



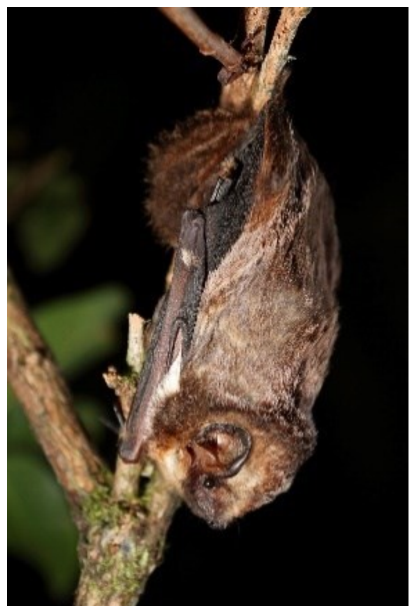




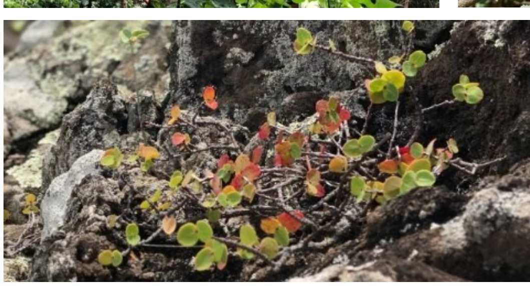
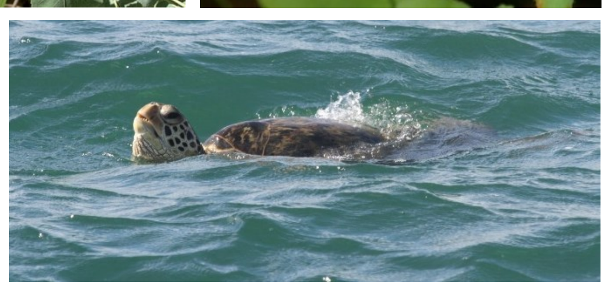

Draft

Integrated Natural Resources Management Plan for Joint Base Pearl Harbor-Hickam, O‘ahu

November 2023

Prepared for:
Naval Facilities Engineering Systems Command, Hawaii

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ES.1 Executive Summary

ES.1.1 Introduction

This Integrated Natural Resources Management Plan (INRMP) has been developed for the United States (U.S.) Department of the Navy (DON), Navy Region Hawaii (NRH) for Joint Base Pearl Harbor-Hickam (JBPHH), Oʻahu (Figures ES-1 and ES-2; Table ES-1) to meet statutory requirements of the Sikes Act (16 U.S. Code [U.S.C.] 670a et seq.), as amended (2015). This document revises and combines previous INRMPs and natural resources management plans for JBPHH lands and submerged areas. As detailed in Table ES-1, JBPHH is composed of:

- Main Base: includes Pearl Harbor Naval Complex and former Hickam Air Force Base (AFB) (surrounding areas detailed in Table ES-1);
- Lualualei Annex: includes Naval Magazine Pearl Harbor (NAVMAG PH) Lualualei Branch and Naval Radio Transmitter Facility Lualualei (NRTF Lualualei);
- Wahiawa Annex: includes Naval Computer and Telecommunications Area Master Station Pacific (NCTAMS PAC) Wahiawa, Camp Stover Housing Community, and Opana Radar Site (Opana); and
- Former Naval Air Station Barbers Point (NASBP) (referred to as Kalaeloa).

This INRMP complies with the Sikes Act, which requires the preparation, implementation, and review for operation and effect of an INRMP at all U.S. Department of Defense (DoD) installations in the U.S. and its territories that contain significant natural resources. Section 101(a)(2) of the Sikes Act as amended requires the Secretary of the Navy to prepare INRMPs in cooperation with the U.S. Fish and Wildlife Service (USFWS) and appropriate state and territorial fish and wildlife agencies. DoD Instruction (DoDI) 4715.03 instructs military installations to identify, address, and resolve INRMP issues with the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) when matters of essential fish habitat (EFH), listed marine species, and/or marine fisheries are involved.

