries and turbid coastal waters, but some occur over inner protected reefs, and at least one species, the oceanic or buccaneer anchovy, is found in large atoll lagoons or deep, clear bays (WPRFMC 2001a). Juvenile and adult anchovies are planktivores, utilizing the surface waters over sand, mud, rock, or coral reef habitats (Myers 1999).

Life History—Anchovies are serial spawners that produce and disperse large quantities of eggs. While most anchovy species inhabit and spawn in coastal waters, some enter brackish water or freshwater to feed or spawn (Munroe 2002).

Common Prey Species—Anchovies feed on planktonic organisms (Randall 1996; Myers 1999).

Gobiidae (Gobies)

Status—Thirty-one species of gobies occur in the Hawaiian archipelago (Randall 1996), are managed as part of the PHCRT by the WPRFMC (2001a), and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Five species of gobies are endemic in Hawaiian waters (WPRFMC 2001a). Currently, no data are available to determine if gobies of the PHCRT are approaching an over fished situation (NMFS 2004c). Most gobies have no commercial or recreational importance other than food for larger fishes (Larson and Murdy 2001). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Gobies are distributed worldwide in temperate and tropical seas represented by 212 genera and 1,000 species in the Indo-Pacific region (WPRFMC 2001a; Allen et al. 2003).

Habitat Preference—Gobies occur in a variety of habitats such as rocky shorelines, coral reefs, reef flats, shallow seaward reefs, sand flats, and seagrass beds (Myers 1999). The majority of gobies utilize the coral reef habitat where they exhibit high diversity and abundance, but may occur in adjacent coastal and estuarine waters (Larson and Murdy 2001). Many gobies also occupy a wide variety of substrata ranging from mud, rock, or coral at depths from one to 48 m (Debelius 2002). Certain species live in close association with other marine organisms such as sponges, gorgonians, or snapping shrimps. Different genera of gobies (e.g., *Bryaninops* spp., *Pleurosicya* spp.) live within or occur in groups hovering above the branches of various coral species (*Porites cylindrica, P. lutea, Acropora* spp., and *Cirrhipathes anguina*) (WPRFMC 2001a). Some species (e.g., Hawaiian shrimp goby, *Psilogobius mainlandi*) have a symbiotic relationship with alpheid prawns in which the gobies occupy and/or share a burrow (Randall 1996; WPRFMC 2001a). The gobies, either singly or in pairs, act as sentinels for the snapping shrimp (*Alpheus* spp.) who maintains the burrow (WPRFMC 2001a).

Life History—Gobies appear to spawn promiscuously with many individuals loosely organized into a social hierarchy or with individuals maintaining small contiguous territories (WPRFMC

2001a). Pairing and apparent monogamy have also been documented for a number of gobies (Debelius 2002). Female gobies lay in a small mass of eggs in burrows, on the underside of rocks or shells, or in cavities within the body of sponges (Larson and Murdy 2001a). Males guard the nesting site and eggs, which are attached to the substrate at one end by a tuft of adhesive filaments (WPRFMC 2001a).

Common Prey Species—Gobies feed on tiny crustaceans including shrimps and copepods as well as worms, sponges, and mollusks (Allen et al. 2003).

Lutjanidae (Snappers)

Status—Eleven snapper species occur in the Hawaiian archipelago (Randall 1996) and are managed as part of the BMUS and the PHCRT by the WPRFMC (1998, 2001a). Nine of these species have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if snappers of the PHCRT are approaching an over fished situation (NMFS 2004c). Snappers are important to tropical and subtropical commercial artisanal fisheries where they are caught with hand lines, traps, a variety of nets, and trawls (Anderson and Allen 2001). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Snappers occur in the subtropical and tropical waters of the Atlantic, Indian, and Pacific Oceans and are represented by five genera in Hawaii and the Indo-Pacific region (J. Nelson 1994; Randall 1996; Myers 1999).

Habitat Preference—Snappers are slow growing, long-lived fish that inhabit shallow coastal coral reef areas to deep (0 to 400 m) slope rocky habitats (Allen et al. 2003). Snapper larvae tend to be more abundant over the continental shelf than in oceanic waters, are absent from surface waters during the day, and undergo nighttime vertical migrations (Leis 1987). Juveniles utilize a wide variety of shallow-water reef and estuarine habitats, whereas adults primarily utilize shallow to deep reef and rocky substrate (WPRFMC 2001a). Some snapper species exhibit higher densities on the upcurrent side versus the downcurrent side of islands, banks, and atolls probably due to the increased availability of allochthonous planktonic prey (Moffitt 1993).

Life History—Snappers may be batch or serial spawners, spawning multiple times over the course of the spawning season (spring and summer with peak activity occurring in November and December). Certain snappers may also 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). They form large aggregations near areas of prominent relief for spawning with lunar periodicity coinciding with new/full moon events (Grimes 1987).

Common Prey Species—Most species of snappers feed heavily on crustaceans (crabs), with some eating primarily small fishes, cephalopods, and gastropods while others are zooplanktivorous (Parrish 1987; Randall 1996; Allen et al. 2003).

Monacanthidae (Filefishes)

Status—Eight filefish species occur in the Hawaiian archipelago (Randall 1996), are managed as part of the PHCRT by the WPRFMC (2001a), and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if filefishes of the PHCRT are approaching an over fished situation (NMFS 2004c). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Filefishes occur in tropical and temperate waters of the Atlantic, Indian, and Pacific Oceans (J. Nelson 1994). Three filefish species are endemic to Hawaii (WPRFMC 2001a).

Habitat Preference—Filefishes are found in lagoons, shallow coral and rocky reefs, seaward reefs with steeply sloping areas, and seagrass beds in depths ranging from 10 m to over 220 m (Myers 1999; Hutchins 2001). Adults are solitary or occur in pairs, while some juvenile species forming schools (Debelius 2001).

Life History—Information is lacking on the reproduction of most filefish species (Debelius 2002). Some species are sexually dimorphic (WPRFMC 2001a) and lay demersal eggs in nests near the base of dead corals that may be guarded by at least one of the parents (Myers 1999).

Common Prey Species—Filefishes feed on a wide variety of sessile marine organisms including algae, seagrasses, hydrozoans, branching gorgonians, colonial anemones, tunicates, sea urchins, sponges, mollusks, and bryozoans as well as ingesting detritus (Randall 1996; Myers 1999).

Antennariidae (Frogfishes)

Status—Six frogfish species occur in the Hawaiian archipelago (Randall 1996), are managed as part of the PHCRT by the WPRFMC (2001a), and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if frogfishes of the PHCRT are approaching an over fished situation (NMFS 2004c). Besides their value in the aquarium trade, frogfishes have no significant economic interest in the Pacific (Pietsch 1998). None of these species found are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Frogfishes occur in all subtropical and tropical waters of the Indo-Pacific region and occasionally in temperate waters (J. Nelson 1994). The Hawaiian freckled frogfish (*Antennarius drombus*) is endemic in Hawaiian waters (Randall 1996; WPRFMC 2001a).

Habitat Preference—Frogfishes are found in estuaries and turbid coastal waters, but are rare on most coral reefs, occurring in low numbers (WPRFMC 2001a). Habitats include the bottoms of seagrass beds, algae, sponges, rocks or corals, from tide pools to lagoons and seaward reefs (Waikiki Aquarium 1999d).

Life History—Frogfish spawn in pairs following a quick rush to the surface. Female frogfishes lay thousands of tiny eggs within large, raft-shaped gelatinous masses at three to four day intervals (Myers 1999).

Common Prey Species—Frogfishes prey upon fishes or crustaceans (Randall 1996).

Syngnathidae (Pipefishes and Seahorses)

Status—Eight pipefish and seahorse species occur in the Hawaiian archipelago (Randall 1996), are managed as part of the PHCRT by the WPRFMC (2001a), and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). The redstripe pipefish (*Dunckerocampus baldwini*) is endemic in Hawaii (Randall 1996; WPRFMC 2001a). Currently, no data are available to determine if pipefishes or seahorses of the PHCRT are approaching an over fished situation (NMFS 2004c). Some species regularly appear in the trade for traditional medicine, curios, and aquaria (Paulus 1999). The spiny seahorse (*Hippocampus histrix*) and Fisher's seahorse (*H. fisheri*) have been listed as data deficient and the common seahorse (*H. kuda*) as vulnerable on the IUCN Red List of threatened species (Project Seahorse 2002a, 2002b, 2003; Lourie et al. 2004).

Distribution—Pipefish and seahorses are circumtropical and temperate in their distribution occurring in the Atlantic, Indian, and Pacific Oceans in marine, brackish, and freshwaters (J. Nelson 1994).

Habitat Preference—Syngnathids are small, inconspicuous bottom dwellers that occur in a wide variety of shallow habitats from estuaries and shallow sheltered reefs to seaward reef slopes (WPRFMC 2001a). Habitats include seagrasses, floating weeds, algae, corals, mud bottoms, sand, rubble, or mixed reef substrate from tide pools to lagoons and seaward reefs (Myers 1999). Demersal syngnathid populations occur in pairs or singly at depths ranging from a few centimeters to more than 400 m, although they are generally limited to water shallower than 50 m (Allen et al. 2003). Juveniles are occasionally found in the open sea in association with floating debris (WPRFMC 2001a).

Life History—Spawning by pipefish and seahorses involves the female depositing her eggs into a ventral pouch on the male, which carries the egg until hatching at intervals of three to four days (WPRFMC 2001a). Breeding populations occur throughout the salinity range from fresh to hypersaline waters (Dawson 1985).

Common Prey Species—Pipefish and seahorses feed upon small free-living crustaceans such as copepods (Dawson 1985; Randall 1996).

<u>Invertebrate Management Unit Species</u>

Gastropods (Sea Snails and Sea Slugs)

Status—Gastropods consisting of sea snails (prosobranchs) and sea slugs (opisthobranchs) are managed in the Hawaiian archipelago as part of the PHCRT by the WPRFMC (2001a). About 572 gastropod species representing 66 prosobranch and 33 opisthobranch families have been reported as occurring in Hawaii (Hoover 1998) and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). At least 116 species of Hawaiian gastropods are known to be endemic (Kay 1979). Various species of prosobranchs (e.g., turbans, tops, cowries, cones, and miter shells) are highly prized among collectors and currently utilized in the shellcraft industries (Hoover 1998; Poutiers 1998a). None of these species found are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Gastropods are found worldwide in tropical, subtropical, and temperate waters of marine and freshwater ecosystems (Kay 1995).

Habitat Preference—Gastropods inhabit all bottom econiches of coral reef ecosystems including the surfaces of sediments, rocks, dead coral heads, living corals, and seaweed thalloms (Sorokin 1995). The prosobranch are the most numerous of the gastropods and occupy a variety of reef habitats including soft sediments, rocky and stony littoral/sublittoral areas, reef flat rocks, outer slope rocks, lagoons of barrier reefs, trenches of rocks at the reef-flat edge, reef flats, and patch reefs (Sorokin 1995). Nudibranchs, the largest of the sea slugs, are predatory opisthobranchs inhabiting the surface of soft corals (alcyonaceans and gorgonaceans), hydroids, and sponges, which they utilize as prey (Russo 1994; Colin and Arneson 1995).

Life History—Sea snails generally have separate sexes, whereas sea slugs are unisexual. Fertilization may be external or internal in sea snails. Sea snail species that undergo internal fertilization produce eggs that may be enclosed in protective layers of gelatinous mucus or corneous capsules. Sea slugs deposit eggs in ribbon-like clusters, whereas sea snail embryos hatch as free-swimming planktonic larvae or as crawling young (Poutiers 1998a).

Common Prey Species—Depending upon the species, sea snails feed on a wide variety of benthic organisms such as turf or fleshy algae, hydroids, sponges, heart and sea urchins, echinoderms, mollusks, sea stars, worms (polychaetes), scleractinian hard corals, small crustaceans, and sleeping fish as well as detritus. Different species of sea slugs consume hydroids, small crustaceans, soft corals, red and blue-green algae, sponges, tunicates, bryozoans, and other sea slugs (Colin and Arneson 1995; Sorokin 1995; Hoover 1998).

Bivalves (Oysters and Clams)

Status—Oysters and clams are managed in the Hawaiian archipelago as part of the PHCRT by the WPRFMC (2001a). At least 171 bivalve species, including 83 endemics, have been reported as occurring in Hawaii (Eldredge and Evenhuis 2003) and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). The black-lipped pearl oyster (*Pinctada margartifera*) occurs in the Hawaiian archipelago, but is uncommon in near-shore waters and has been illegal to harvest for 60 years (Hoover 1998). Several oysters and clams from North America and Japan have been introduced successfully to Hawaii and occur in limited numbers in shallow sheltered areas such as Pearl Harbor, Maunalua Bay, and Kaneohe Bay, O‘ahu (Hoover 1998). Different species of bivalves have been locally collected for subsistence purposes and utilized as decorative items in the shellcraft industry (ark and pen shells) or introduced for aquaculture (oysters) (Poutiers 1998b). Currently, the season is closed and collection of clams, oysters, and other shellfish is prohibited in Hawaii's state waters (Hoover 1998; HDAR 2003b). None of these species found are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Bivalves are found in all tropical and temperate seas of the world (Briggs 1974), with the overall biodiversity of the malacological fauna being the greatest in the western central Pacific (Poutiers (1998b).

Habitat Preference—Bivalves comprise 10 to 30% of the coral reef malacofauna utilizing rocky hard substrates for sessile and boring species and soft bottom areas for vagile species (Sorokin 1995). Sessile bivalves inhabit reef areas such as rocky surfaces of reef-flats, dead coral heads, patch reefs, walls of trenches and channels, and on coarse sands and rubble substrates on flat and littoral areas (Sorokin 1995). Boring bivalves are extremely widespread in areas of the rocky flat and in areas of profuse coral growth hidden in coral colonies (Sorokin 1995). The sandy bottom of channels crossing the reef-flat and its outer slopes, as well as on silty coral sands in the lagoons of barrier reefs, are inhabited mainly by vagile bivalves (Sorokin 1995). The black-lipped pearl oyster occurs in lagoons, bays, and sheltered reef areas to around 40 m depth, but is most abundant just below the low-water (Sims 1993).

Life History—In the majority of bivalves, sexes are separate. Fertilization is external, giving rise to free-swimming larvae followed by a metamorphosis leading to a benthonic mode of life (Poutiers 1998b). Some species may be unisexual with fertilization occurring in the pallial cavity with protection of eggs or larvae in a brooding chamber. If the planktonic larval stage is reduced or totally absent, young hatch directly as benthic organisms (Poutiers 1998b).

Cephalopods (Squids and Octopuses)

Status—Cephalopods are managed in the Hawaiian archipelago as PHCRT by the WPRFMC (2001a). Seven octopus species and more than a dozen squids and cuttle-like fishes (including one endemic cuttle-like fish (*Euprymna scolopes*), one possibly extirpated bigfin reef squid (*Sepioteuthis lessoniana*), most of which are pelagic, have been reported as occurring in Hawaii (Kay 1979; Hoover 1998; WPRFMC 2001a; Eldredge and Evenhuis 2003). All have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if cephalopods of the PHCRT are approaching an over fished situation (NMFS 2004c). Cephalopods are of considerable ecological and commercial fisheries importance in the Pacific where they are harvested for food items in the subsistence fishery (Dunning et al. 1998). Octopuses are a component of the incidental catch of the lobster-trap fishery in the NWHI (WPRFMC 2001a). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Cephalopods are found in all tropical and temperate seas of the world (Roper et al. 1984).

Habitat Preference—Cephalopods occur over a wide variety of habitats including holes and crevices in rocky or coral areas. Octopuses burrow in the sand and are found around seagrass beds, whereas squid are associated with nearby reef areas over sandy, muddy, and rocky bottoms (Dunning 1998; Norman 1998; Reid 1998). Their range of depth extends from the surface to over 5,000 m (Roper et al. 1984). Some species (e.g., squids) exhibit diurnal vertical migration, moving upward to feed during the night and dispersing into the deeper water during the day (Dunning 1998). Eggs are encapsulated in gelatinous finger-like strings (squids) or attached to each other (octopuses) adhering to various substrates (e.g. rocks, shells, seagrass) (Dunning 1998; Norman 1998; Reid 1998).

Life History—Cephalopods have separate sexes and reproduction occurs through copulation (Colin and Arneson 1995). Spawning varies between the various groups of cephalopods. Squids migrate in aggregations biannually to spawn in response to temperature changes (Dunning 1998; Reid 1998). Octopuses lay eggs, which are tended by the female until hatching (Norman 1998; Waikiki Aquarium 1998d).

Common Prey Species—Cephalopods exhibit a wide range of feeding habits and food preferences. Free-swimming squids prey upon fish, crustaceans (shrimp), and other squids, while octopuses mostly prey on shrimp and occasionally crabs (Kay 1979; Hoover 1998; Waikiki Aquarium 1998f; WPRFMC 2001a).

Ascidians (Tunicates)

Status—Tunicates are managed in the Hawaiian archipelago as part of the PHCRT by the WPRFMC (2001a). At least 70 species have been reported as occurring in Hawaii (Eldredge and Evenhuis 2003) and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Ascidians are of economic importance for bio-prospecting and are problematic as marine fouling organisms by clogging cooling water intakes and interfering with boat operations (WPRFMC 2001a).

Distribution—Ascidians are common worldwide and are important inhabitants of the shallow water tropical Pacific (Colin and Arneson 1995; WPRFMC 2001a).

Habitat Preference—Solitary (sea squirts) and colonial (clusters) tunicates are important components of the reef cryptofauna ranging from high-light and high-energy environments to protected deeper water areas (Russo 1994; Sorokin 1995; WPRFMC 2001a). Ascidians attach to inert surfaces such as dead corals, stones, shells, pilings, ship bottoms, and less durable surfaces of seaweeds, mangrove roots, sand, and mud, or grow epizoically on other sessile organisms (e.g., soft corals, sponges, other tunicates) (Colin and Arneson 1995). Solitary forms colonize new surfaces in disturbed areas, whereas colonial types are more suited for growth on the outer reef slopes (WPRFMC 2001a). Larval and adult tunicates occur from intertidal areas to 120 m depth or greater (WPRFMC 2001a).

Life History—Both sexual and asexual reproduction occurs in ascidians and is highly variable, both by family and genera. Egg production is year-round (WPRFMC 2001a). Solitary forms release both unfertilized eggs and sperm into the water, whereas the colonial forms are ovoviviparous, releasing only larvae (Colin and Arneson 1995). The release of certain chemicals by tunicates may trigger various processes, such as spawning, larval attraction, etc. (WPRFMC 2001a). Solitary and colonial ascidians are unisexual but may also reproduce asexually by budding (WPRFMC 2001a).

Common Prey Species—Ascidians filter-feed non-selectively on phytoplankton and other suspended food particles and nutrients (WPRFMC 2001a).

Bryozoans (Moss Animals)

Status—Bryozoans are managed in the Hawaiian archipelago as part of the PHCRT (WPRFMC 2001a). At least 168 species have been reported as occurring in Hawaii (Eldredge and Evenhuis 2004a) and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Surveys conducted in Kaneohe Bay reported 57 species of bryozoans (45 cheilostomes, 13 cyclostomes, and one ctenostome), of which 23% are considered endemic (WPRFMC 2001a). Bryozoans are of economic importance for bio-prospecting and as marine fouling organisms, which interfere with boat operations and clog industrial water intakes and conduits (Hoover 1998; WPRFMC 2001a). Another type of brachiopod (*Lingula reevii*) inhabits a solitary sandbar in Kaneohe Bay, O‘ahu and has been designated as a species of concern by NMFS (2004f).

Distribution—Bryozoans are inhabitants of tropical Pacific reefs ranging from Hawaii to the Indian Ocean (Colin and Arneson 1995).

Habitat Preference—Though widespread on tropical reefs, bryozoans are often not recognized due to the fact that they occur in mixed associations with algae, hydroids, sponges, and tunicates on older portions of coral reefs (WPRFMC 2001a). These benthic sessile organisms occur from the intertidal zone to abyssal depths with the majority occurring in shallower clear waters ranging from 20 to 80 m (WPRFMC 2001a). Forming encrusting, erect branching, or foliose colonies, bryozoans attach to rocks, corals, shells, other animals, mangrove roots, and algae or grow on shaded surfaces on the undersides of coral heads, rock ledges, rubble, and fill cavities within the reef structure (Sorokin 1995). Encrusting forms would be associated with intertidal areas (fringing and patch reefs, barrier reef coral-algal flat breaker zone) or other sites subject to strong waves (ocean slope bench), whereas the erect branching or foliose types would be confined to deeper, more stable habits not subject to strong ocean surges (Sorokin 1995; WPRFMC 2001a). The pelagic larvae exhibit a positive phototropic reaction, but become negatively phototropic before metamorphosis, settling in dark places on the reef. This may be dependent upon day length and temperature (WPRFMC 2001a). Thermal boundaries of 27°C may provide a filtering mechanism that determines the distribution of bryozoan larvae (WPRFMC 2001a).

Life History—Most marine bryozoans are unisexual releasing sperm and eggs into the water or brooding eggs in a cavity until fertilized (WPRFMC 2001a). Larvae take approximately two weeks from fertilization to development (WPRFMC 2001a).

Common Prey Species—Bryozoans are suspension-feeders that capture plankton such as diatoms, detritus, bacteria, silicoflagellates, peridinians, coccolithophores, algal cysts, and flagellates (WPRFMC 2001a).

Crustaceans (Mantis Shrimps, Lobsters, Crabs, and Shrimps)

Status—Crustaceans of the orders Stomatopoda (mantis shrimp) and Decapoda (penaeid, stenopodidean, and caridean shrimps, astacidean/palinurid lobsters, and hermit/true crabs) are managed in the Hawaiian archipelago as part of the CMUS and the PHCRT by the WPRFMC (1998, 2001a). Over 600 crustacean species (20 stomatopods and 652 decapods) have been reported as occurring in Hawaii (Eldredge and Evenhuis 2003) and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Currently, no data are available to determine if crustaceans of the PHCRT are approaching an over fished situation (NMFS 2004c). Stomatopods are of little economic importance due to their limited use in subsistence fisheries and ornamental trade. However, decapods are very important in commercial, recreational, and artisanal fisheries with limited use in the ornamental trade (except shrimp) throughout the tropical Pacific (WPRFMC 2001a). In the Hawaiian Islands, spiny/slipper lobsters and crabs (e.g., Kona) have many restrictions regarding harvest (Hoover 1998; Waikiki Aquarium 1998a; 1998b; HDAR 2003b). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Crustaceans occur in all tropical and temperate seas of the world and are one of the most abundant and diverse groups of the coral reef vagile and sedentary benthic organisms in waters of the Pacific tropical and subtropical islands (Eldredge 1995; Sorokin 1995).

Habitat Preference—Crustaceans occur over a wide variety of coral reef habitats and associated environments. Mantis shrimp inhabit cavities of coral and rock or smooth-walled burrows on sandy bottoms (Manning 1998). Penaeid, caridean, and stenopodidean shrimps utilize pockets of corals and are found among rubble, or buried in sand on reef flats and in seagrass beds (Chan 1998a). The spiny, slipper, and coral lobsters use subtidal holes or crevices of rocky and coralline bottoms (Chan 1998b). True and hermit crabs can be found in mud or sandy bottoms in high littoral sands, crevices or burrows among subtidal rocks and coral heads, or on the surfaces of marine plants and other invertebrates (Ng 1998). The depth distribution of these different reef crustaceans varies from the intertidal and subtidal zones to over 100 m (mantis shrimp: 5 to 70 m, coral associated shrimps: 3 to 15 m, lobsters: 20 to 50 m, true crabs: 0 to 115 m, and hermit crabs: 0 to 305 m) (Hoover 1998; WPRFMC 2001a). Some crustaceans also provide symbiotic or commensal associations with other marine organisms (Colin and Arneson 1995).

Life History—Information is available on the spawning seasons and reproductive capability of most crustaceans in the subtropical and tropical regions of the Pacific (WPRFMC 2001a). In decapods, for example, the spiny lobster spawns continuously throughout the year with individual females spawning four times per year (Pitcher 1993). Other lobster species may have more defined spawning seasons (WPRFMC 2001a). Eggs are carried on the pleopods of the female in the stomatopods prior to being deposited at the bottom of their burrows where they are constantly aerated (Hoover 1998). Other decapod eggs are also carried on the female’s pleopods except for penaeid shrimp that shed their eggs directly into the water (WPRFMC 2001a).

Common Prey Species—Crustaceans are typically carnivorous or omnivorous predators or scavengers preying upon mollusks, other crustaceans and small fish. Some taxa feed on ectoparasites, whereas others are filter feeders (Hoover 1998; WPRFMC 2001a).

Echinoderms (Sea Cucumbers and Sea Urchins)

Status—Echinoderms, including sea cucumbers (holothuriods), sea urchins (echinoids), brittle stars and basket stars (ophuiroids), sea stars (asteroids), and feather stars/sea lilies (crinoids), are managed in the Hawaiian archipelago as part of the PHCRT (WPRFMC 2001a). More than 300 echinoderm species (over 58 holothuroids, 84 echinoids, 61 ophuiroids, 90 asteriods, and 16 crinoids) have been reported as occurring in Hawaii (Hoover 1998; Eldredge and Evenhuis 2003) and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Echinoderms have some economic importance; particularly the holothurians or sea cucumbers which are prized as beche-de-mer or trepang (dried body wall) and some species of sea urchins whose gonads are edible (Conand 1998). Of negative economic importance are the species, such as the crown-of-thorns starfish (*Acanthaster planci*), that can devastate coral reefs (Pawson 1995). In Hawaii, this species infested reefs off southern Moloka'i in 1969 but did not cause extensive damage to living coral polyps (*Pocillopora meandrina*) (Gulko 1998; Hoover 1998). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—The phylum Echinodermata is exclusively marine and distributed throughout all oceans, at all latitudes, and depths from the intertidal zone down to the abyssal plains (Colin and Arneson 1995). Echinoderm fauna are widely distributed across several localities of the Indo-Pacific region with few taxa being endemic (Pawson 1995), except for Hawaii where at least 48% of the population is considered endemic (Eldredge and Evenhuis 2003).

Habitat Preference—Echinoderms form dense monospecific populations in shallow reef zones and play important roles in trophodynamics and nutrient regeneration. They occupy all the trophic niches, as filters (ophiuroids [brittle stars], crinoids [feathered stars]), detritus and sediment eaters (holothurians, ophiuroids), phytophages (sea urchins), and predators (sea stars, and in part, sea urchins and ophiuroids) from the intertidal regions to depths of about 2,000 m (Colin and Anderson 1995). The coral reef habitat and associated environments inhabited by echinoderms include sandy bottoms of lagoons, coral sand, and reef-flats rocks (sea urchins); hardbottom biotopes of reef flats, sublittoral and patch reefs, outer reef slope, and cryptofaunal habitats (sea stars); under stones in trenches on reef flats or on seagrasses (brittle stars); weak current areas in reef-flats and outer slope trenches and caves (feathered stars); and coral slopes (passages), inner/outer lagoons, inner/outer reef-flats covered with sand and rubble (sea cucumbers) (Sorokin 1995; Conand 1998; Miskelly 2002). Most echinoderms (e.g., brittle stars and feathered stars) are nocturnal, hiding in the daytime and feeding at nighttime (Sorokin 1995). They also have formed commensal relationships with small reef organisms (e.g., shrimps and fishes) (Colin and Arneson 1995).

Life History—The majority of echinoderms have separate sexes, but unisexual forms occur among the sea stars, sea cucumbers, and brittle stars. Many species of echinoderms are broadcast spawners (e.g., sea cucumbers, sea stars) (Waikiki Aquarium 1998g, 1998h). These species have external fertilization producing planktonic larvae; but some brood their eggs, never releasing free-swimming larvae (Colin and Arneson 1995).

Common Prey Species—Many echinoderms are either scavengers or predators on sessile organisms such as algae, stony corals, sponges, clams, and oysters. Some species, however, filter food particles from sand, mud or water (Hoover 1998).

Annelids (Segmented Worms)

Status—Segmented worms or polychaetes are managed in the Hawaiian archipelago as part of the PHCRT (WPRFMC 2001a). At least 295 polychaetes, with over 70 endemic species, have been reported as occurring in Hawaii (Eldredge and Evenhuis 2003) and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Polychaetes are important food resources of reef fishes and invertebrates with some species being indicators of environmental perturbation and reef condition (Bailey-Brock 1995).

Distribution—Polychaetes are primarily marine worms that are extremely abundant and widespread in tropical and temperate oceans with brackish and freshwater forms living in streams and estuaries of tropical regions (Colin and Arneson 1995). Islands in the tropical central and western Pacific region have species-rich polychaete communities that are mostly cryptic, endolithic, or infaunal (Bailey-Brock 1995).

Habitat Preference—Benthic coral reef polychaetes are associated with hard or softbottom materials or live among marine vegetation (Bailey-Brock 1995). The polychaetes occupying all these econiches in the coral reef biotopes are classified into two groups: free-living (free-swimming) errant and sedentary (tube-dwelling) segmented worms (Sorokin 1995). Specific types of coral reef habitats frequently colonized by these polychaetes at depths to 15 m include rocky intertidal areas (e.g., tide pools and shallow sand-filled depressions associated with lava rocks, basalt, and limestone benches), mud and sand at the sediment-water interface, reef flats, sandy tops of patch reefs, sandy cays, seagrasses, mangroves, and fleshy or thalloid algae (Bailey-Brock 1995; Sorokin 1995; Hoover 1998). In addition to coral reefs, polychaetes also colonize vessel hulls, docks, and harbor walls, as well as floating slippers, glass floats, and debris (Bailey-Brock 1995). Polychaetes stabilize sand on reef flats by their tube-building activities, bore into coral rock contributing to the erosion of reef materials, or are commensals of sponges, mollusks, holothurians, and hydroids (Sorokin 1995).

Life History—Most polychaetes have separate sexes, although some are unisexual, and a few change sex. Fertilization of eggs takes place in the water column for species, which release their gametes into the water. Other species mate and lay encapsulated eggs in the female, while a few retain their fertilized eggs in the body of the female (Colin and Arneson 1995). Some species swarm in water during their breeding season, others spawn during the first lunar cycle, and some undergo asexual breeding by simple division of the body into several pieces (Sorokin 1995).

Common Prey Species—Polychaetes are raptorial predators, omnivorous scavengers, filter or suspension feeders of sand, sediment, and water, deposit feeders, and selective deposit feeders (Bailey-Brock 1995; Hoover 1998).

<u>Sessile Benthos Management Unit Species</u>

Algae (Seaweeds)

Status—Algae (belonging to the blue-green, green, brown, and red algal groups) are managed in the Hawaiian archipelago as part of the PHCRT by the WPRFMC (2001a). Over 850 algal species have been reported from the NWHI (196 species) (WPRFMC 2001a) and the MHI (636 species) (Abbott 1999; Eldredge and Evenhuis 2003; Abbott and Huisman 2004) and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Algae are classified as EFH because they are direct contributors to the well-being and protection of fish species, both as a source of food and protection to larvae and small fish species (WPRFMC 2001a). Several species are harvested for commercial and subsistence use in the MHI, including *Gracilaria parvispora, Codium edule, Asparagopsis taxiformis,* and *Ulva fasciata* (Green 1997). None of these species are listed on the IUCN Red List of threatened species (IUCN 2004).

Distribution—Algae are found worldwide along most shorelines and shallow water environments. In the Indo-Pacific, they have a discontinuous distribution and a low level of endemicity (South 1993).

Habitat Preference—Seaweeds are prominent organisms in the shallow water photic zone ranging from the spray zone well above the high tide level to depths as great as 268 m (South 1993; Russo 1994). From the intertidal to shallow subtidal zones, they occur on soft and/or hard substrata within a variety of marine benthic habitats such as flat reefs, sheltered bays and coves, and rocky wave-exposed areas along the shore or on the edge of the reef (Truno 1998). Habitat distribution of the most abundant common algal forms include the blue-green algae (cyanobacteria) on sandy bottoms of lagoons; green and brown algae in shallow, calm fringing reefs; colonies of large brown algae and tufts of red algae on the barrier reef coral boomies; encrusting calcified algae and belts of brown algae on outer reef flats; and red algae and crustose coralline algae on the outer reef slope (WPRFMC 2001a). Coralline algae are of primary importance in constructing algal ridges that are characteristic of exposed Indo-Pacific reefs preventing oceanic waves from eroding coastal areas (WPRFMC 2001a).

Life History—Both sexual and asexual reproduction occurs in the algae, with predominance of one or the other being linked to the type of algae and the predominant geographical and environmental conditions affecting the algal populations (WPRFMC 2001a). Unicellular algae reproduce asexually, while the multicellular algal forms have asexual or sexual life cycles of varying complexity (South 1993).

Common Prey Species—Although algae do not utilize prey species, marine macroalgal forms contribute significantly to organism interrelationships in reef ecosystems. This is accomplished either by the production of chemical or structural by-products on which other organisms depend, by providing protective micro-habitats for other species of algae or marine invertebrates, or by offering surfaces promoting the settlement and growth of other algal species or the larvae of some herbivorous invertebrates (WPRFMC 2001a).

Porifera (Sponges)

Status—Sponges are managed in the Hawaiian archipelago as part of the PHCRT by the WPRFMC (2001a). At least 122 sponges, including 24 endemic species, have been reported as occurring in Hawaii (Eldredge and Evenhuis 2003) and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Within the study area, sponges are common under stones or rubble and on docks, pilings, or mangrove roots in protected locations such as Pearl Harbor, Honolulu Harbor, and the quiet backwater areas of Kaneohe

Bay, O‘ahu. They also blanket the walls and caves and crevices along Hawaii's (main island) volcanic shore (Hoover 1998).

Distribution—Poriferans represent a significant component of all tropical, temperate, and polar marine benthic communities (Kelley-Borges and Valentine 1995) with the sponge fauna of the broad Indo-West Pacific region being the most diverse in the world (Briggs 1974). Within Oceania, sponge faunas are divided into four broad groups: (1) regionally endemic sponges that are habitat- or locality-specific (e.g., patch-reefs within nutrient-rich bays or caves); (2) regionally endemic sponges occurring within a single island group; (3) species that are found in "super-regions" (e.g., Hawaii alone); and (4) species that occur throughout the Indo-West Pacific Region (Kelley-Borges and Valentine 1995).

Habitat Preference—Sponge diversity is greatest on coral reefs where they occur at various depths in caves and vertical areas not colonized by hard coral (WPRFMC 2001a). They are also abundant in seagrass beds, mangroves, and other environments at depths from 0.6 to 15 m (Colin and Arneson 1995; Hoover 1998). Within the reef benthic community, the shallow biotopes are dominated by demosponges and to a lesser degree by calcareous ones, while the deeper shadowed zones of the outer reef slopes, caves, and tunnels are colonized mainly by sclerosponge species (Sorokin 1995). On the reef-flat and on upper zones of the reef slope, the spongal fauna consists mostly of phototropic and boring species. The more abundant and varied spongal communities inhabit the middle depths of the outer slope, especially the buttress zone and the upper part of the fore-reef (Sorokin 1995). Sponges also provide homes for a huge variety of animals including shrimp, crabs, barnacles, worms, brittle stars, holothurians, and other sponges (Colin and Arneson 1995).

Life History—Reproduction among sponges is highly variable and includes sexual (viviparous and oviparous), asexual (budding, fragmentation, and gemmules), or unisexual reproduction (Colin and Arneson 1995). Mass spawning and release of sperm is triggered by lunar and diurnal periodicity (WPRFMC 2001a).

Common Prey Species—Sponges are living filters, feeding on organic particles and ingesting plankton and bacteria (Hoover 1998; WPRFMC 2001a).

Corals (Hydrozoans)

Status—Hydrozoans consisting of sea fans and feather hydroids are managed in the Hawaiian archipelago as part of the PHCRT by the WPRFMC (2001a). Eighty-five hydrozoan species have been reported as occurring in Hawaii (Eldredge and Evenhuis 2003) and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Within the study area, hydroids are an important component of marine fouling assemblages and have been reported from artificial habitats (e.g., pillings, floats, etc.) or from disturbed areas such as Kaneohe Bay, O‘ahu (Cooke 1977).

Distribution—Hydroids are the most common and conspicuous invertebrates found in shallow tropical waters (Collin and Arneson 1995). Distribution of hydrozoan species in the Hawaiian archipelago consists solely of the family Solanderidae which ranges from western Africa through the central Indo-Pacific with its northerly limit being Japan and Hawaii (Gulko 1998; WPRFMC 2001a).

Habitat Preference—Hydrozoans are colonial, polyp-like animals that occur in cryptic habitats or occur as epizotic on other organisms (Colin and Arneson 1995; Gulko 1998). Similar in appearance to gorgonians and other sea fans, *Solanderia* spp. exhibits branching, ramose or encrusting forms that are commonly found in exposed areas on wave-swept, shallow outer reefs, caves, or overhanging environments at depth ranges from shallow outer reefs to 100 m (Colin and Arneson 1995).

Life History—Most hydroids have both sexes, but their life cycle is highly variable, complex and poorly understood (Colin and Arneson 1995). Generally, attached colonial hydroids develop an asexual polyp (gonozooid) stage (male or female medusa) and a free-living, medusa stage which reproduce by asexual division or budding (WPRFMC 2001a).

Common Prey Species—The feeding polyp (gastrozoid) of the hydroid captures and ingests small zooplankters (Gulko 1998; WPRFMC 2001a).

Corals (Scleractinian Anthozoans)

Status—Stony corals are managed in the Hawaiian archipelago as part of the PHCRT by the WPRFMC (2001a). At least 126 scleractinian species (72 shallow-water and 54 deep-water forms) have been reported as occurring in Hawaii (Eldredge and Evenhuis 2003) and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Within the study area, coral collecting is banned in Hawaiian state waters under regulations that prohibit the collection or damaging of any live stony corals including reef or mushroom corals and harvesting or breaking of live rock to which marine life of any type is visibly attached (Hoover 1998; HDAR 2003b). This statute also prohibits the sale of all native Hawaiian coral species (regardless of origin), including the following hermatypic forms: cauliflower or rose coral (*Pocillopora meandrina*), lace coral (*P. damicornis*), antler coral (*P. eydouxi*), rice coral (*Montipora capitata*), lobe coral (*Porites lobata*), finger coral (*P. compressa*), and mushroom or razor coral (*Fungia scuteria*), and ahermatypic types: orange or cup coral (*Tubastraea coccinea*) (Gulko 1998; HDAR 2003b). In addition, the Hawaiian reef coral (*M. dilatata*), which has been reported from Kaneohe Bay, Oahu in the MHI, and Midway Atoll and Maro Reef in the NWHI, is listed as a species of concern by NMFS (2004f).

Distribution—The communities of scleractinian reef-building (hermatypic) and non-reef building (ahermatypic) corals grow in tropical and subtropical seas globally (Veron 1995), with the Pacific Ocean containing the most diverse coral fauna in the world (Colin and Arneson 1995). In Hawaii, the genera *Porites* spp*., Montipora* spp., and *Pavona* spp. dominate the reef scleractinians (Maragos 1977; WPRFMC 2001a).

Habitat Preference—Stony corals have polyps which manifest themselves into attached colonial forms that may be branching, tabulate, massive, or encrusting. Stony corals may also be solitary, free-living (e.g., mushroom corals, Fungiidae) forms (WPRFMC 2001a) that extend to a maximum depth of 60 m (Hodgson 1998). The hermatypic coral fauna are found in shallow surf zones and submerged areas of reef flats, lagoon patch-reef zones, patch reefs, and upper outer reef slopes (Sorokin 1995). A typical Hawaiian zonation reef pattern would include: reef flat—0 to 2 m, cauliflower coral; reef bench—2 to 10 m, lobe coral; reef slope—10 to 30 m, finger coral; and rubble—30 to 40 m, lobe and finger coral rubble (Gulko 1998; Tissot 2005). Mushroom corals inhabit shallow water reef areas unsuitable for permanently attached corals such as bottom of pits and channels with sand or rubble in turbulent zones of reef flats, reef edge, and moat on outer slopes (Sorokin 1995; WPRFMC 2001a). Ahermatypic corals (e.g., orange cup coral) colonize areas of low scleractinian coral or algal occurrence including poorly illuminated or even dark biotopes in caves and trenches in shallow water, and in deep, steep-reef zones below 40 m (Sorokin 1995; Gulko 1998; WPRFMC 2001a).

Life History—Hermatypic corals reproduce by both sexual (external fertilization and development and brooded planulae, bisexual, unisexual) and asexual (brooded planulae, polyp-balls, polyp bail-out, fission, fragmentation, and re-cementation) development (Veron 2000; WPRFMC 2001a). Corals may be free spawners (12 month maturation cycle) or brooders (several cycles per year) depending upon their geographic distribution (WPRFMC 2001a). Spawning follows a lunar periodicity beginning on the 15th to 24th night of the lunar cycle (Colin and Arneson 1995). Mushroom corals are asexual (fragmentation or natural regeneration through fracture) or sexual (dioecious or unisexual) (Veron 2000). Ahermatypic corals are dioecious with fertilization being internal and larvae being brooded (WPRFMC 2001a). They also may be free-spawners (Harrison and Wallace 1990). Currents play a major role in transport and abundance of coral eggs and larvae, often concentrating them into a dense mass and dispersing them into the ocean flow (WPRFMC 2001a).

Common Prey Species—The majority of reef-building corals, and all ahermatypic corals, feed on small planktonic organisms or dissolved organic matter (DOM) (Gulko 1998). Mushroom corals feed heterotrophically through prey capture of zooplankters and autotrophically through nutrient exchange with zooxanthellae (WPRFMC 2001a).

Corals (Non-Scleractinian Anthozoans)

Status—Non-scleractinian anthozoans are managed in Hawaiian archipelago as part of the PHCRT by the WPRFMC (2001a). At least 140 non-scleractinian anthozoan species (40 anemones and 100 octocorals) have been reported as occurring in Hawaii (Eldredge and Evenhuis 2003) and have EFH designated within the boundaries of the study area (WPRFMC 2001a; NMFS 2004e). Collecting of sea anemones is discouraged and importation into Hawaii is illegal (Hoover 1998).

Distribution—The communities of non-scleractinian corals are distributed in shallow tropical and subtropical habitats worldwide (Veron 1995). However, little is known about the zoogeography of individual hexacoral and octocoral species across the tropical Pacific due to improper identification of specimens (Colin and Arneson 1995).

Habitat Preference—Members of the non-scleractinian anthozoans (hexacorals and octocorals) exist only as polyps, either solitary or as colonies. Hexacorals consist of anemones and zooanthids (Colin and Arneson 1995). Anemones have solitary polyps that are attached to hard substrate by their basal disc, burrowed into soft substrate, or attached as symbionts to sessile and mobile reef organisms (e.g., fish or shrimps) (Colin and Arneson 1995). Some species of anemones also exhibit mimicry, appearing like their background or other reef entities (e.g., hard coral or algae) (WPRFMC 2001a). In addition, many anemones can form large colonies of related individuals (Waikiki Aquarium 1998i). Zooanthids have species that are either colonial or solitary, often forming large monospecific patch or belt associations on biotopes of reef flats (Colin and Arneson 1995). They usually colonize rock bottom substrates in reef-crest and reef-edge zones (*Palythoa* spp.), rubble areas and dead corals (*Zoanthus* spp., *Isaurus* spp.), and even living colonies of acroporids corals (*Zoanthus* spp.) (Walsh and Bowers 1977; Sorokin 1995; Waikiki Aquarium 1998j).

Octocorals consist of soft corals and gorgonian corals (Colin and Arneson 1995). Soft corals occur as large, lobed colonial forms intertidally with high light intensity or as smaller colonies on roofs and caves (WPRFMC 2001a). Gorgonians, which take the form of fans, whips, or brushy shrub-like colonies, inhabit well-illuminated zones of the reef as well as deeper dark biotopes, caves or channels in strong currents (Collin and Arneson 1995; Sorokin 1995). Two endemic octocorals, the blue octocoral (*Anthelia edmondsoni*) and the bicolor sea fan (*Acabaria bicolor*), along with the introduced snowflake coral (*Carijoa riisei*), occur in the study area (Hoover 1998; Gulko 1998). The blue octocoral forms light blue to purple patches on both hard and soft surfaces in shallow water habitats such as bays, harbors, and the leeward side of islands, particularly, O‘ahu (Russo 1994; Hoover 1998). Producing tiny colonies, the bicolor sea fan, the only native shallow-water bicolor gorgonian coral typically grows in rocky crevices in surgy or current-swept locations as shallow as 1.8 m but usually deeper to 427 m (Hoover 1998). Introduced to Hawaii in 1972, the snowflake coral forms dense colonies in cavities along vertical walls or on the ceilings of caves and overhangs where current is strong, under docks where plankton is plentiful, on shipwrecks, and in the same areas as black coral (*Antipathes* spp.) down to 50 m (Russo 1994; Hoover 1998).

Life History—Hexacorals and octocorals utilize both asexual (pedal laceration, longitudinal or transverse fission, budding, arising as new polyps) and sexual (dioecious, external/internal fertilization giving rise to brooded planulae, clonal propagation) reproductive strategies (WPRFMC 2001a). Spawning in anemones is synchronized with a full moon or low tide; whereas zooanthids exhibit seasonal free spawning or spawning synchronous with mass spawning of stony coral (WPRFMC 2001a). Sexual reproduction in zooanthids is thought to allow for dispersal and colonization over large distances (WPRFMC 2001a). Broadcast spawning occurs in both soft and gorgonian corals (WPRFMC 2001a).