The Navy has partnered with the USFWS, NMFS, and State of Hawaiʻi (SOH) Department of Land and Natural Resources (DLNR) to provide technical assistance, review, and expert guidance regarding terrestrial and marine resources addressed in this INRMP, in particular, species listed under the Endangered Species Act (ESA) (16 U.S.C. 1531 et seq.), Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703-712), Marine Mammal Protection Act (MMPA) (16 U.S.C. 1361 et seq.), and species and habitats covered under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (16 U.S.C. 1801 et seq.). This INRMP furthermore reflects the mutual agreement between DON and its partnering agencies on the conservation of natural resources.

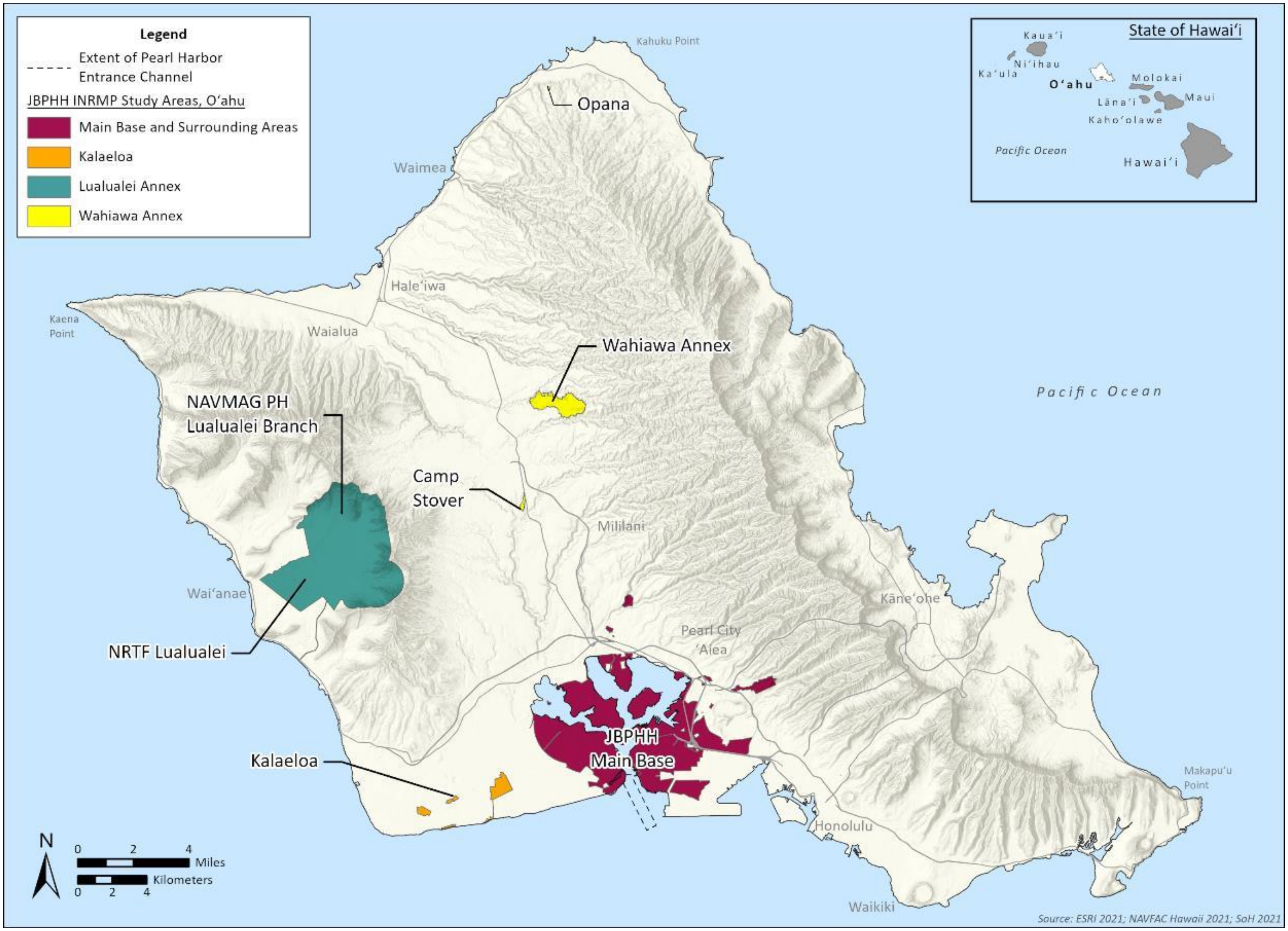

Figure ES-1 JBPHH INRMP Study Area

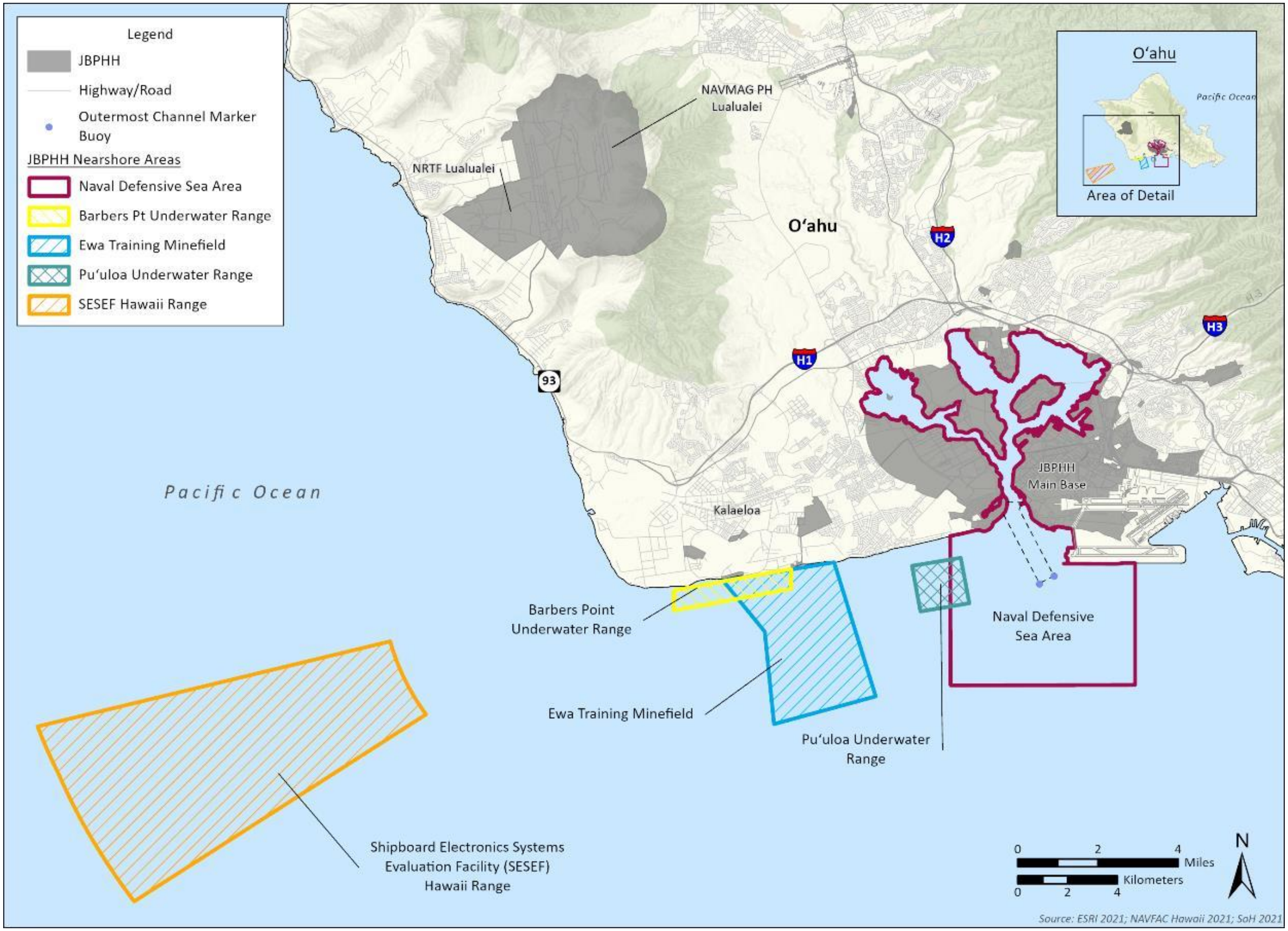

Figure ES-2 JBPHH Nearshore Areas

Table ES-1 Lands and Waters Owned, Leased, or Otherwise Controlled by JBPHH

JBPHH INRMP Study Area	*Land Use and Types of Operations*	*Requires a Natural Resources Management Plan*
JBPHH Main Base and Surrounding Areas (Chapter 4)	**Main Base** (i.e., Pearl Harbor Shipyard, Intermediate Maintenance Facility, and former Hickam AFB) is largely developed and includes industrial areas. Hickam Airfield supports the Pacific Air Forces' strategic air operations Main Base also includes family and troop housing, community support, administrative buildings, recreation areas, and managed grass and landscape. The Main Base shoreline along the Southeast Loch of Pearl Harbor is industrial. Hickam