Common Prey Species—Anemones are polyphagous opportunists feeding on plankton born crustacea, fish worms, algal fragments, gastropods, echinoderms, small fish, DOM, nutrients produced by algae (zooxanthellae), and possibly the excrement from associated symbiotic fishes (Gulko 1998; Waikiki Aquarium 1998i; WPRFMC 2001a). Zooanthids ingest a variety of live and dead crustacea and fish portions, as well as DOM (WPRFMC 2001a). Octocorals feed heterotrophically through zooplankton capture and autotrophically through nutrient exchange with zooxanthellae, digestion of zooxanthellae, and absorption of DOM (WPRFMC 2001a).

5.0 POTENTIAL IMPACTS TO EFH AND MANAGED SPECIES

This section discusses the potential impacts by the proposed actions to EFH and managed species. Despite nearshore and offshore designations of the Hawaii Range Complex, species within all FMPs may utilize both nearshore and offshore areas during their lives, as eggs and larvae for most species are planktonic and can occur in nearshore and offshore waters, while adults may be present in nearshore and/or offshore waters. Therefore, all project activities can potentially affect a lifestage of a managed species.

Adverse effects mean any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810(a)).

Permanent, adverse impacts to EFH components are not anticipated since operations are conducted to avoid potential impacts; however, there are temporary unavoidable impacts associated with several operations that may result in localized adverse impacts. In addition, a single operation may potentially have multiple effects on EFH. The proposed operations in the Hawaii Range Complex have the potential to result in the following impacts:

- Physical disruption of open ocean habitat
- Physical destruction or adverse modification of benthic habitats
- Alteration of water or sediment quality from debris or discharge
- Cumulative impacts

Each impact and operations associated with those impacts are discussed in the following sections, and a summary for each proposed activity is provided in Table 5-1.

5.1 PHYSICAL DISRUPTION OF OPEN OCEAN HABITAT

The majority of the operations in the Hawaii Range Complex occurs in open ocean habitat or the pelagic zone. The pelagic zone encompasses the open ocean waters beyond the depth of approximately 200 m, and the pelagic environment in the Hawaiian Islands extend from the surface to water depths of more than 6,000 m. Pelagic biota live in the water column and have little or no association with the benthos, and consist of drifters (plankton) or swimmers (pelagic animals capable of swimming against currents).

5.1.1 SHOCK WAVE

Many of the operations involve the use of mines, bombs, munitions, missiles, or targets that fall into the waters of the Hawaii Range Complex. Some examples include:

- Mine Countermeasures Exercise
- Mine Neutralization
- Mine Laying Exercise
- Surface-to-Surface Gunnery Exercise
- Surface-to-Surface Missile Exercise
- Air-to-Surface Gunnery Exercise
- Air-to-Surface Missile Exercise
- BOMBEX (Sea)
- SINKEX
- Antisurface Warfare Torpedo Exercise

Mines, bombs, and intact missiles and targets could impact the water surface with great force and produce a large shock wave. Impulses of this magnitude could injure or kill all life stages of fish, and larvae of other marine organisms within the immediate area. While many of the exercises are conducted with inert weapons, some exercises use live ordnance or explosives creating a larger area of impact and potentially injuring or killing an even greater number of fish and larvae.

Several factors determine a fish's susceptibility to injury and death from shock wave effects. Most blast injuries in fish and other marine animals involve damage to air- or gas-containing organs (Yelverton 1981). Many species of fish have a swim bladder, which is a gas-filled organ used to control buoyancy. Fish with swim bladders are vulnerable to effects of underwater explosions, whereas fish without swim bladders, like most species of invertebrates, are much more resistant (Yelverton 1981; Young 1991). During exposure to shock waves, the differential speed of shock waves through the body of the fish (which has a density close to water) versus the gas-filled space of the swim bladder causes the bladder to oscillate. If the swim bladder ruptures, it may cause hemorrhages in nearby organs. In the extreme case, the oscillating swim bladder may rupture the body wall of the fish (Yelverton 1981). Some fish have a swim bladder that is ducted to the intestinal tract and some do not, but there is no difference in susceptibility between fish with these two types of bladders (Yelverton et al. 1975; Yelverton 1981). After a nearby underwater blast, most fish that die do so within 1–4 hours, and almost all do so within 24 hours (Yelverton et al. 1975; Yelverton 1981).

The rapid rise time of the shock wave resulting from detonation of high explosives causes most of the organ and tissue damage. Mortality of fish correlates better with impulse, measured in units of pressure time, than with other blast parameters (Yelverton 1981). The received impulse depends on the depth at which the fish is swimming, the depth of the charge, the mass of the charge, and the distance from charge to fish. Fish near the bottom or near a bank will receive a larger impulse. A fish on the bottom over a hard surface would receive a greater impulse than it would in open water (Yelverton et al. 1975; Yelverton 1981). Bottom reflection can also be enhanced if it is focused by bottom terrain.

Data from explosive blast studies indicate that very fast, high-level acoustic exposures can cause physical damage and/or mortally wound fishes (Hastings and Popper 2005). There is also reason to believe that lesser effects might also occur, but these have not been well documented. Just as in investigations testing the effects of sound, however, the number of species studied in tests of the effects of explosives is very limited, and there have been no investigations to determine whether blasts that do not kill fish have had any impact on short- or long-term hearing loss, or on other aspects of physiology (e.g., cell membrane permeability, metabolic rate, stress), and/or behavior (e.g., feeding or reproductive behavior, movement from preferred home sites).

In addition to impacts occurring near the ocean surface, there is also the possibility that falling fragments may injure or kill FMP species below the ocean surface. However, most missiles hit their target or are disabled before hitting the water. Therefore, 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, but 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.

These physical disruptions could result in temporary adverse impacts on FMP species due to the unavoidable direct loss of pelagic fishes and larvae, and potential prey items. However, given the random distribution of juvenile and adult pelagic fish species, planktonic eggs and larvae, and prey items, the relatively large area of the range, and the relatively infrequent number of operations, recovery is expected to occur quickly.

5.1.2 NOISE IMPACTS

The same objects mentioned above (See Section 5.1.1) could also produce a large noise when impacting the water surface. In addition, exercises such as ASW exercises require the use of sonar or other acoustic transmitters. Some exercises or proposed actions that produce noise or use sonar include:

- Antisubmarine Warfare Tracking Exercise
- Antisubmarine Warfare Torpedo Exercise
- FORACS
- MK-84/MK-72 Pinger Acoustic Test Facility

There are insufficient data on the effects of exposure to sound, let alone sonar, for the vast majority of fishes, and there is a great diversity of ear structures, hearing capabilities, and/or acoustic behaviors among fish. The literature on the detection of, and response to, sound are limited and the data on vulnerability to injury are almost totally non-existent, only relevant to particular species, and because of the great diversity of fishes are not easily extrapolated. The major differences in anatomy between fish may affect the degree of injury to fish from high intensity sounds or sonar.

If the sound is loud enough and within the range of frequencies that a fish can hear, a sound will be detected by a fish at some distance from the source. Because of the variable hearing thresholds, this distance will vary among species. Theoretically, a yellowfin tuna would have to be much closer than an Atlantic cod to hear a low-frequency sound at a given energy level. Underwater sounds have been used by fishermen to guide herring and other schooling fish to their nets (Yelverton 1981), or to exclude fish from water intakes (Haymes and Patrick 1986). The noises made by fishing boats can scare some target fish (Anon. 1970). Sudden changes in noise level can cause fish to dive or to avoid the sound by changing direction. Time of year, whether the fish have eaten, and the nature of the sound signal may all influence how fish will respond to it.

In the studies that have been conducted, effects of noise or sonar have been noted at the individual level. However, these studies have focused on a few species and it is not known whether their responses are representative of the wide diversity of other marine fish species. Based on the limited information currently available, these operations are not likely, but may potentially injure or kill FMP species in close proximity to the source. However, it is more likely that there would be a behavioral avoidance to the area. There may also be a response by prey items producing a localized adverse impact. The managed fish species are unlikely to be affected at the population level with current rates of usage (and areas of usage) of military sonar and exercises.

5.2 PHYSICAL DESTRUCTION OR ADVERSE MODIFICATION OF BENTHIC HABITATS

The majority of the operations that use live munitions, bombs, or missiles occur in the open ocean away from sensitive nearshore habitats (see Section 4.3.1). However, some operations involving the use of explosives in nearshore waters may damage sensitive EFH, such as rocky substrate or coral reef habitat.

Rocky substrate can support extensive communities and provides habitat for a diverse ecosystem of fish, invertebrates, and algae. Live bottoms, as defined by the Bureau of Land Management, are areas "containing biological assemblages consisting of such sessile invertebrates as sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans, and hard corals living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; and whose lithotope favors accumulation of turtles, pelagic and demersal fish."

In the Hawaiian Islands OPAREA, colonized hard bottom, macroalgae, invertebrates, deep-slope terraces, and islets are found on every island (Figure 3-5). The marine benthic invertebrate assemblages are extremely diverse and include representatives of nearly all phyla. Subtidal colonized hard bottom habitats in the Hawaiian Islands include coral reefs and communities, deep-slope terrace, and islets.

The WPRFMC identifies HAPC, which are specific areas within EFH that are essential to the life cycle of important species. For example, HAPC for all life stages of the CHCRT and PHCRT of the CRE MUS includes all hard bottom substrate between depths of 0 and 100 m in the Hawaiian Island OPAREA. Within this depth distribution, over 47 HAPC have been identified for the MHI and Nihoa of the NWHI chain. Of these, 9 sites occur within the inshore sections of the study area: 6 on Oahu and 3 on Hawaii (WPRFMC 2001a, Figure A-18).

For mine neutralization operations, all demolition activities are 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. Before any explosive is detonated, divers are transported a safe distance away from the explosive. Standard practices for tethered mines in Hawaiian waters require ground mine explosive charges to be suspended 10 feet below the surface of the water. For mines on the shallow water floor (less than 40 feet of water), only sandy areas that avoid/minimize potential impacts to coral are used for explosive charges.

Detonations in nearshore sandy subtidal habitat can lead to a temporary adverse 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. Mobile species are expected to rapidly move back into the area following detonations, whereas sedentary species would be eliminated and may or may not recover to previous abundances depending on the spatial overlap and time interval between detonations. Increases in turbidity could temporarily decrease the foraging efficiency of fishes, however, given the dynamic nature of the habitat and the grain size of the material, turbidity is expected to be minimal and localized.

Under Alternative 1, PMRF would move the simulated underwater minefield used to exercise the Kingfisher mine detection system closer to Niihau. This underwater training area would be approximately 2 miles off the southeast coast of Niihau at a depth of between 300 and 400 ft. The Kingfisher system would consist of less than 20 steel sphere-shaped buoys that are approximately 37 inches in diameter. The buoys would be anchored to the ocean floor by a clump of chain weighing approximately 2,000 lb. Although the proposed location is outside an HAPC (0 to 300 ft), there may be temporary, localized, adverse impacts to FMP species.

Also under Alternative 1, the Portable Undersea Tracking Range (PUTR) would be developed to provide submarine training in areas where the ocean depth is less than 300 fathoms (Figure 2.2.6-4). This proposed project's purpose is to instrument a 25-square mile or smaller area on the seafloor with a portable tracking system that would allow better training for Pearl Harbor-based submarines. Seven electronics packages would be temporarily installed on the seafloor in water depths greater than 600 feet. Each package is a cylinder about 3 feet long and about 2 feet in diameter, powered by D cell alkaline batteries. They would temporarily sit on the seafloor and be recovered after the end of the operation. The anchors used to keep the electronics packages on the seafloor would be either concrete or sand bags. After the end of the battery life, the electronic packages would be recovered and the anchors would remain on the seafloor. Although the proposed location is outside an HAPC (0 to 300 ft), there may be temporary, localized, adverse impacts to FMP species.

Operations involving the sinking of large vessels (SINKEX) may have a greater likelihood to affect sensitive EFH, such as deep water coral reef habitat. Each 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 ship hull that is towed to a designated location where various platforms would use multiple types of weapons to fire shots at the hulk. Platforms can consist of air, surface, and subsurface elements. Weapons can include missiles, precision and non-precision bombs, gunfire, and torpedoes. If none of the shots result in the hulk sinking, either a submarine shot or placed explosive charges would be used to sink the ship. Charges ranging from 100 to 200 pounds, depending on the size of the ship, would be placed on or in the hulk. These activities can have an adverse impact on FMP species (See Section 4.3.1), but to avoid impacts to sensitive EFH, all vessel sinkings are conducted in water at least 1,000 fathoms (6,000 feet) deep and at least 50 nautical miles from land." In Hawaii, SINKEX events take place within PMRF Warning Area W-188. Therefore, SINKEX operations would not destroy or adversely effect sensitive benthic habitats, but may alter soft bottom habitats and may provide a beneficial use by providing habitat in the deep water environment.

Operations involving relatively smaller weapons or equipment (e.g., sonobuoys, inert mines, torpedoes, targets, munitions, intact missiles) may also physically affect benthic habitats. All of the expendable materials would eventually sink to the bottom, but are unlikely to result in any physical impacts to the sea floor because they would sink into a soft bottom, where they eventually would be covered by shifting sediments. Soft-bottom habitats are considered less sensitive than hard bottom habitats, and in such areas, the effects of debris would be minimal because the density of organisms and debris are low. Debris may also serve as a potential habitat or refuge for invertebrates and fishes. Given the smaller size debris (compared to SINKEX) and the large size of the range, these items are not expected to adversely affect sensitive EFH or FMP species. Over time, these materials would degrade, corrode, and become incorporated into the sediments. Rates of deterioration would vary, depending on material and conditions in the immediate marine and benthic environment.

Expeditionary Assault consists of a seaborne force from over the horizon assaulting across a beach in a combination of helicopters, vertical takeoff and landing (VTOL) aircraft, landing craft air cushion (LCAC), amphibious assault vehicles (AAVs), expeditionary fighting vehicle (EFV) and landing craft. More robust expeditionary assault operations include support by Naval surface fire support (NSFS), close air support (CAS), and Marine artillery with the purpose of securing a lodgment.

Amphibious landings may also potentially damage EFH, since the exercise consists of a seaborne force assaulting across a beach using a variety of large vehicles and crafts. Before each major amphibious landing exercise is conducted, a hydrographic survey is performed to map out the precise transit routes through sandy bottom areas. During the landing, the crews follow established procedures, such as having a designated lookout watching for other vessels, obstructions to navigation, marine mammals (whales or monk seals), or sea turtles.

Although amphibious landings are restricted to specific areas of designated beaches, amphibious landings in nearshore sandy subtidal habitat can lead to a temporary adverse 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, however, given the dynamic nature of the habitat and the grain size of the material, turbidity is expected to be minimal and localized.

5.3 ALTERATION OF WATER OR SEDIMENT QUALITY FROM DEBRIS OR DISCHARGE

One potential impact to water quality would primarily be associated with the incidental release of materials from surface ships, submarines, or other vessels. Hazardous constituents of concern possibly emitted from the surface ship or submarine (i.e., fuel, oil) are less dense than seawater and would remain near the surface and therefore would not affect the benthic community. Sheens produced from these activities are not expected to cause any significant long-term impact on water quality or EFH because a majority of the toxic components would evaporate within several hours to days and/or be degraded by biogenic organisms (e.g., bacteria, phytoplankton, zooplankton).

The resulting debris and/or discharges from operations may also affect the physical and chemical properties of benthic habitats and the quality of surrounding marine waters, in turn, affecting EFH. Hazardous constituents can be released from sonobuoys, targets, torpedoes, missiles, and underwater explosions (discussed individually below). Impacts from hazardous materials, primarily batteries, may affect water or sediment quality in the vicinity of the debris. The release of metal ions (e.g., Pb^{+2}, Cu^{+2}, and Ag^{+}) during operation of the seawater batteries or as a result of corrosion of sonobuoy or target components represents a source of potential environmental degradation for marine invertebrates. In general, the toxicological impact of exposure to high concentrations of heavy metals can result in either immediate mortality of exposed organisms (acute effect) or accumulation of heavy metal residues by these same species. Benthic communities exposed to high concentrations of heavy metals (specifically copper and zinc) are characterized by reduced species richness (number of species), reduced abundance (number of organisms), and a shift in community composition from sensitive to more tolerant taxa.

Sonobuoys are expendable devices used for the detection of underwater acoustic sources and for conducting vertical water column temperature measurements. The primary source of contaminants in each sonobuoy is the seawater battery; these batteries have a maximum operational life of 8 hours, after which the chemical constituents in the battery are consumed. Long-term releases of lead and other metal from the remaining sonobuoy components would be substantially slower than the release during seawater battery operation. Lead has the potential to accumulate in bottom sediments, but the potential concentrations would be well below sediment quality criteria based on thresholds for negative biological effects. By far the greatest amount of material would likely to be deposited in a relatively inert form, as the lead ballast weights would become encrusted with lead oxide and other salts and would be covered by the bottom sediments. Sonobuoy emissions are not anticipated to accumulate or result in additive effects on water or sediment quality as would occur within an enclosed body of water since the constituents of sonobuoys would be widely dispersed in space and time throughout training areas. In addition, dispersion of released metals and other chemical constituents due to currents near the ocean floor would help minimize any long-term degradation of water and sediment quality. As a result, substantial long-term degradation of marine water or sediment quality, and impacts on EFH would not likely occur as a result of sonobuoy operations.

Most air targets contain jet fuel, oils, hydraulic fluid, batteries, and explosive cartridges as part of their operating systems. Following a training operation, targets are generally flown (using remote control) to a pre-determined recovery point. Fuel is shut off by an electronic signal, the engine stops, and the target descends. A parachute is activated and the target ascends to ocean surface where it is retrieved by range personnel using helicopters or range support boats. However, some targets are physically hit by missiles, and these targets fall into the ocean, and could potentially result in temporary, localized adverse impacts on water quality. This would occur in the open ocean away from sensitive EFH. Most of the hazardous constituents of concern (i.e., fuel, oil) are less dense than seawater and would remain near the surface and therefore would not affect sediment quality. Ocean currents at the surface and within the water column would also rapidly dilute any metal ions or other chemical constituents released by the target. Sheens (e.g., oil or fuel) produced from these activities have a less than significant long-term effect on EFH because a majority of the toxic components (e.g., aromatics) would evaporate within several hours to days or be degraded by biogenic organisms. This process may occur at a faster rate depending on sea conditions (e.g., wind and waves).

Potential effects of torpedoes on water or sediment quality are associated with propulsion systems, chemical releases, or expended accessories. During normal exercise operations, none of the potentially hazardous or harmful materials are released into the marine environment because the torpedo is sealed and, at the end of a run, the torpedoes are recovered. It would be unlikely that OTTO Fuel II contained in a torpedo would be released into the marine environment. Under the worst-case scenario of a catastrophic failure, however, up to 59 pounds (lb) (27 kg) could be released from a MK-46 (USDoN 1996). It is anticipated that in the event of such a maximum potential spill, temporary adverse impacts to water quality and EFH would occur, but no long-term adverse impacts to water quality are anticipated because:

- The water volume and depth of the Hawaii Range Complex would dilute the spill.
- Although OTTO Fuel II may be toxic to marine organisms (USDoN 1996), in particular, sessile benthic animals and vegetation, mobile organisms may move away from areas of high OTTO Fuel II concentrations.
- Common marine bacteria degrade and ultimately break down OTTO Fuel (USDoN 1996).

Missiles contain hazardous materials as normal parts of their functional components. In general, the largest single hazardous material type is solid propellant, but there are numerous hazardous materials used in igniters, explosive bolts, batteries, and warheads. For missiles falling in the ocean, the principal source of potential impacts to water and sediment quality would be the unburned solid propellant residue and batteries. The remaining solid propellant fragments would sink to the ocean floor and undergo changes in the presence of seawater. Testing has demonstrated that water penetrates only 0.06 inches (0.14 centimeters [cm]) into the propellant during the first 24 hours of immersion, and that fragments would very slowly release ammonium and perchlorate ions (Aerospace Corporation 1998). These ions would be expected to be rapidly diluted and disperse in the surrounding water such that local concentrations would be extremely low. However, assuming that all of the propellant on the ocean floor would be in the form of 4-inch cubes, only 0.42 percent of it would be wetted during the first 24 hours. If all the ammonium perchlorate leaches out of the wetted propellant, then approximately 0.01 lb (0.003 kg) would enter the surrounding seawater. The concentration would decrease over time as the leaching rate decreases and further dilution occurs. The aluminum would remain in the propellant binder and would eventually be oxidized by seawater to aluminum oxide. The remaining binder material and aluminum oxide would not pose a threat to the marine environment. Therefore, effects from missile propellant may have temporary adverse impacts on water quality and EFH, but are less than significant.

Both chaff and flares are used during aircraft training exercises. Chaff is an aluminum coated glass fiber used as a defensive mechanism to reflect radar. All of the components of the aluminum coating are present in seawater in trace amounts, except magnesium, which is present at 0.1 percent. The stearic acid coating is biodegradable and nontoxic. The potential for chaff to have a long-term adverse impact on water quality and sensitive EFH is very unlikely, and chemicals leached from the chaff would also be diluted by the surrounding seawater, thus reducing the potential for concentrations to build up to levels that could have effects on sediment quality and benthic habitats.

Flares are used over water during training. They are composed of a magnesium pellet that burns quickly at a very high temperature leaving ash and end caps and pistons. Laboratory leaching tests of flare pellets and residual ash using synthetic seawater found barium in the pellet tests, while boron and chromium were found in the ash tests. The pH of the test water was raised in both tests. Ash from flares would be dispersed over the water surface and then settle out. Chemical leaching would occur throughout the settling period through the water column, and any leaching after the particles reached the bottom would be dispersed by currents. Therefore, localized and temporary adverse impacts to water quality and EFH may occur, but no significant, long-term impact is anticipated.

Turbidity is the only potential water quality impact from detonations, since products from the detonation of high explosives are non-hazardous (e.g., CO, CO_2, H_2, H_2O, N_2, and NH_3). In shallow water, underwater explosions would resuspend sediments into the water column creating a turbidity plume. This would be a localized event and impacts would not be considered significant because the turbidity plume would eventually dissipate as particles return to the bottom and/or currents disperse the plume. Therefore, potential effects to water and sediment quality, and EFH from underwater demolitions are less than significant.

5.4 CUMULATIVE IMPACTS

Impacts to EFH were assessed based on single events and not necessarily cumulative events. Based on single events, some operations would result in temporary adverse impacts to FMP species. This finding was based on the generally small area that was affected, the relatively large size of the range complex, and the distribution of FMP species. For operations that occur in nearshore waters, there is a greater probability that operations could affect sensitive EFH, such as coral reefs. However, administrative controls reduce the likelihood of impacts to coral reefs and HAPC, such as conducting nearshore operations in less sensitive habitats, like sandy bottom habitat. Although there may still be adverse impacts to these less sensitive habitats, the impacts would be localized and temporary.