Beach and Āhua Reef Wetland are located on the southern shoreline of Main Base adjacent to the Reef Runway at Daniel K. Inouye International Airport (Figure 4-1). **Surrounding Areas (Figure 4-1)** **Ford Island** includes administrative facilities; community support and military housing; recreation areas; and historical landmarks, memorials, and a museum. **Pearl City Peninsula** includes administrative and logistic facilities, laydown and storage areas, family housing, and a leased agricultural area. Natural resource features of Pearl City Peninsula include wetlands, open space, and the Pearl Harbor National Wildlife Refuge, Waiawa Unit. **Waipiʻo Peninsula** includes administrative and operational facilities, training areas, and open spaces. The northern portion of the peninsula is leased to the City and County of Honolulu as a soccer complex. There are wetlands present along the shorelines of Waipiʻo Peninsula.	Yes, includes federally-listed bird species, marine mammals, and sea turtles; SOH-listed birds; MBTA-protected birds; wildlife refuges; wetlands; mature and significant trees; agricultural leased areas; and outdoor recreation areas. Includes Pearl Harbor, Naval Defensive Sea Area, Nearshore Training Areas (Figure ES-2), and shorelines/coastal areas of Pearl Harbor.

JBPHH INRMP Study Area	*Land Use and Types of Operations*	*Requires a Natural Resources Management Plan*