The cumulative effects would consist of numerous localized impacts from individual operations conducted through the year. During several major range exercises, such as RIMPAC and the Increased Tempo alternative, multiple operations could be conducted simultaneously over a relatively short period of time. Therefore, there are potential cumulative impacts to EFH and managed species. No long-term adverse impacts to EFH or managed species would be expected from these operations since individual operations could affect FMP species at the individual level due to localized impacts; however, no sensitive EFH or HAPC would be permanently affected by the operations. Therefore, EFH and managed species would unlikely to be affected at the population level with current rates of usage (and areas of usage).

5.5 CONCLUSIONS

Due to the mitigation measures implemented to protect sensitive habitats in nearshore waters, and the localized and temporary impacts of the proposed project and alternatives, it is concluded that the proposed project and alternatives would not significantly adversely affect EFH for the five major FMPs and their associated management units.

Table 5-1. Summary of Potential Impacts to EFH by Operation

Mission Area	Event	Operation Area	Brief Description of Operation	Potential Impacts to EFH			
				No Impact	Temporary or Localized Adverse Impact	Significant or Permanent Adverse Impact	Description of Impact and Mitigation Measures
OFFSHORE OPERATIONS							
Anti-Air Warfare	Air Combat Maneuver	W-188, 189, 190, 192, 193, 194	ACM includes basic flight maneuvers where aircraft engage in offensive and defensive maneuvering against each other.	**X**			**N/A**
	Air-to-Air Missile Exercise	W-188	In an A-A MISSILEX, missiles are fired from aircraft against unmanned aerial target drones such as BXM-34s and BQM-74s. Typically, about half of the missiles fired have live warheads and half have telemetry packages. The fired missiles and targets are not recovered, with the exception of the BQMs, which have parachutes and will float to the surface where they are recovered by boat.		**X**		Potential impacts to EFH due to: • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.
	Surface-to-Air Gunnery Exercise	W-188, 192, Mela South	Gunnery training operations involve the use of highly automated guns against aerial targets. Crews respond to threats from air attack and surface-skimming missiles that require extremely fast reaction times and a heavy volume of fire. The exercise involves 1 to 10 surface vessels, towed aerial targets, and/or jet aerial targets. Ship-deployed and air-deployed weapons systems are used, ranging from 20 mm to 5 inch caliber guns.				Potential impacts to EFH due to: • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.
	Surface-to-Air Missile Exercise	W-188	A Surface-to-Air MISSILEX involves surface combatants firing live missiles (RIM-7 Sea Sparrows, SM-1 or SM-2 Standard Missiles) at target drones. The exercise consists of one or more surface ships, one or more target drones, and a helicopter and weapons recovery boat for target recovery.		**X**		Potential impacts to EFH due to: • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.
	Chaff Exercise	Hawaii Offshore	A CHAFFEX trains aircraft and shipboard personnel in the use of chaff to counter antiship 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.		**X**		Potential impacts to EFH due to: • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to release of hazardous materials. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.

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				No Impact	Temporary or Localized Adverse Impact	Significant or Permanent Adverse Impact	Description of Impact and Mitigation Measures
Amphibious Warfare (AMW)	Naval Surface Fire Support Exercise	W-188	Navy surface combatants conduct fire support exercise (FIREX) operations at PMRF on a virtual range against "Fake Island", located on BARSTUR. Ships conducting FIREX training against targets on the island are given the coordinates and elevation of targets.	X			N/A
Anti-Surface Warfare (ASUW)	Visit, Board, Search, and Seizure	Hawaii Offshore	Visit, Board, Search, and Seizure (VBSS) is conducted to train helicopter crews to insert personnel onto a vessel for the purpose of inspecting the ship's personnel and cargo for compliance with applicable laws and sanctions.	X			N/A
	Surface-to-Surface Gunnery Exercise	W-191, 192, 193, 194, 196, Mela South, PMRF	GUNEX training operations conducted in the Offshore OPAREA involve stationary targets such as a MK-42 Floating At Sea Target (FAST) or a MK-58 marker (smoke) buoy.		X		Potential impacts to EFH due to: • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to increased turbidity. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.
	Surface-to-Surface Missile Exercise	Pacific Missile Range Facility (PMRF) (W-188)	Surface-to-surface missile exercise (MISSILEX [S-S]) involves the attack of surface targets at sea by use of cruise missiles or other missile systems, usually by a single ship conducting training in the detection, classification, tracking and engagement of a surface target.		X		Potential impacts to EFH due to: • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.
	Air-to-Surface Gunnery Exercise	Hawaii Offshore, PMRF	Air-to-Surface GUNEX operations are conducted by rotary-wing aircraft against stationary targets (FAST and smoke buoy).		X		Potential impacts to EFH due to: • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.

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Mission Area	Event	Operation Area	Brief Description of Operation	Potential Impacts to EFH			
				No Impact	Temporary or Localized Adverse Impact	Significant or Permanent Adverse Impact	Description of Impact and Mitigation Measures
Anti-Surface Warfare (ASUW) (Continued)	Air-to-Surface Missile Exercise	PMRF	The air-to-surface missile exercise (MISSILEX [A-S]) consists of the attacking platform releasing a forward-fired, guided weapon at the designated towed target.		X		Potential impacts to EFH due to: • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.
	Bombing Exercise (Sea)	Hawaii Offshore, PMRF	Fixed-wing aircraft conduct BOMBEX (Sea) operations against stationary targets (MK-42 FAST or MK-58 smoke buoy) at sea.		X		Potential impacts to EFH due to: • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.
	Sink Exercise	Hawaii Offshore, PMRF	A SINKEX provides training to ship and aircraft crews in delivering live ordnance on a real target. Each 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 ship hull that is towed to a designated location where various platforms would use multiple types of weapons to fire shots at the hulk.		X		Potential impacts to EFH due to: • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.
	Antisurface Warfare Torpedo Exercise (Submarine-Surface)	Hawaii Offshore, PMRF	Surface targets will typically be PMRF range boats or targets, or US Navy combatants. The ASUW TORPEX culminates with the submarine firing a MK-48 torpedo against the surface target.		X		Potential impacts to EFH due to: • Sonar may injure or kill FMP species in close proximity to the source, and displace prey items. • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.

Table 5-1. Summary of Potential Impacts to EFH by Operation

Mission Area	Event	Operation Area	Brief Description of Operation	Potential Impacts to EFH			
				No Impact	Temporary or Localized Adverse Impact	Significant or Permanent Adverse Impact	Description of Impact and Mitigation Measures
Anti-Submarine Warfare (ASW)	Antisubmarine Warfare Tracking Exercise	Hawaii Offshore, PMRF	ASW TRACKEX trains aircraft, ship, and submarine crews in tactics, techniques, and procedures for search, detection, localization, and tracking of submarines. The use of sonobuoys is generally limited to areas greater than 100 fathoms, or 600 feet, in depth.		X		Potential impacts to EFH due to: • Sonar may injure or kill FMP species in close proximity to the source, and displace prey items. • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.
	Antisubmarine Warfare Torpedo Exercise	Hawaii Offshore, PMRF	ASW TORPEX operations train crews in tracking and attack of submerged targets, using active or passive acoustic systems, and firing one or two Exercise Torpedoes (EXTORPs) or Recoverable Exercise Torpedoes (REXTORPs). TORPEX targets used in the Offshore Areas include live submarines, MK-30 ASW training targets, and MK-39 Expendable Mobile ASW Training Targets (EMATT).		X		Potential impacts to EFH due to: • Sonar may injure or kill FMP species in close proximity to the source, and displace prey items. • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.
	Major Integrated ASW Training Exercise	Hawaii Offshore, PMRF	ASW training conducted during a major integrated ASW training exercise utilizes ships, submarines, aircraft, non-explosive exercise weapons, and other training systems and devices. These large scale ASW exercises occur as part of RIMPAC, USWEX, or any other exercise where one or more CSGs converge to train in the range complex.		X		Potential impacts to EFH due to: • Sonar may injure or kill FMP species in close proximity to the source, and displace prey items. • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.
Electronic Combat (EC)	Electronic Combat Operations	W-188, 192, 193, 194, Lono West, Mela South	Electronic Combat (EC) operations consist of air-, land-, and sea-based emitters simulating enemy systems and stimulating air, surface and submarine electronic support measures (ESM) and electronic countermeasures (ECM) systems.	X			**N/A**

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				No Impact	Temporary or Localized Adverse Impact	Significant or Permanent Adverse Impact	Description of Impact and Mitigation Measures
Mine Warfare (MIW)	Mine Countermeasures Exercise	PMRF, Maui Basin	Mine Countermeasures (MCM) exercises train forces to detect, identify, classify, mark, avoid, and/or disable mines using a variety of methods including air, surface, sub-surface, and ground assets.	X			N/A
Naval Special Warfare (NSW)	Swimmer Insertion/Extraction	Hawaii Offshore, MCTAB, PMRF	Naval Special Warfare (NSW) personnel conduct underwater swimmer insertion and extraction training in the Hawaii Offshore Areas using either the SEAL Delivery Vehicle (SDV), or the Advanced SEAL Delivery System (ASDS).	X			N/A
Strike Warfare (STW)	Bombing Exercise (Land)	Kaula Rock, PTA	Transiting CSG fixed-wing aircraft account for all of the Navy BOMBEX operations at Kaula Rock. Only inert ordnance 500 pounds or less is authorized for use on Kaula Rock.	X			N/A
	Air-to-ground Gunnery Exercise	Kaula Rock	GUNEX (A-G) includes live-fire gunnery training from fixed- or rotary-wing aircraft. 20mm and 30mm cannon fire is not allowed from November through May.	X			N/A
Other	Command and Control (C2)	U.S. Command Ship at sea	The purpose of the C2 activities is to provide continuous command and control support for ongoing training operations and for major exercises.	X			N/A
NEARSHORE OPERATIONS							
AMW	Expeditionary Assault	PMRF, MCTAB	Expeditionary Assault consists of a seaborne force from over the horizon assaulting across a beach. Amphibious landings are restricted to specific areas of designated beaches. Before each major amphibious landing exercise is conducted, a hydrographic survey will be performed to map out the precise transit routes through sandy bottom areas.		X		Potential impacts to EFH due to: • Disturbance to FMP species, and loss of benthic epifauna and infauna that may serve as prey items for managed species. • Temporary impacts to water quality due to increased turbidity. Mitigation Measures: • Amphibious landings are restricted to specific areas of designated beaches. • A hydrographic survey is performed to map out the precise transit routes through sandy bottom areas.
ASUW	Flare Exercise	W-188	A flare exercise is an aircraft defensive operation in which the aircrew attempts to cause an infrared (IR) or radar energy source to break lock with the aircraft.		X		Potential impacts to EFH due to: • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to release of hazardous materials. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.

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MIW	Mine Neutralization	Puuloa Underwater Range	Tactics for neutralization of ground or bottom mines involve the diver placing a specific amount of explosives, which when detonated underwater at a specific distance from a mine results in neutralization of the mine. Floating, or moored, mines involve the diver placing a specific amount of explosives directly on the mine. Floating mines encountered by fleet ships in open-ocean areas will be detonated at the surface.		X		Potential impacts to EFH due to: • Death or injury to FMP species, and loss of benthic epifauna and infauna that may serve as prey items for managed species. • Temporary impacts to water quality due to increased turbidity. Mitigation Measures: • Sandy areas that avoid/minimize potential impacts to coral are used for explosive charges
	Mine Laying	PMRF	The use of inert exercise mines is generally limited to areas greater than 100 fathoms, or 600 feet in depth. The mine can be designed to float on the surface or near surface or to sink on a tether.		X		Potential impacts to EFH due to: • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • No impacts to water or sediment quality since inert mines are used. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.
NSW	Swimmer Insertion/Extraction	Hawaii Offshore, MCTAB, PMRF	Naval Special Warfare (NSW) personnel conduct underwater swimmer insertion and extraction training in the Hawaii Offshore Areas using either the SEAL Delivery Vehicle (SDV), or the Advanced SEAL Delivery System (ASDS).	X			**N/A**
Other	Salvage Operations	Pearl Harbor, Puuloa Underwater Range, Keehi Lagoon	The purpose of Salvage Operations is to provide a realistic training environment for fire at sea, de-beaching of ships, and harbor clearance operations training by U.S. Navy diving and salvage units.		X		Potential impacts to EFH due to: • Temporary impacts to water quality due to release of hazardous materials. Mitigation Measures: • A surface safety zone around the diving and salvage operations to ensure diver safety during operating procedures and emergency situations.
	In Port Support Operations	Pearl Harbor	In-port support includes the typical operations that are carried out when foreign and U.S. warships and submarines are berthed at Pearl Harbor. This includes in port briefings and debriefings and in-port training activities, including oil spill response training. Once berthed, ships would re-supply, plan for refueling, load ammunition, and conduct other maintenance activities, including the off loading of solid wastes and wastewater (black and gray water).	X			**N/A**

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				No Impact	**Temporary or Localized Adverse Impact**	**Significant or Permanent Adverse Impact**	**Description of Impact and Mitigation Measures**
RDT&E							
Research, Development, Test, and Evaluation (RDT&E)	Anti-air Warfare Research, Development, Test, and Evaluation (RDT&E)	PMRF	AAW RDT&E operations include post construction test and training, which is performed on Aegis capable ships after refurbishment or overhaul.	**X**			**N/A**
	Antisubmarine Warfare	PMRF	ASW T&E operations at PMRF include sensor, fire control and weapon testing.	**X**			**N/A**
	Combat System Ship Qualification Trial	PMRF	CSSQT is conducted for new ships and for ships that have undergone modification and/or overhaul of their combat systems. The primary goals are to ensure that the ship's equipment and combat systems are in top operational condition, and that the ship's crew is proficient at operating these systems.	**X**			**N/A**
	Electronic Combat/Electronic Warfare	PMRF	EC/EW operations include events designed to evaluate EC/EW exercises.	**X**			**N/A**
	High Frequency	PMRF	High frequency T&E operations include those events where high frequency radio signals are evaluated.	**X**			**N/A**
	Joint Task Force Wide Area Relay Network	PMRF	JTF WARNET is a demonstration of advanced Command, Control and Communications (C3) technologies in a highly mobile, wireless, wide-area relay network in support of tactical forces.	**X**			**N/A**
	Missile Defense	PMRF	Missile training exercises conducted at PMRF include general air-to-air, air-to-surface, surface-to-air, and surface-to-surface missile exercises; specific anti-surface missile exercises; AAW exercises.		**X**		Potential impacts to EFH due to: • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.

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				No Impact	Temporary or Localized Adverse Impact	Significant or Permanent Adverse Impact	Description of Impact and Mitigation Measures
	Science & Technology / Other	PMRF	PMRF operations include one-of-a-kind or short duration RDT&E events conducted for both government and commercial customers. Examples of these include Acoustic Data Acquisition System (ADAS), Littoral Airborne Sensor Hyper-spectral (LASH) evaluations, humpback whale detection, UHF Electronically Scanned Array (UESA), Maritime Synthetic Range, numerous System Integration Checkout (SICO) operations, and electromagnetic interference/electronic countermeasures (EMI/ECM).	**X**			**N/A**
Research, Development, Test, and Evaluation (RDT&E) (Continued)	Terminal High Altitude Area Defense	PMRF	THAAD is the antimissile system designed to intercept and destroy missiles in the final phase of their trajectories.		**X**		Potential impacts to EFH due to: • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.
	Fleet Operational Readiness Accuracy Check Site (FORACS) Tests	FORACS	The purpose of the FORACS range is to provide accuracy checks of ship and submarine sonar, both in active and passive modes.		**X**		Potential impacts to EFH due to: • Sonar may injure or kill FMP species in close proximity to the source, and displace prey items. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC.
	Shipboard Electronic Systems Evaluation Facility (SESEF) Quick Look Tests	SESEF / Pearl Harbor	Quick look (Q/L) tests are generally conducted during transit to and from port, or while pier side at Pearl Harbor.	**X**			**N/A**
	SESEF System Performance Tests	SESEF	System performance testing provides the ship with a detailed analysis and evaluation of the system(s) under test.	**X**			**N/A**

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				No Impact	Temporary or Localized Adverse Impact	Significant or Permanent Adverse Impact	Description of Impact and Mitigation Measures
MAJOR RANGE EVENTS							
Major Fleet Exercises	RIMPAC and USWEX	Various	A "Major Range Event" is defined as a significant operational employment during which several individual training or testing operations are conducted involving multiple NTAs, units, and capabilities that normally encompass a large area and last for several days. . Types of major range events that occur within the HRC are the RIMPAC Exercise and Undersea Warfare Exercise (USWEX). During RIMPAC, each phase of activity includes individual training operations in open ocean, nearshore, and onshore ranges. USWEX includes a single CSG or expeditionary strike group (ESG) training in the HRC for up to 4 days, four times per year.		X		Potential impacts to EFH due to: • Shock wave could injure or kill all life stages of fish and larvae of other marine organisms within the immediate area. • Debris may physically affect benthic habitats. • Temporary impacts to water quality due to increased turbidity and release of hazardous materials. • Sonar may injure or kill FMP species in close proximity to the source, and displace prey items. • Disturbance to FMP species, and loss of benthic epifauna and infauna that may serve as prey items for managed species. • Temporary impacts to water quality due to increased turbidity. • Death or injury to FMP species, and loss of benthic epifauna and infauna that may serve as prey items for managed species. Mitigation Measures: • Exercises conducted in open ocean away from sensitive EFH or HAPC. • Amphibious landings are restricted to specific areas of designated beaches. • Sandy areas that avoid/minimize potential impacts to coral are used for explosive charges

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APPENDIX A

Essential Fish Habitat

APPENDIX A

LIST OF FIGURES

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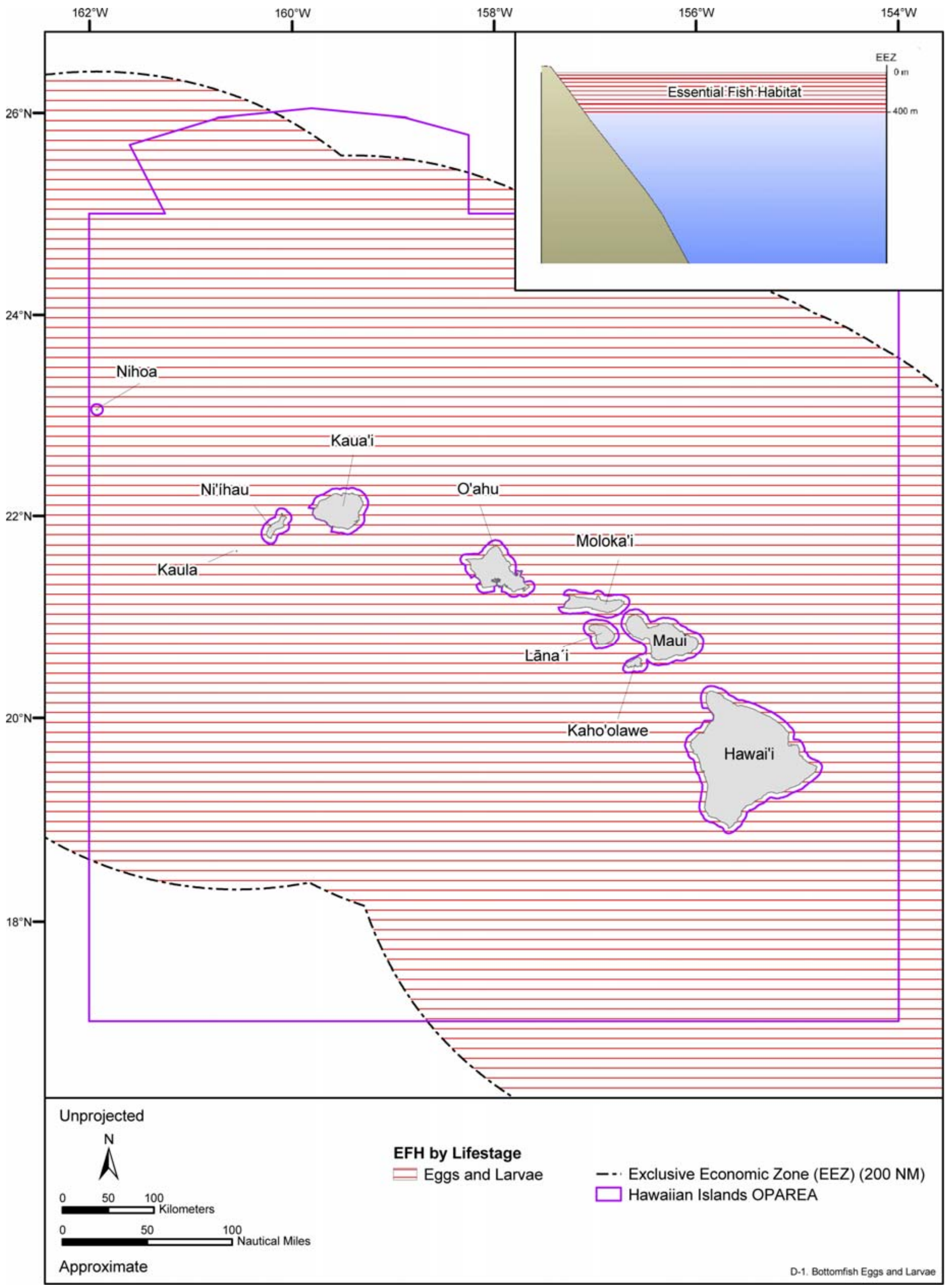


Figure A-1. EFH for all eggs and larval lifestages of bottomfish designated in the Hawaiian Islands OPAREA. Depth ranges noted in legend apply from shoreline to the outer limit of the EEZ. Map adapted from WPRFMC (1998) and GDAIS (2004).