JBPHH Main Base and Surrounding Areas (Chapter 4) **(continued)**	**NAVMAG PH/West Loch Annex** includes magazines, operations and maintenance buildings, community and personnel support. The PHNWR, Honouliuliu Unit is located along the northeastern border of NAVMAG PH/West Loch Annex. **Red Hill Fuel Annex** includes logistics and supply infrastructure. The area is primarily open space. **The areas of Makalapa, ʻOhana Nui, and McGrew Point; Mānana and Hālawa Housing; and Special Area Honolulu** serve primarily as family and community support. These areas provide housing, commercial areas, schools, child development centers, and recreation. These areas are largely developed with limited open areas consisting of managed grass and landscaping. Waiawa Watershed is primarily used for water supply and public works. The area is primarily open space.	
Total acreage (hectares) for Main Base and Surrounding Areas	<u>**Land**</u> **10,728 acres (4,341 hectares)** <u>**Water**</u> **40,199 acres (16,268 hectares)** <u>**Combined**</u> **50,927 acres (20,609 hectares)**	
JBPHH Lualualei Annex (Chapter 5)	**NAVMAG PH Lualualei** Branch is a munitions magazine complex that includes storage and operational facilities, community and personnel support facilities, and large areas of open space. **NRTF Lualualei** is used to transmit state-of-the-art high and low frequency radio signals for the navigation of Navy vessels throughout the Pacific.	Yes, includes federally-listed plants and bird species critical habitat, SOH-listed birds, MBTA-protected birds, wetlands, a wildlife refuge, and agricultural leased areas.
Total acreage (hectares) for JBPHH Lualualei Annex	<u>**Land**</u> **9,220 acres (3,731 hectares)**	