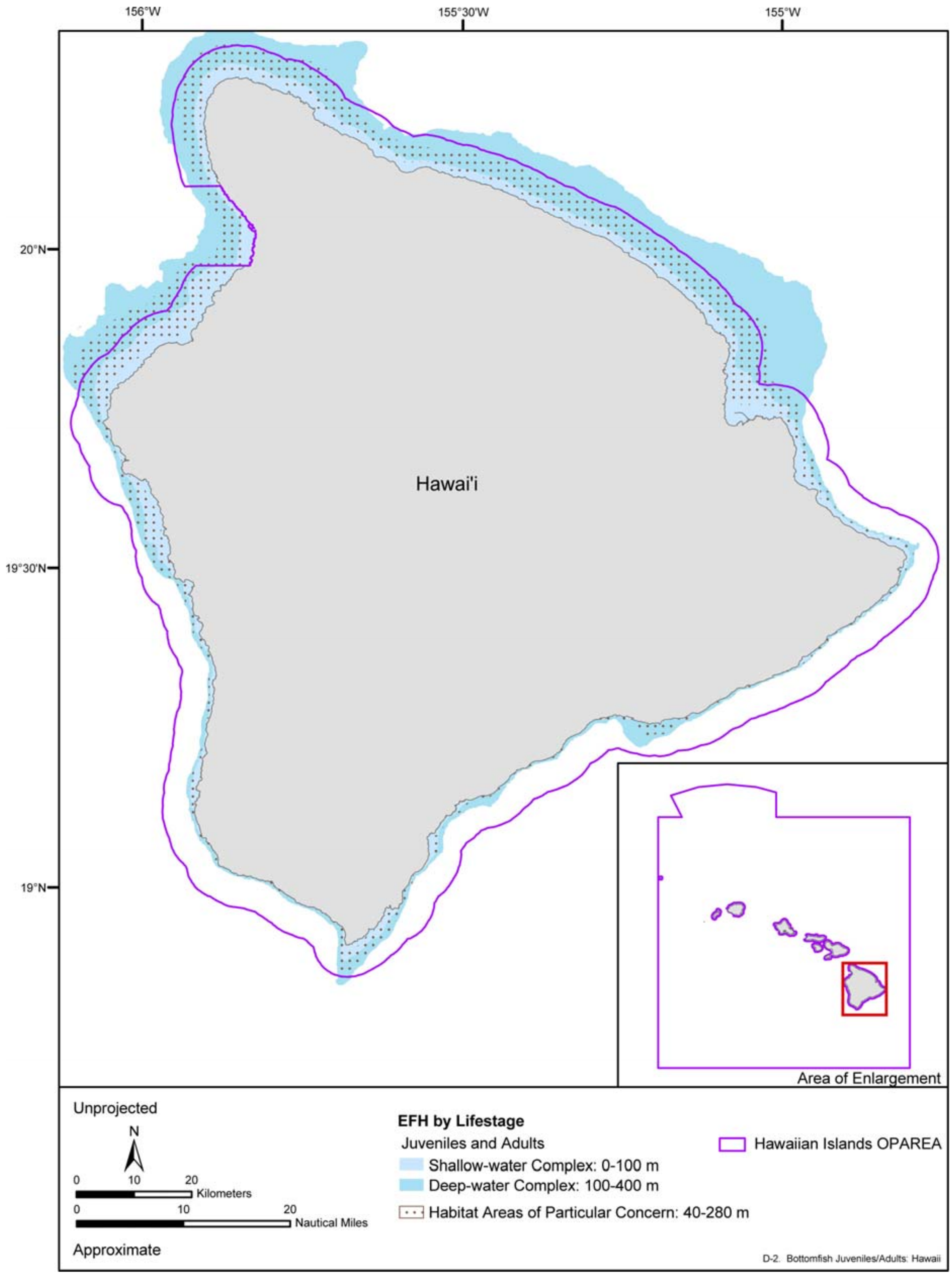
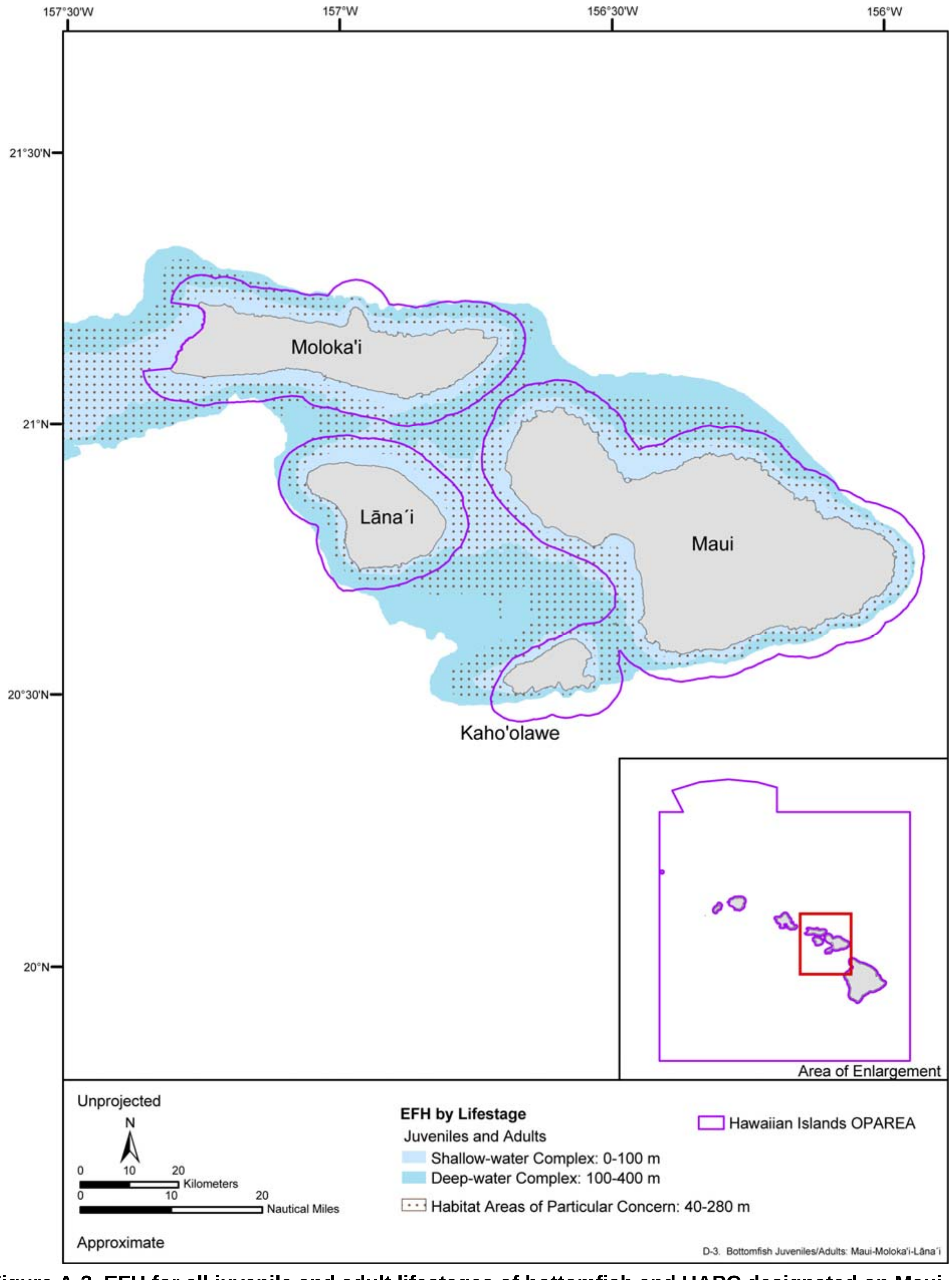


Figure A-2. EFH for all juvenile and adult lifestages of bottomfish and HAPC designated on the main island of Hawai'i in the Hawaiian Islands OPAREA. Map adapted from: WPRFMC (1998).



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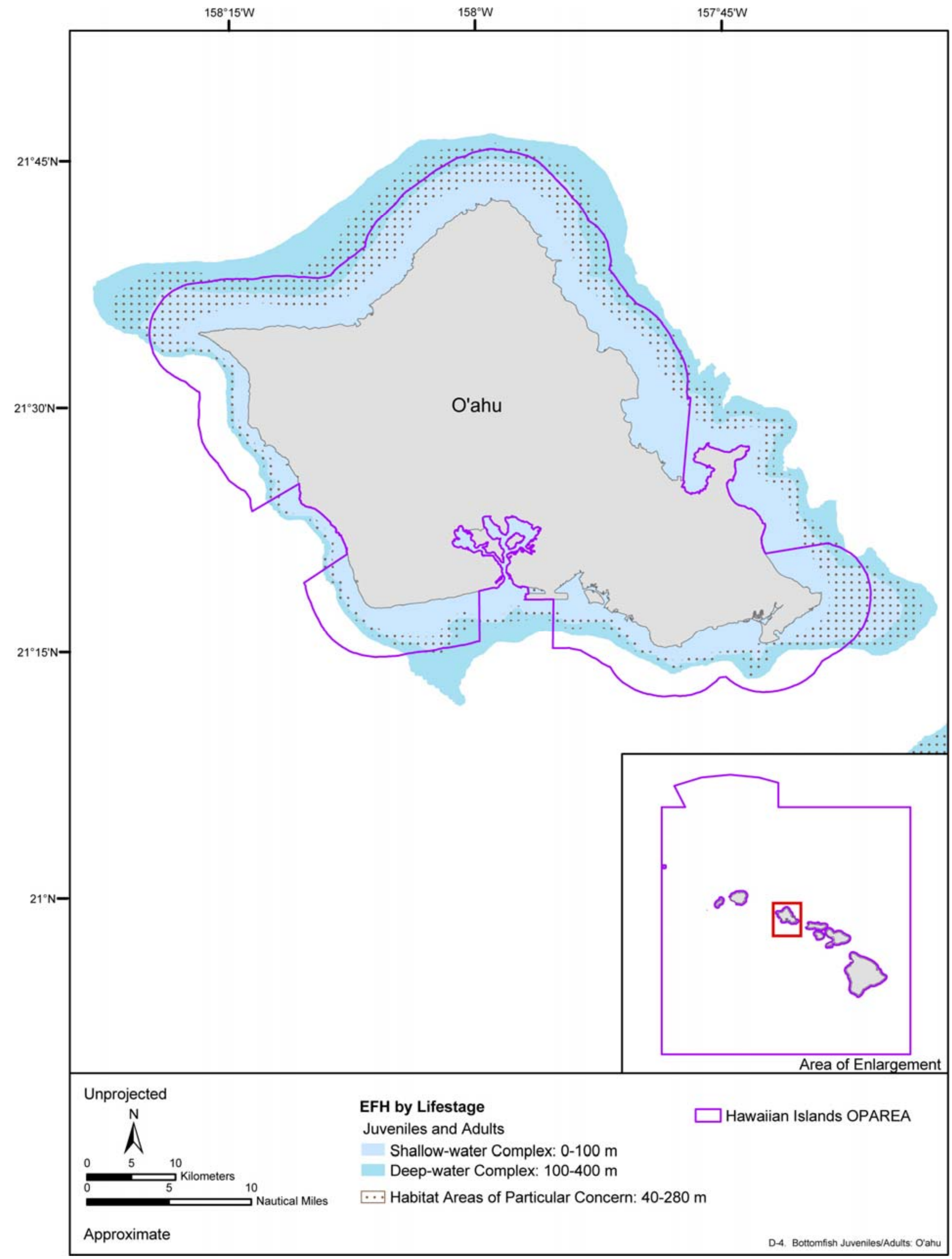

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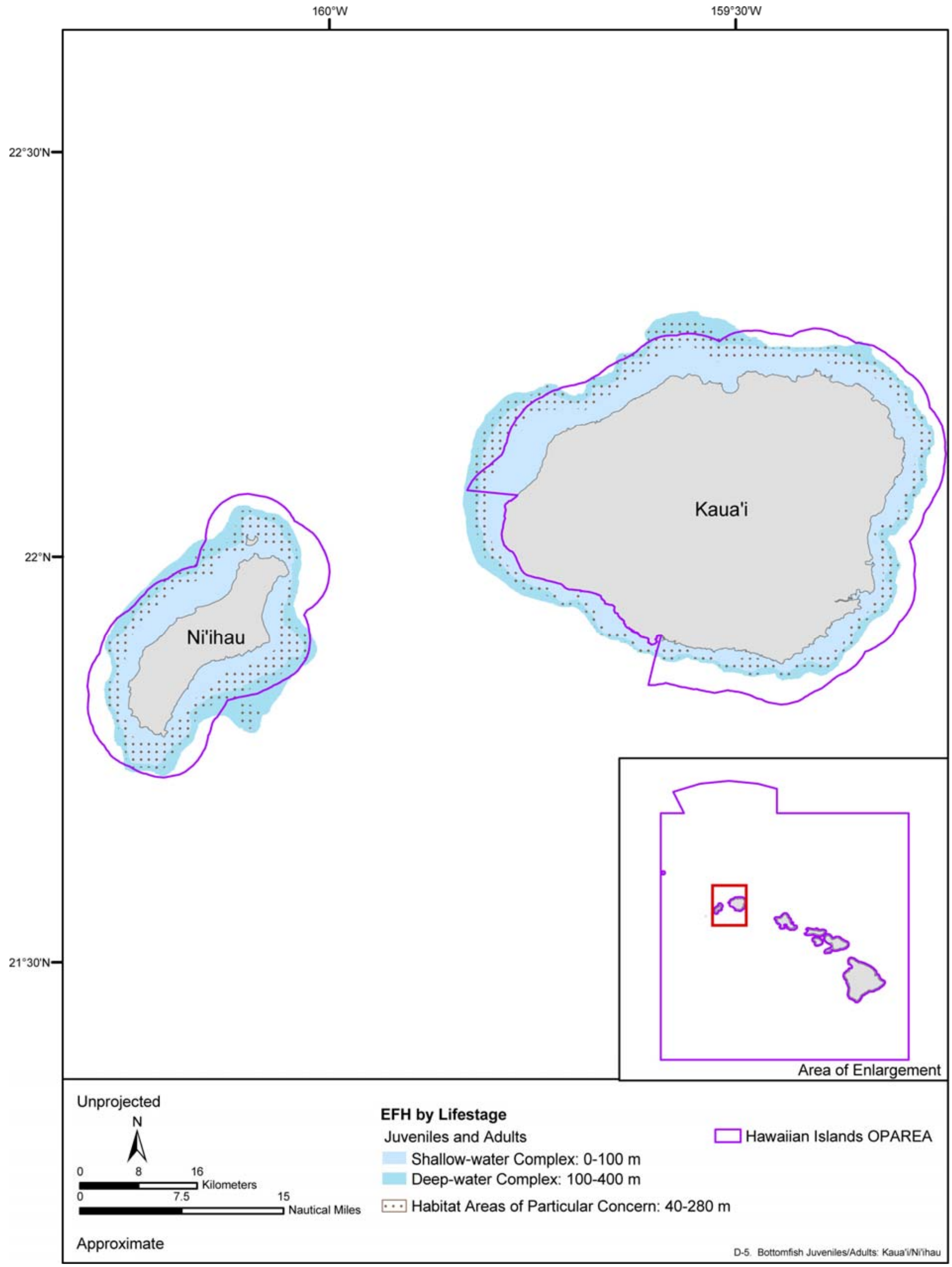


Figure A-5. EFH for all juvenile and adult lifestages of bottomfish and HAPC designated on Kaua‘i and Ni‘ihau in the Hawaiian Islands OPAREA. Map adapted from: WPRFMC (1998).

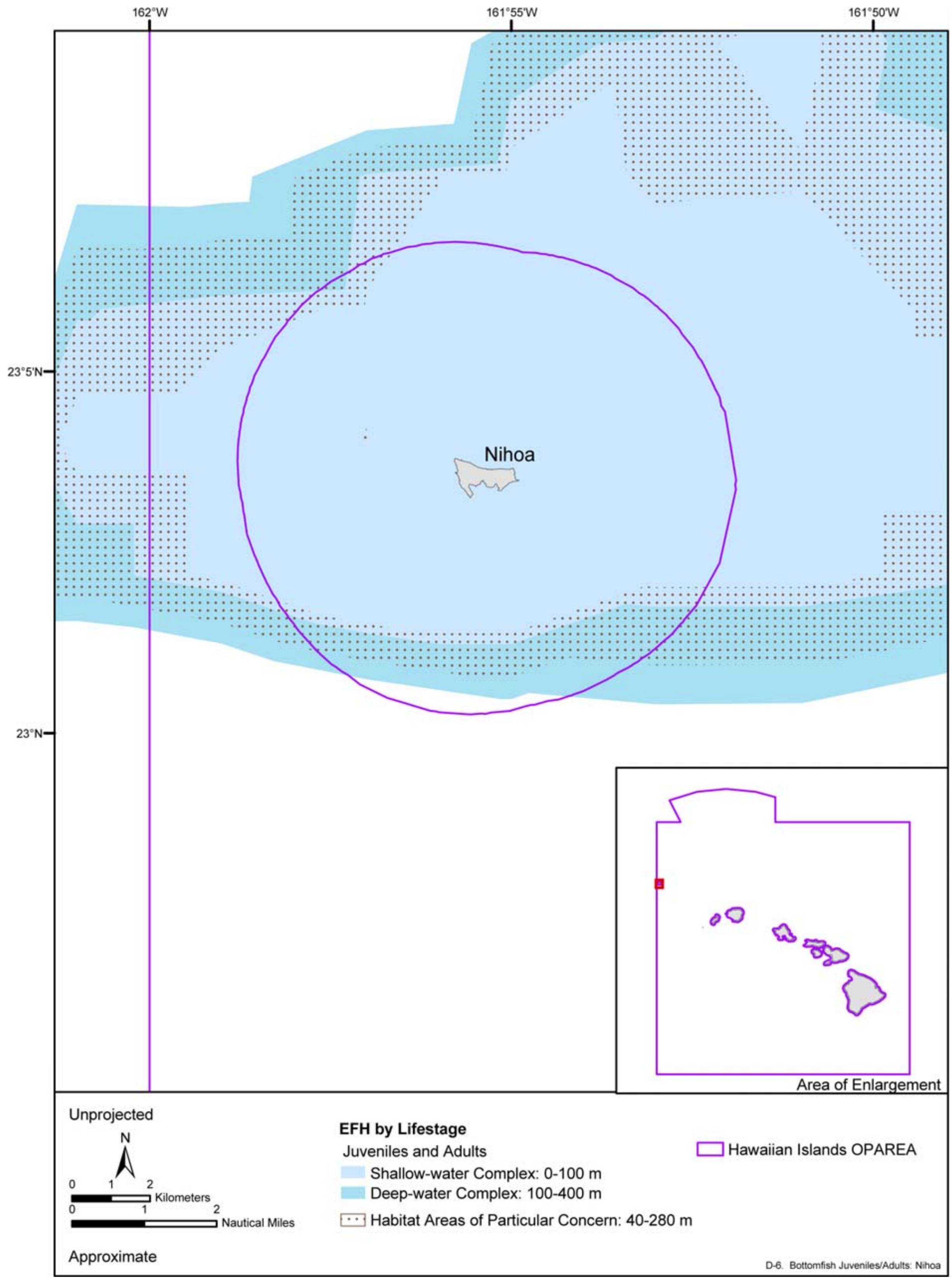


Figure A-6. EFH for all juvenile and adult lifestages of bottomfish and HAPC designated on Nihoa (NWHI) in the Hawaiian Islands OPAREA. Map adapted from: WPRFMC (1998).

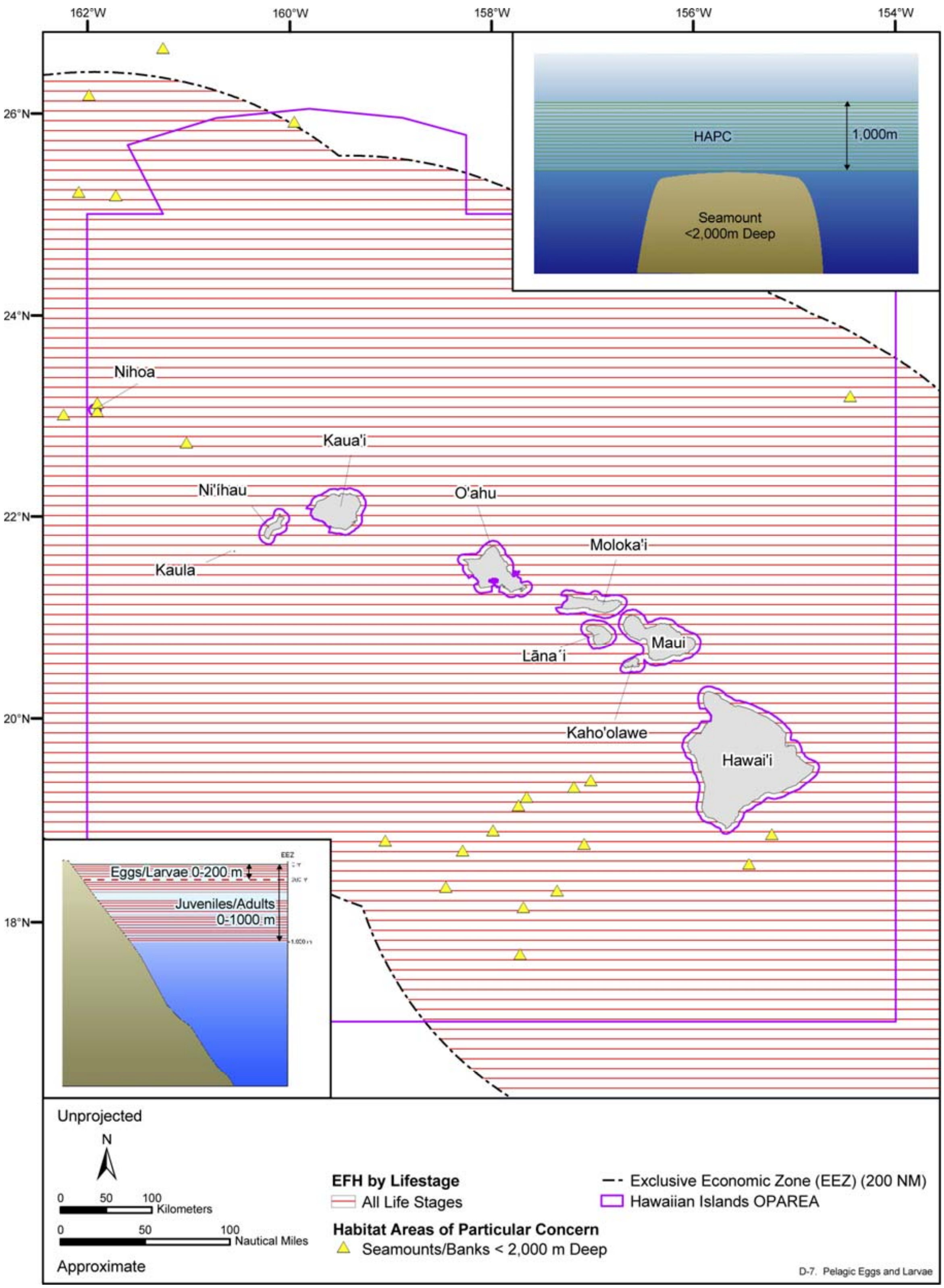
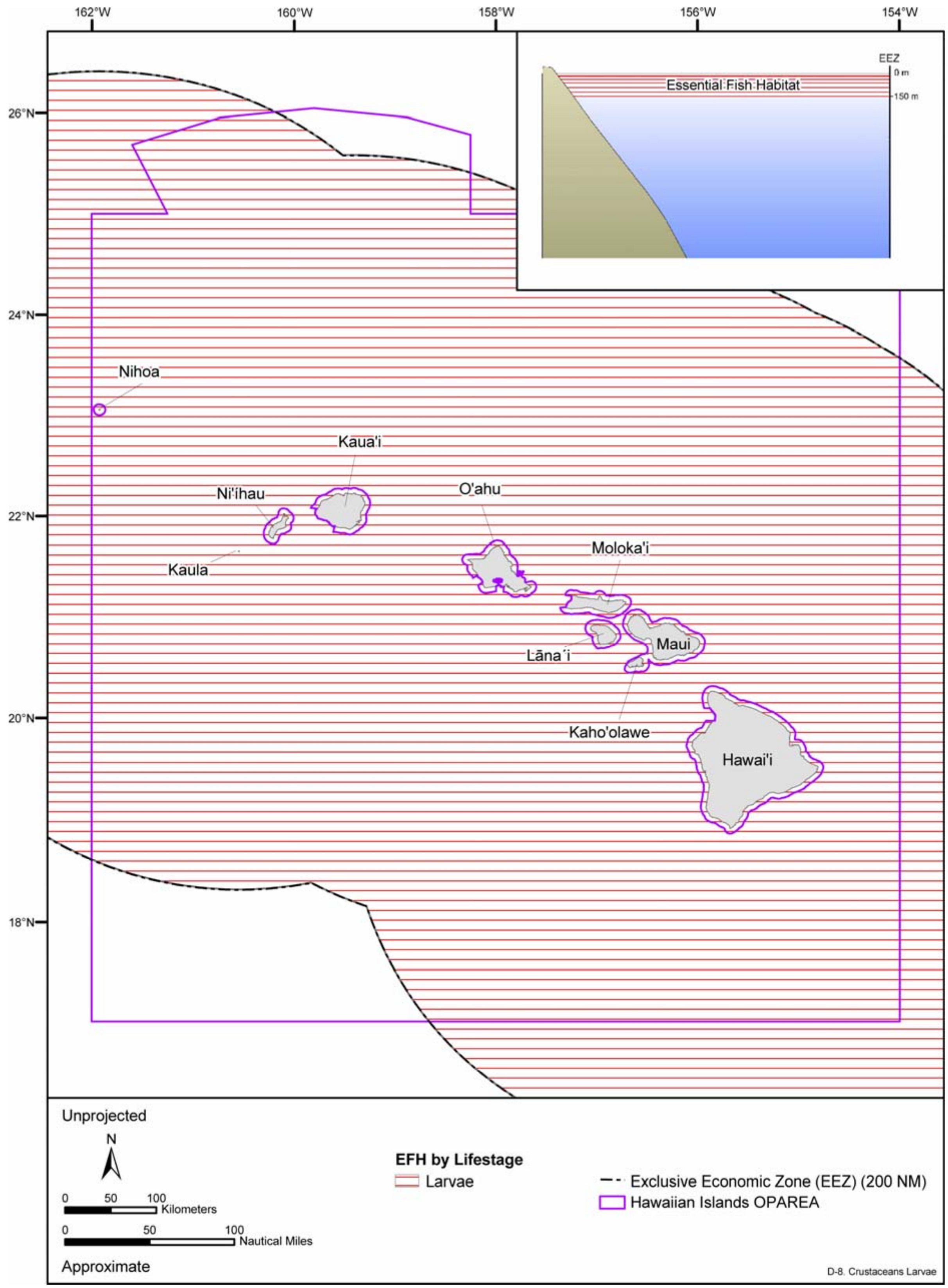