JBPHH INRMP Study Area	*Land Use and Types of Operations*	*Requires a Natural Resources Management Plan*
JBPHH Wahiawa Annex (Chapter 6)	**NCTAMS PAC Wahiawa** includes operations, open space, and family housing and community support facilities. In the valleys surrounding NCTAMS PAC Wahiawa, open areas including mixed forest are present. **Camp Stover Hosing Community** is located on Wheeler Army Airfield. **Opana Radar Site** is the location of an active United States State Department telecommunications station. The area includes facilities and managed lawns and landscaping.	Yes, includes mature and significant trees and landscapes and MBTA-protected birds.
Total acreage (hectares) for JBPHH Wahiawa Annex	**Land** **726 acres (294 hectares)**	
Kalaeloa (Chapter 7)	**Kalaeloa** includes five noncontiguous DON-retained lands from the former NASBP. The DON-retained lands are largely developed. Land cover types include industrial areas, recreation, and disturbed open space. The shorelines along Nimitz Beach and Cottages, and White Plains Beach and Cottages are coastal wetlands.	Yes, includes federally-listed animals (bird, marine mammal, and reptilian species), MBTA-protected birds, SOH-listed birds, and outdoor recreational facilities.
Total acreage (hectares) for Kalaeloa	**Land** **416 acres (168 hectares)**	
Total acreage (hectares) for Joint Base Pearl Harbor-Hickam	**Land Total** **21,090 acres (8,535 hectares)** **Water Total** **40,199 acres (16,268 hectares)** **Combined Total** **61,289 acres (24,803 hectares)**	

Notes: AFB = Air Force Base; DON = Department of the Navy; JBPHH = Joint Base Pearl Harbor-Hickam; MBTA = Migratory Bird Treaty Act; NASBP = Naval Air Station Barbers Point; NAVMAG PH = Naval Magazine Pearl Harbor; NCTAMS PAC = Naval Computer and Telecommunications Area Master Station, Pacific; NRTF Lualualei = Naval Radio Transmitter Facility Lualualei; PHNWR = Pearl Harbor National Wildlife Refuge; SOH = State of Hawaiʻi.

ES.1.2 Purpose

The purpose of this INRMP is to maintain long-term ecosystem health and operational requirements of the DoD's mission while minimizing impacts to natural resources at JBPHH. The INRMP provides a framework where natural resources are managed in accordance with the Sikes Act mandate to provide "no net loss in the capability of military installation lands to support the military mission of the installation." This INRMP serves three main functions: (1) it acts as an information repository for natural resource information, assets, and constraints; (2) provides guidance on how JBPHH is to comply with federal laws, rules, regulations, Executive Orders (EOs), and DoD and Navy directives relating to natural resources; and (3) identifies management goals and strategies, required actions, and resources necessary to protect and manage the installation's natural resources to provide the flexibility required to maintain "no net loss capability."

ES.1.3 Goals and Objectives

In November 2020, DoD and agency stakeholders involved in the preparation of this INRMP developed goals and objectives for the management of natural resources on JBPHH-administered and JBPHH-retained terrestrial and submerged lands. These goals and objectives guided the preparation of the revised JBPHH INRMP with the intent of preparing a document that reflects mutual agreements of the stakeholders. Following are the goals used to guide the development of resource-specific projects, strategies, and actions which are presented in Chapters 4 through 7.

- Support and sustain the military mission of JBPHH while managing, protecting, and enhancing biological diversity and ecosystem integrity of military lands and waters and all associated threatened and endangered species and their habitats.
- Apply ecosystem-based adaptive management strategies to ensure the long-term health, restoration, protection, and recovery of marine and terrestrial natural resources and biodiversity.
- Ensure the management, conservation, recreation, and protection of natural resources is meeting or exceeding regulatory requirements through enforcement and outreach.