Figure A-7. EFH for all lifestages of pelagic fishes and HAPC designated in the Hawaiian Islands OPAREA. Depth ranges noted in legend apply from the shoreline to the outer limit of the EEZ. HAPC locations illustrate the vertical distributions associated with the seamounts and banks EFH designations. Map adapted from: WPRFMC (1998) and GDIAS (2004).



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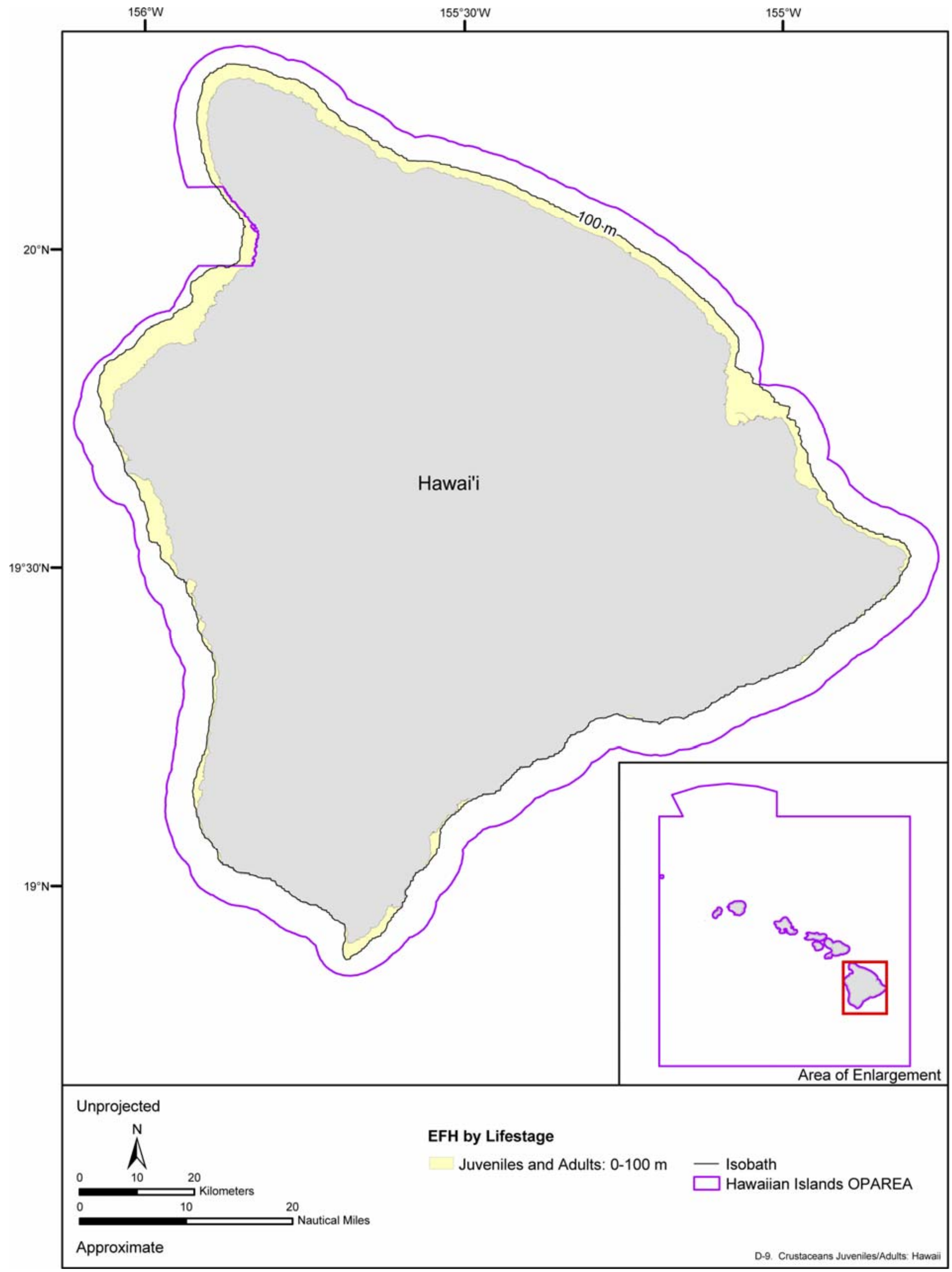
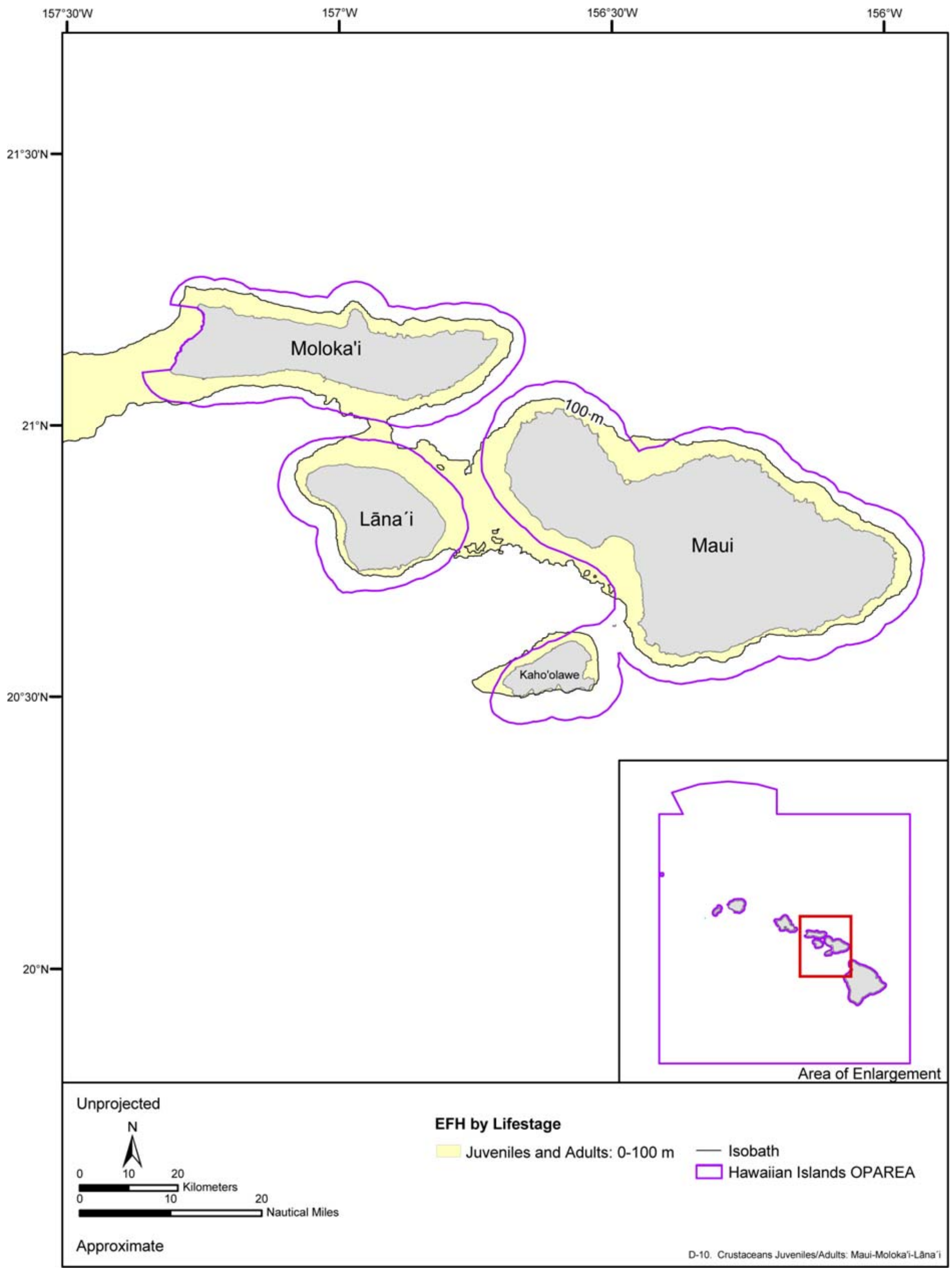


Figure A-9. EFH for all juvenile and adult lifestages of crustaceans designated on the main island of Hawai'i in the Hawaiian Islands OPAREA. Map adapted from: WPRFMC (1998).



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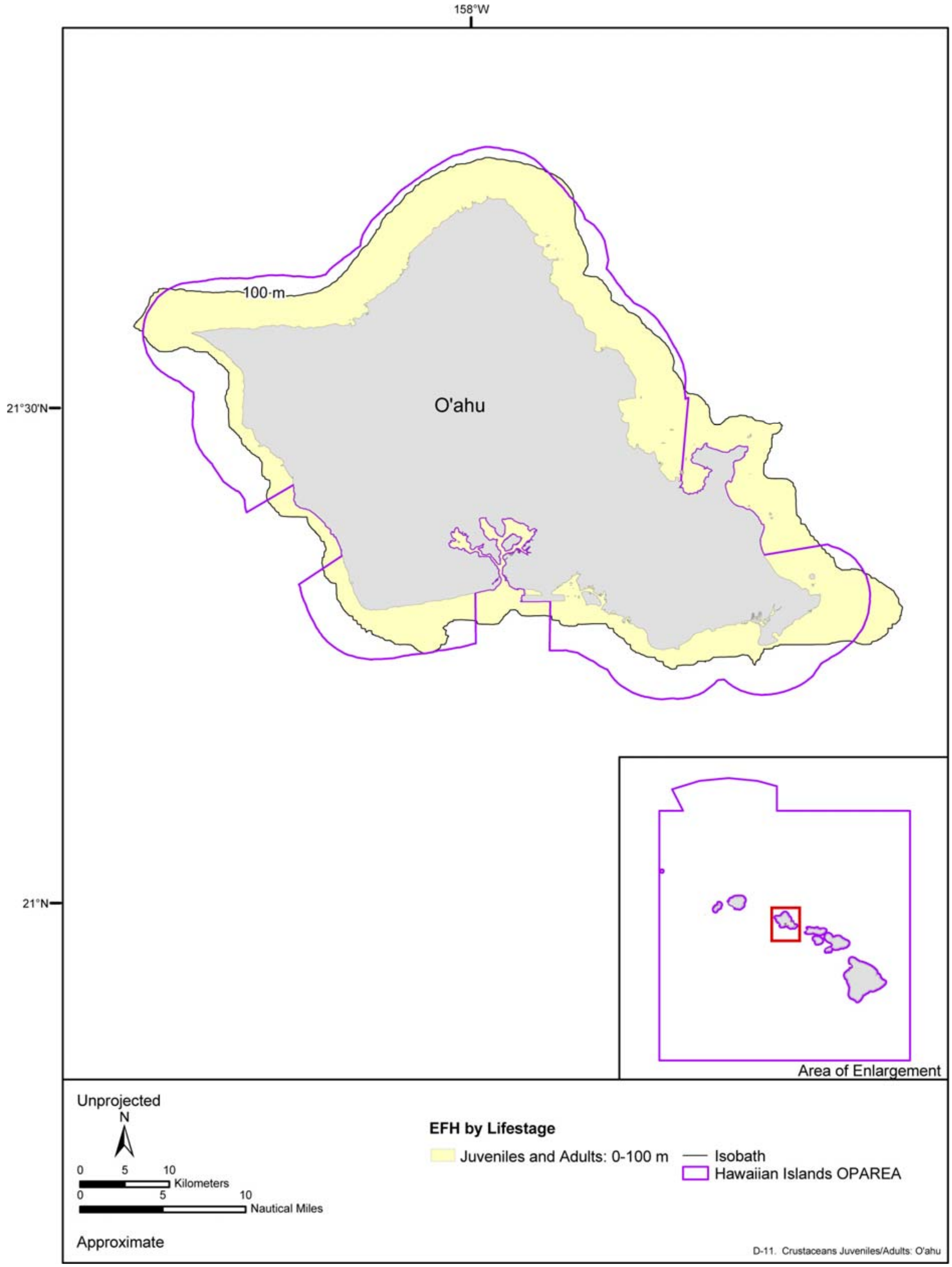

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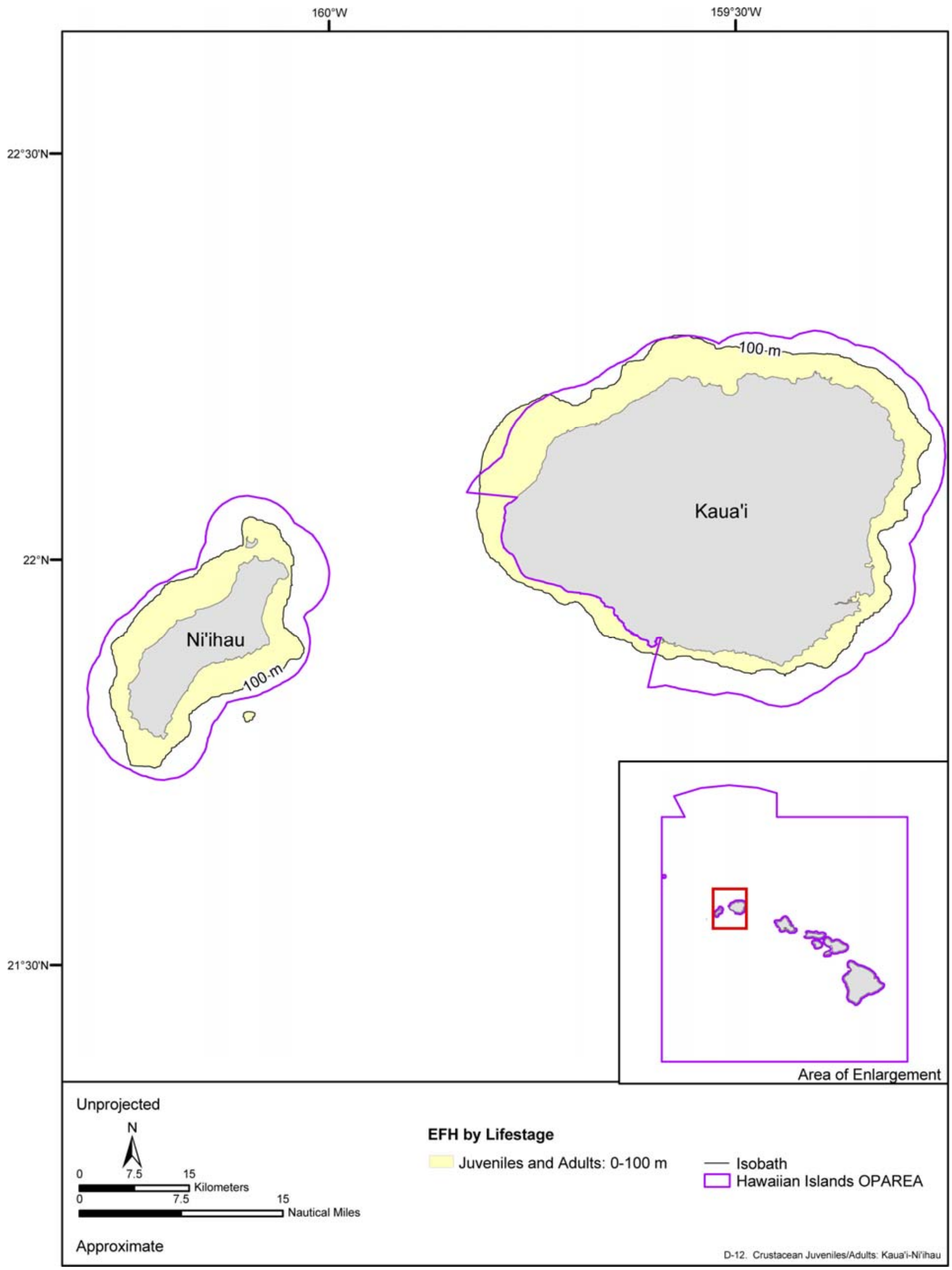

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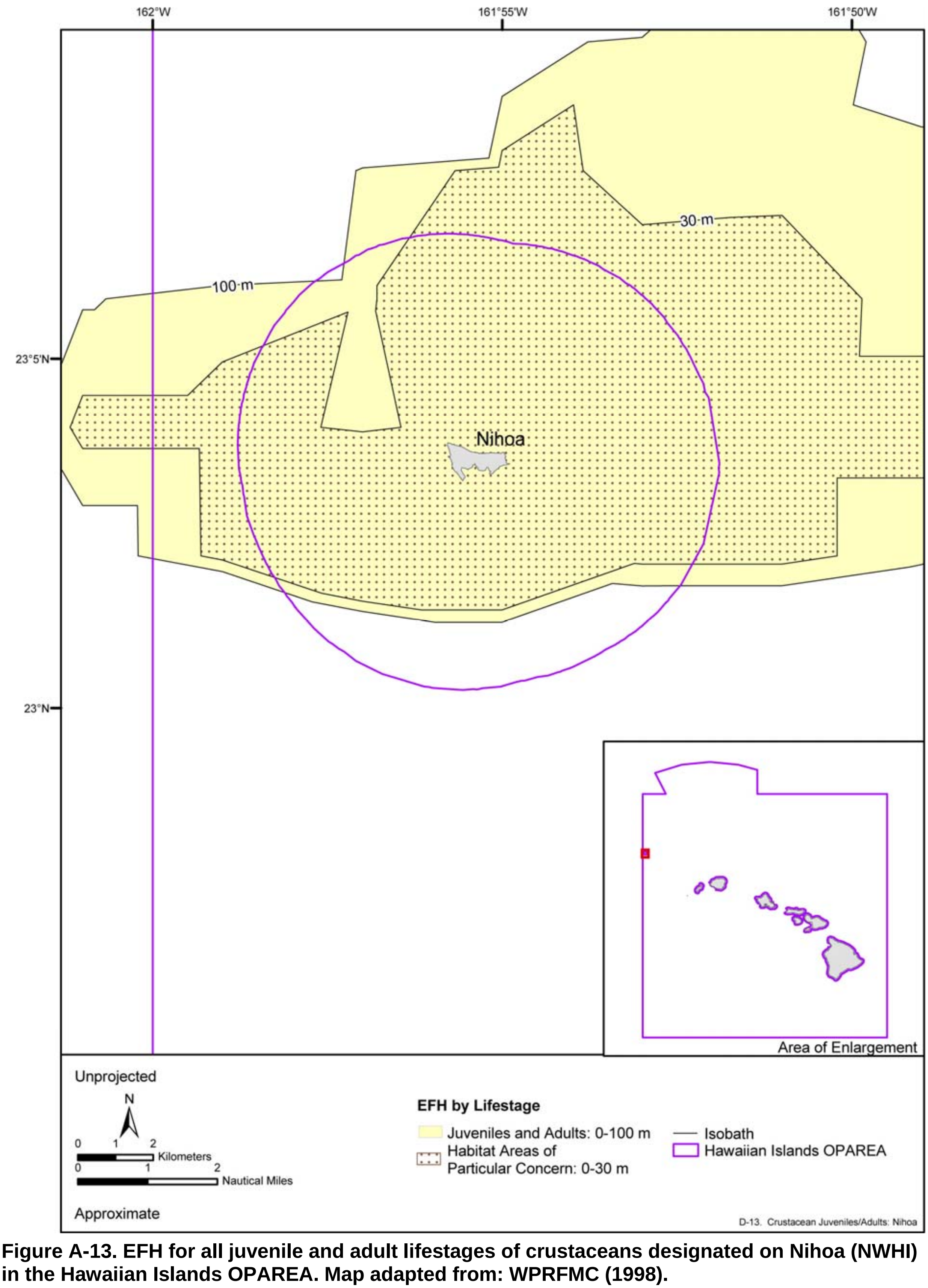

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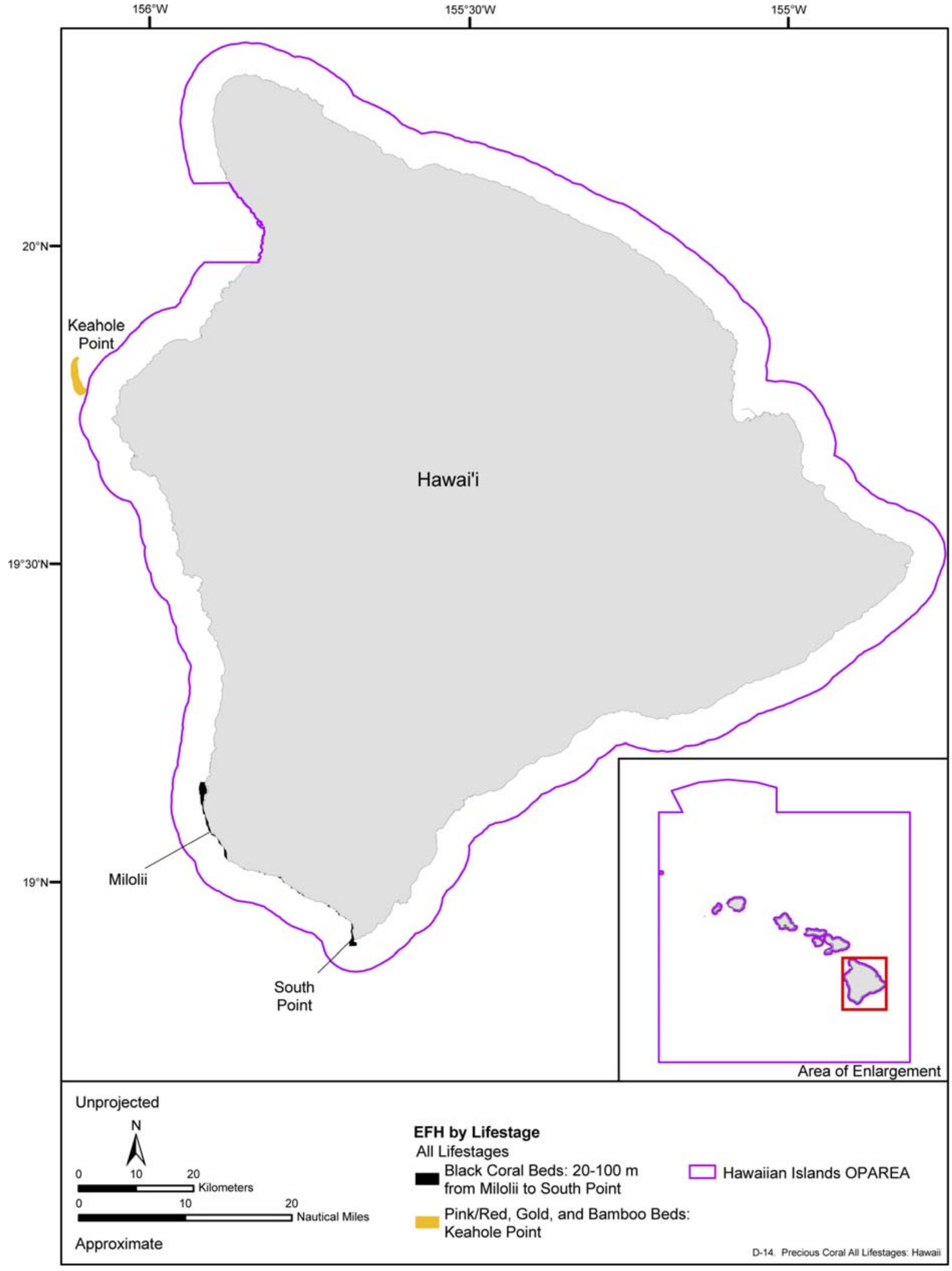
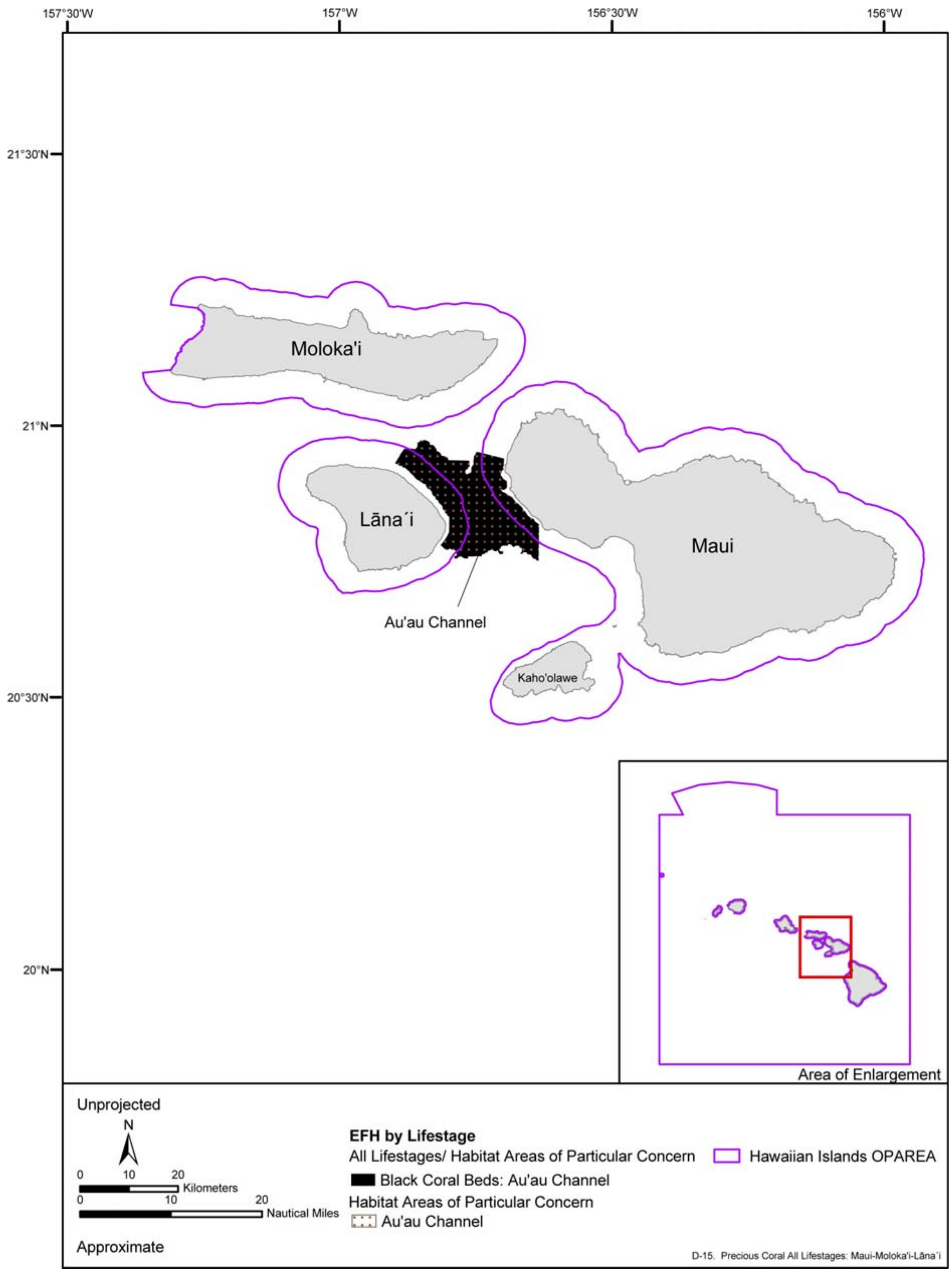


Figure A-14. EFH for all lifestages of precious corals (black, pink/red, gold, and bamboo) designated on the main island of Hawai'i in the Hawaiian Islands OPAREA. Map adapted from: WPRFMC (1998) and GDIAS (2004).



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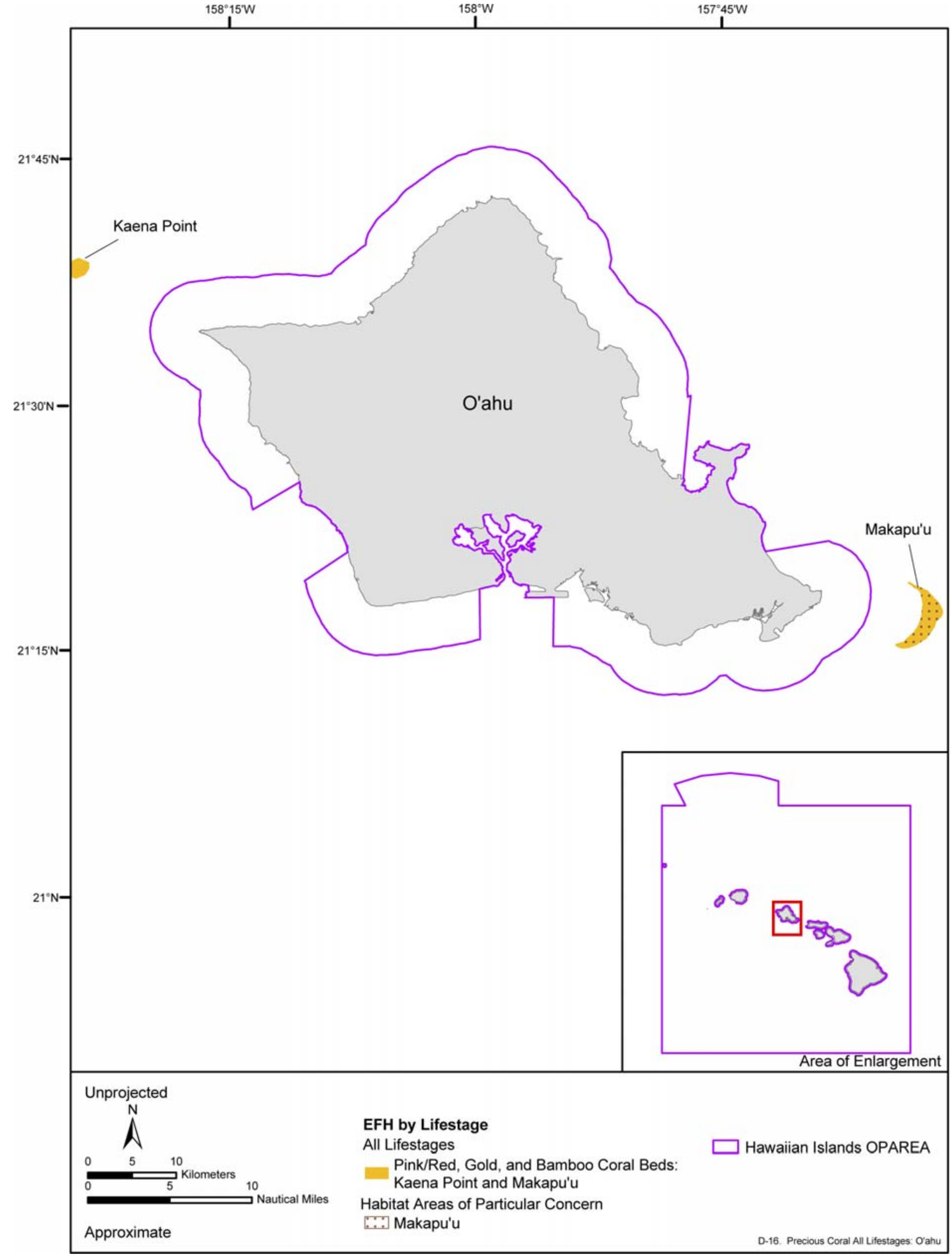

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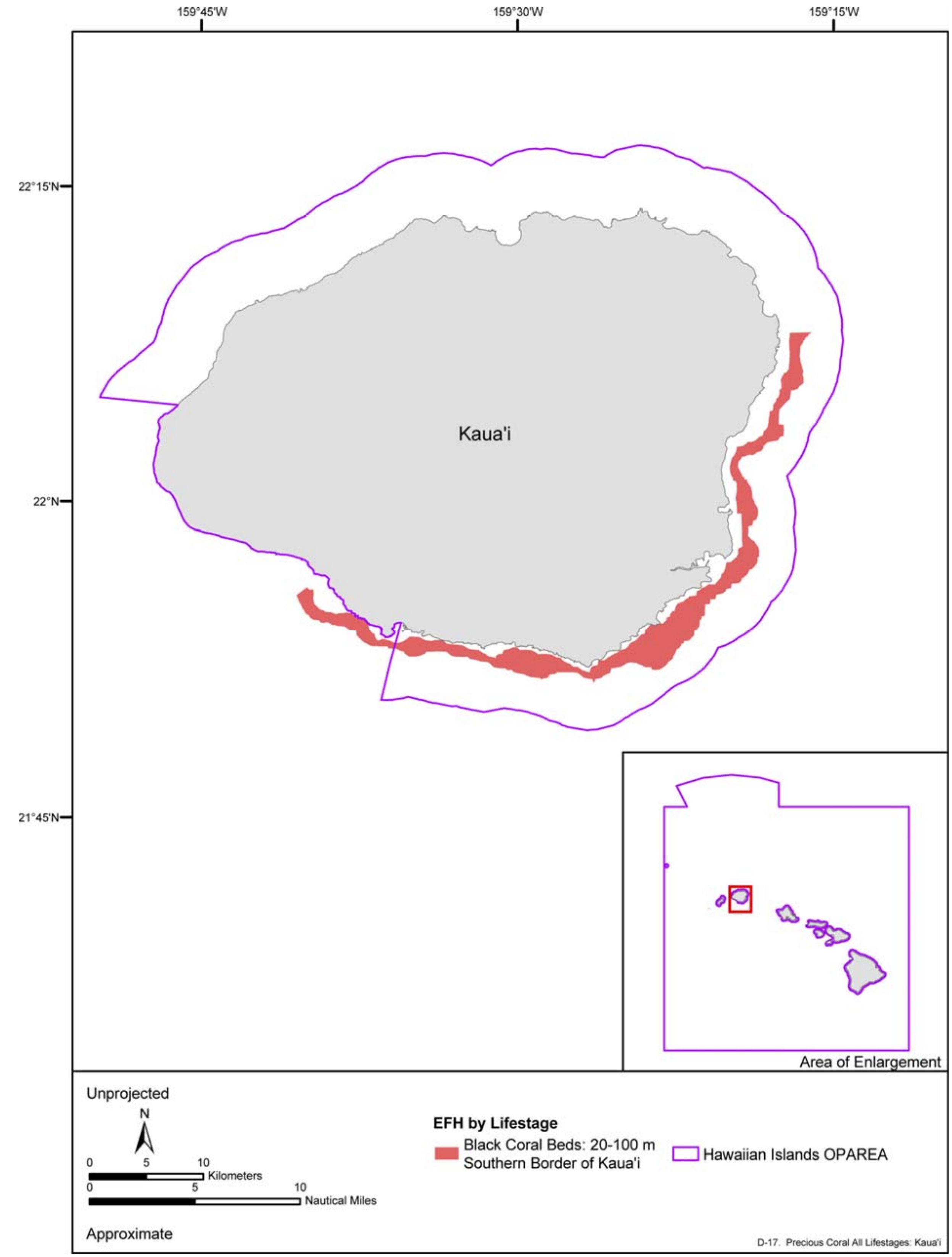

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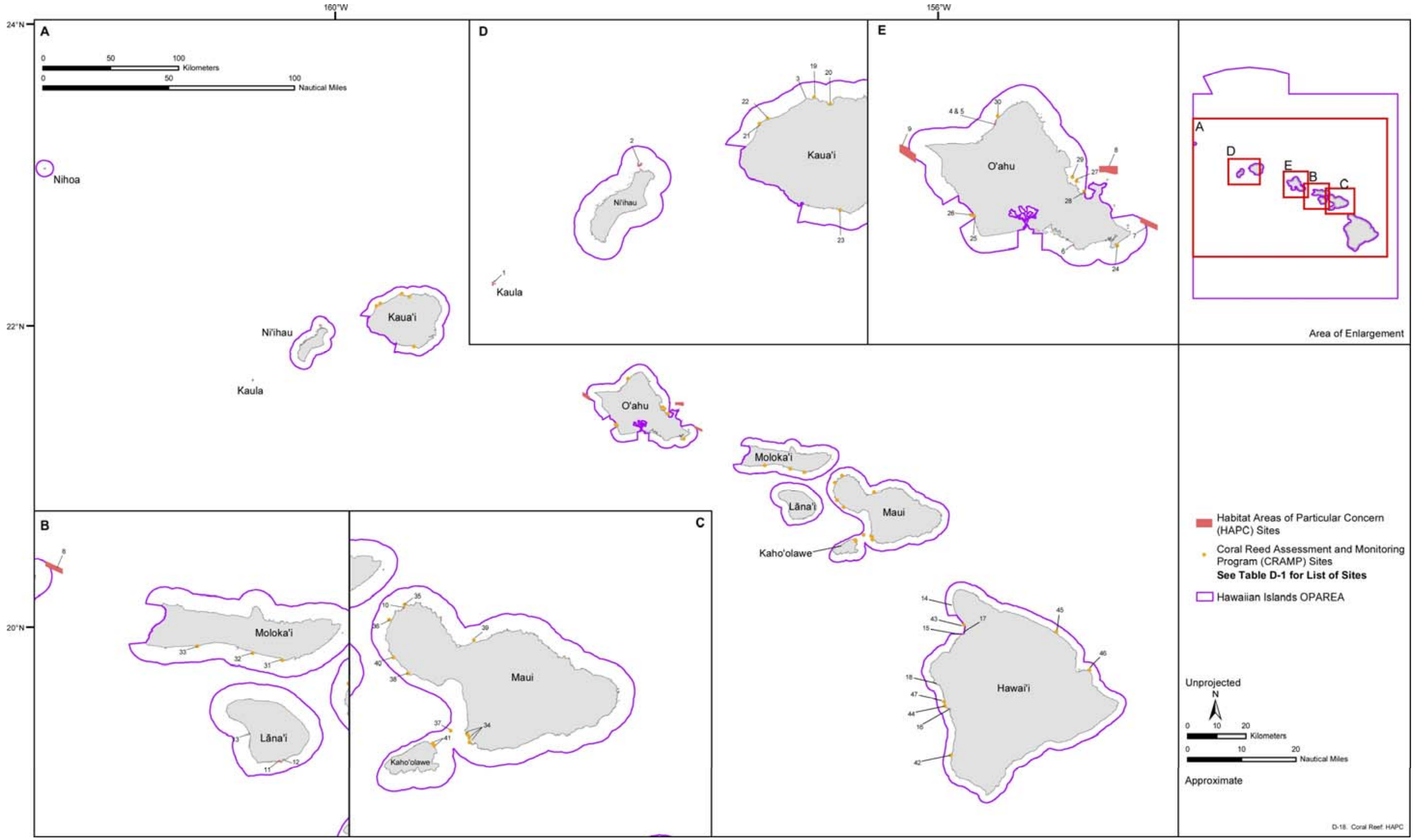

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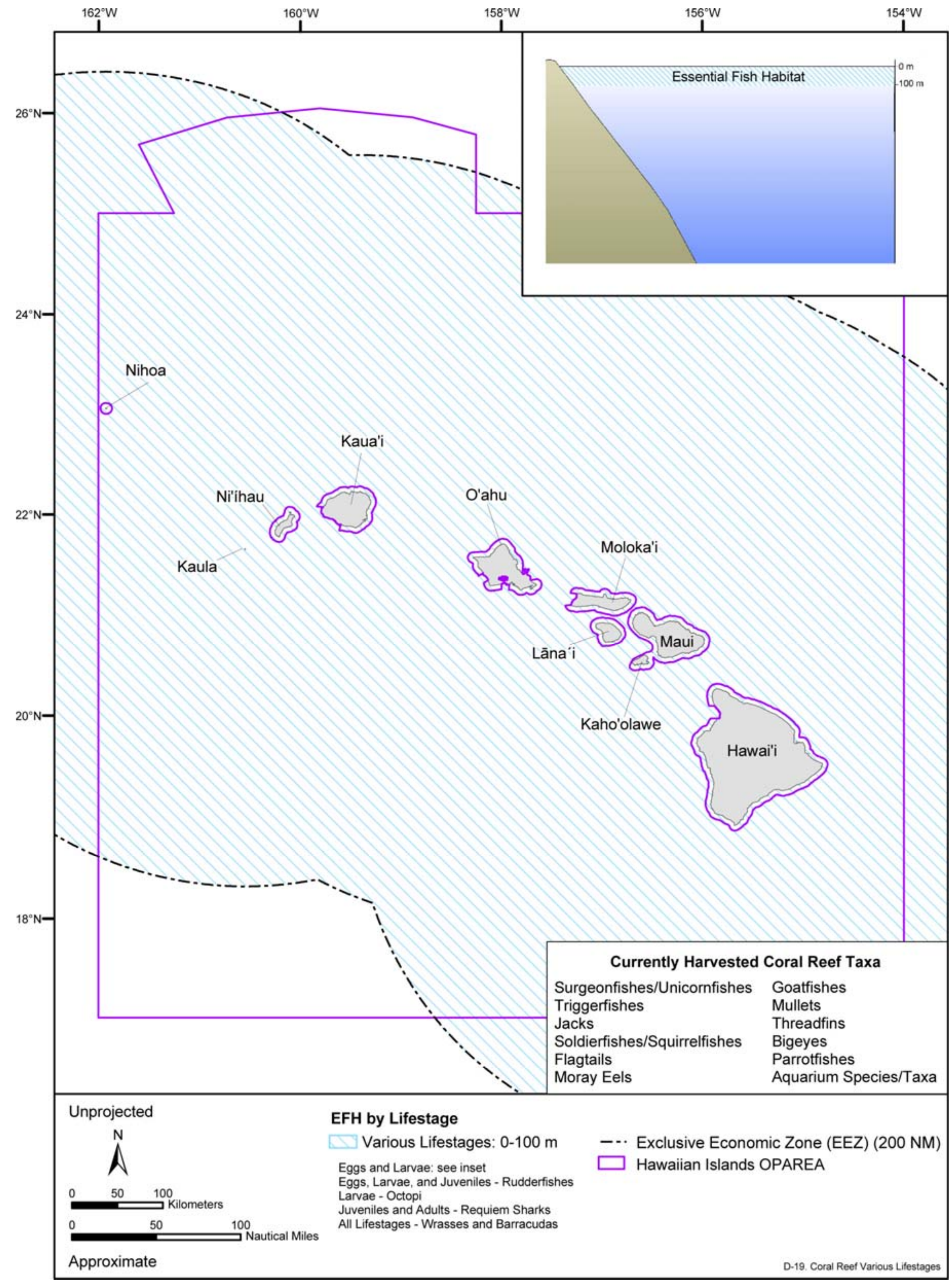

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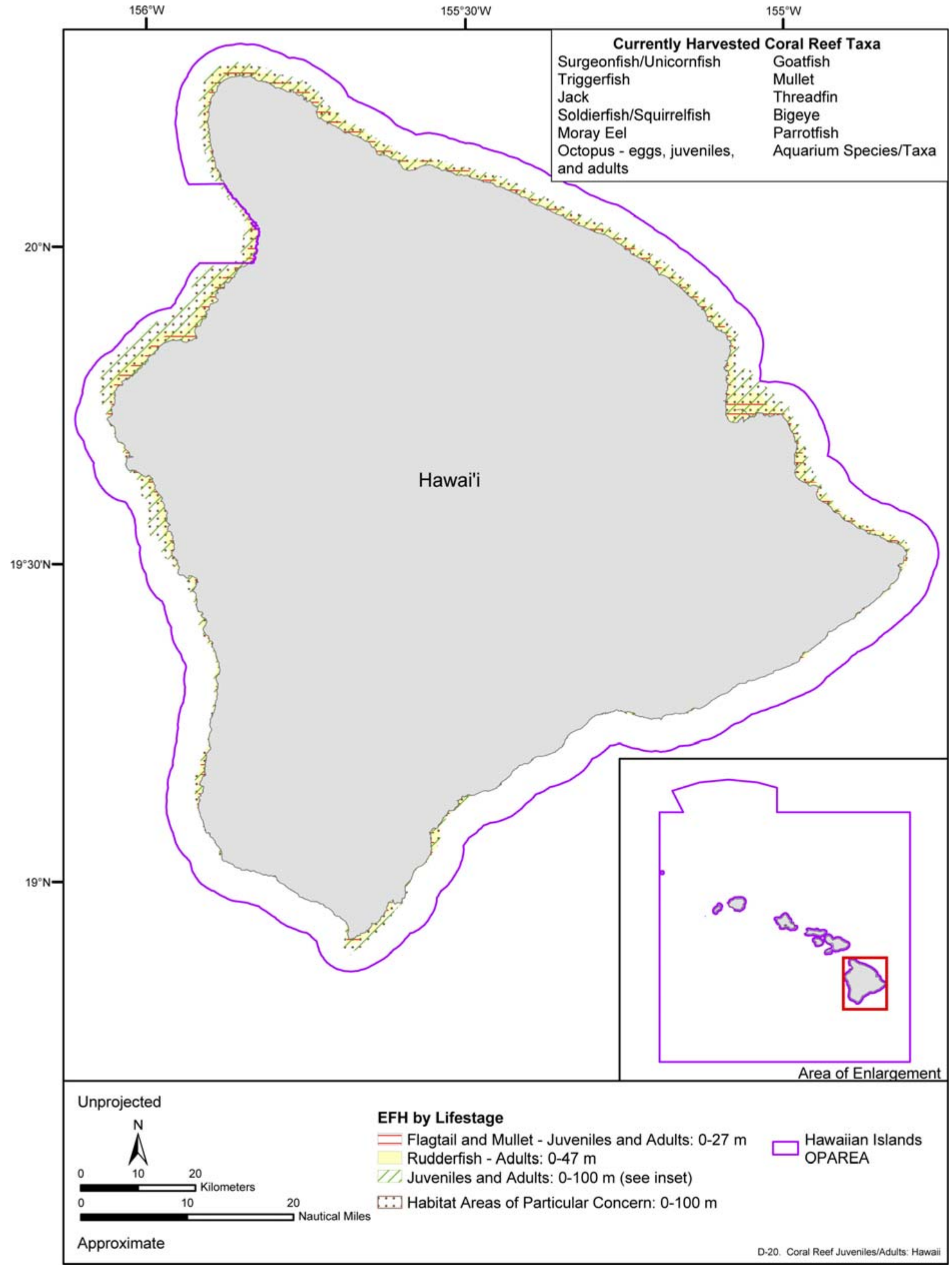
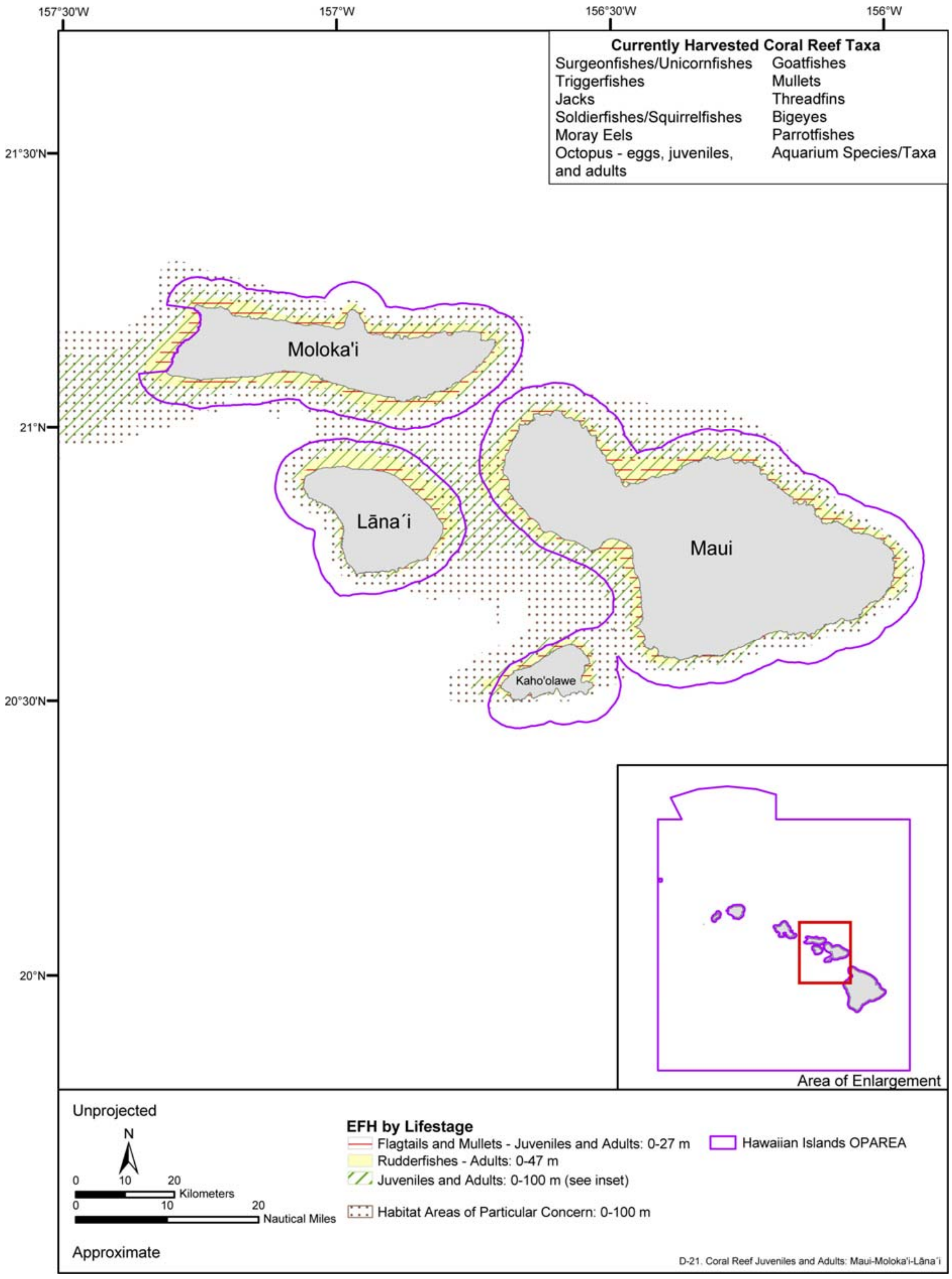


Figure A-20. EFH for all juvenile and adult lifestages of the CHCRT-coral reef ecosystem and HAPC designated in the Hawaiian Islands OPAREA. Map adapted from: WPRFMC (2001a) and GDIAS (2004).



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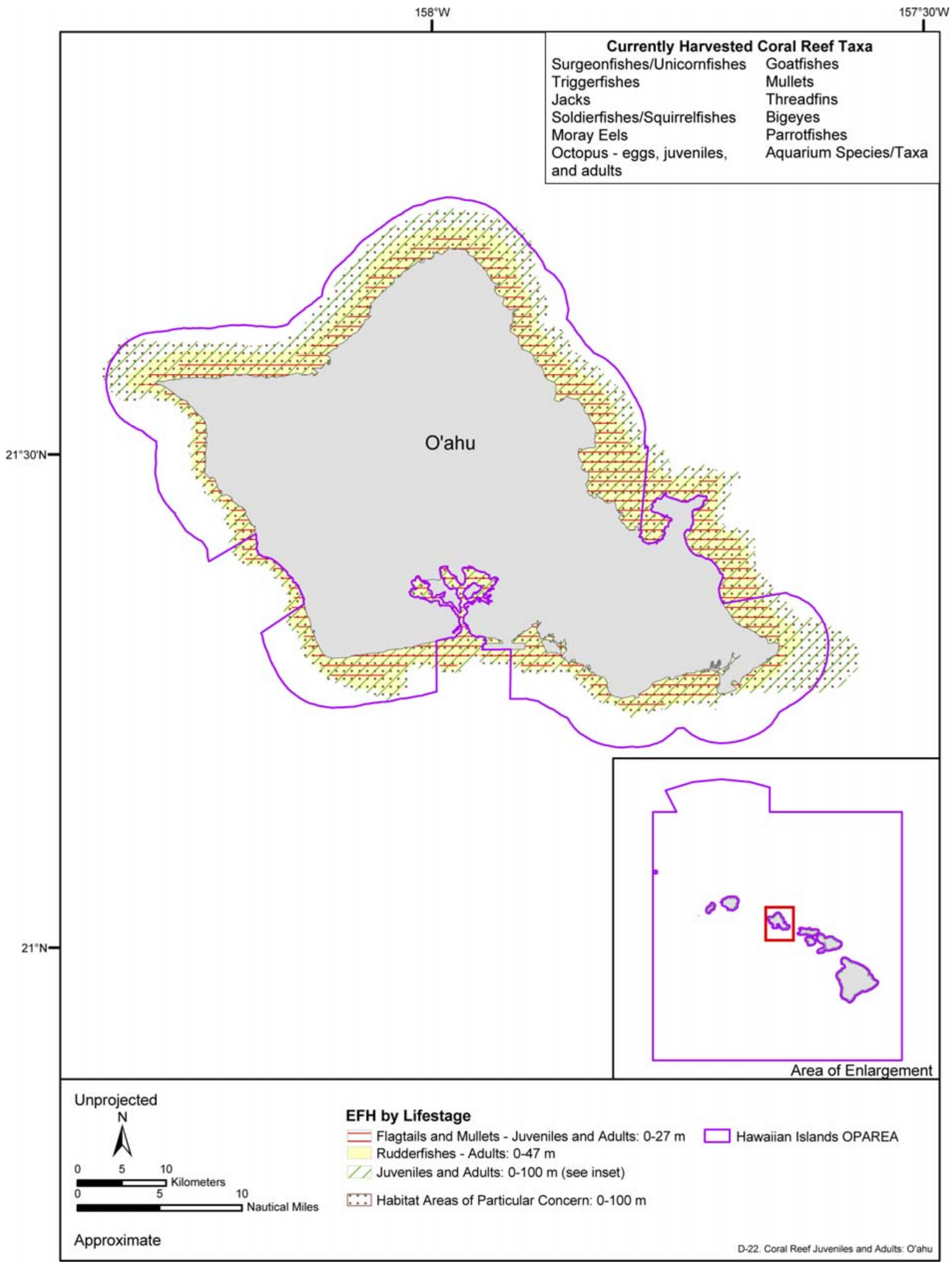

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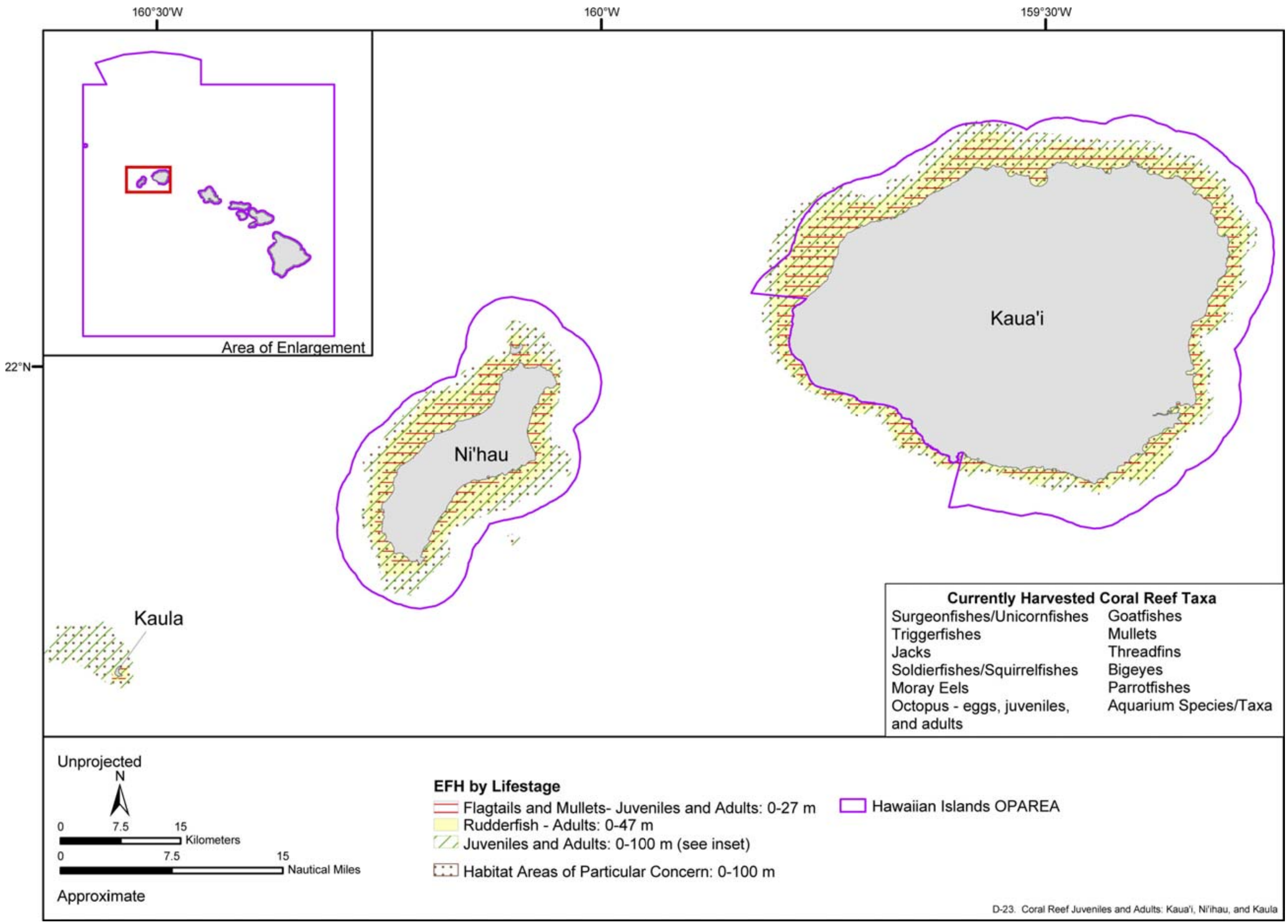

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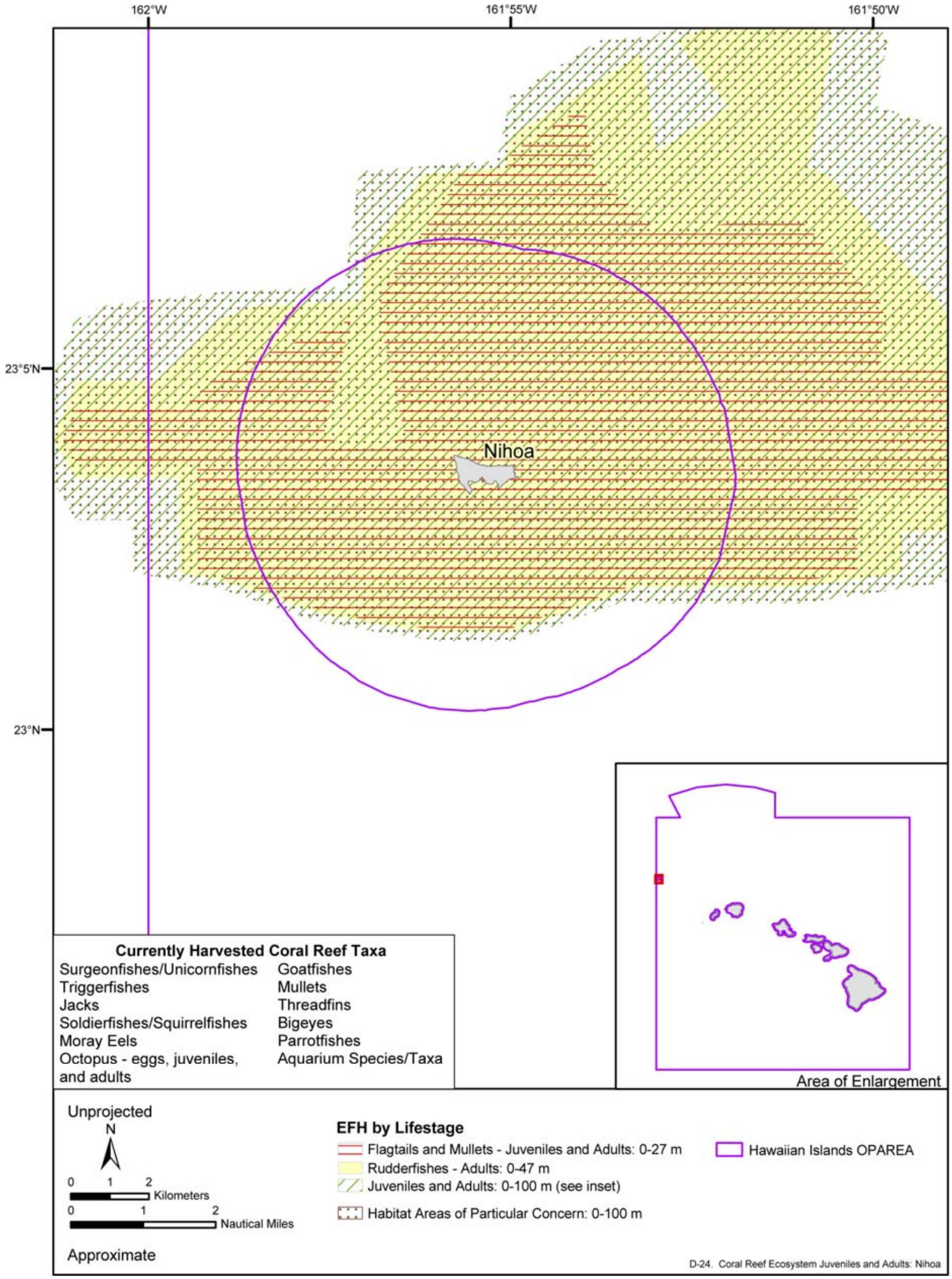

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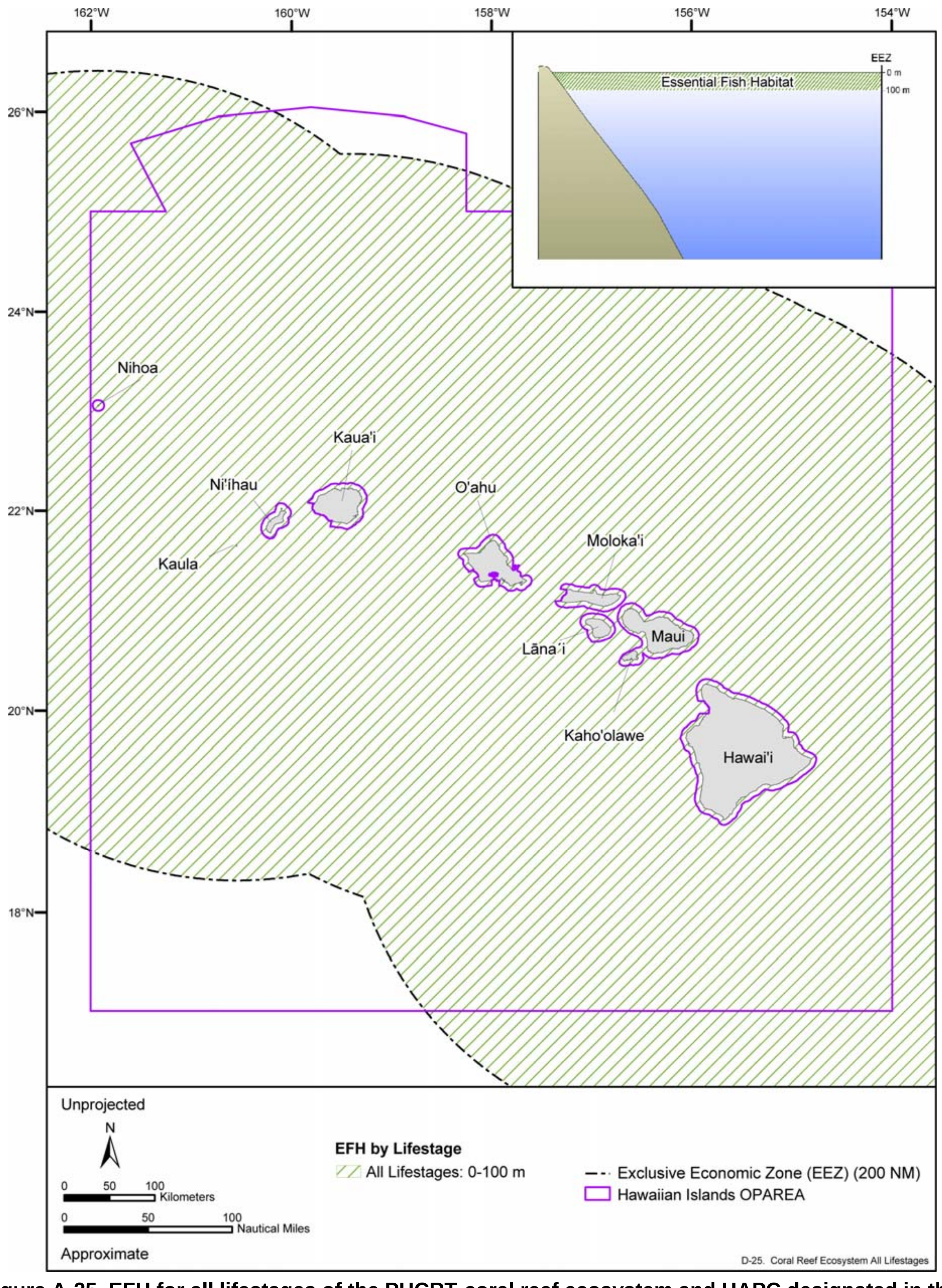

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