ES.1.4 Protected Species and Habitats

The following section details federally-listed species, SOH-listed species, and species of concern with potential to occur at JBPHH Main Base and Surrounding Areas, JBPHH Lualualei Annex, JBPHH Wahiawa Annex, and Kalaeloa.

ES.1.4.1 JBPHH Main Base and Surrounding Areas

Table ES-2 provides a list of the federally- and SOH-listed species that have potential to occur at JBPHH Main Base and Surrounding Areas. Critical habitat has not been designated at JBPHH Main Base and Surrounding Areas for any of these species. The USFWS maintains the Waiawa and Honouliuli Units of Pearl Harbor National Wildlife Refuge (PHNWR), which provide habitat for protected bird species.

Table ES-2 Federally- and SOH-Listed Species with Potential to Occur at JBPHH Main Base and Surrounding Areas

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence*
Bird Species				
Anas wyvilliana	Hawaiian Duck	Koloa maoli	FE, SE, MBTA	Potential
Asio flammeus sandwichensis	Hawaiian Short-eared Owl	Pueo	SE	Confirmed
Branta sandvicensis	Hawaiian Goose	Nēnē	FE, SE, MBTA	Potential
Fulica alai	Hawaiian Coot	ʻAlae keʻokeʻo	FE, SE, MBTA	Confirmed
Gallinula chloropus sandvicensis	Hawaiian Gallinule	ʻAlae ʻula	FE, SE	Confirmed
Gygis alba	White Tern	Manu-o-kū	SE, MBTA	Confirmed
Himantopus mexicanus knudseni	Hawaiian Stilt	Aeʻo	FE, SE	Confirmed
Oceanodroma castro	Band-rumped Storm Petrel	ʻAkēʻakē	FE, SE	Potential
Pterodroma sandwichensis	Hawaiian Petrel	ʻUaʻu	FE, SE, MBTA	Potential
Puffinus newelli	Newell's Shearwater	ʻAʻo	FT, ST, MBTA	Potential
Terrestrial Mammal Species				
Lasiurus cinereus semotus	Hawaiian Hoary Bat	ʻŌpeʻapeʻa	FE, SE	Confirmed
Marine Mammal Species				
Balaenoptera borealis	Sei Whale	-	FE, SGCN	Within 5 miles nearshore waters
Balaenoptera musculus	Blue Whale	Koholā Polū	FE, SGCN	Within 5 miles nearshore waters
Balaenoptera physalus	Fin Whale	-	FE, SE, SGCN	Within 5 miles nearshore waters
Megaptera novaeangliae	Humpback Whale	-	SE, SGCN, MMPA	Confirmed
Neomonachus schauinslandi	Hawaiian Monk Seal	Īlioholoikauaua	FE, SE, SGCN, MMPA	Confirmed
Physeter macrocephalus	Sperm Whale	Palaoa, Koholā Kēpama	FE, SE SGCN, MMPA	Within 5 miles nearshore waters
Pseudorca crassidens	Main Hawaiian Islands Insular False Killer Whale DPS	-	FE, SE, SGCN	Confirmed
Stenella longirostris	Spinner Dolphin	Naia	SGCN, MMPA	Confirmed in nearshore waters

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence*
Reptilian Species				
Caretta caretta	Loggerhead Turtle (North Pacific DPS)	-	FE, ST	Within 5 miles nearshore waters
Chelonia mydas	Green Sea Turtle (Central North Pacific DPS)	Honu	FT, ST	Confirmed
Dermochelys coriacea	Leatherback Turtle	-	FE	Within 5 miles nearshore waters
Eretmochelys imbricata	Hawksbill Turtle	Honuʻea	FE, SE	Confirmed
Lepidochelys olivacea	Olive Ridley Turtle	-	FT, ST	Within 5 miles nearshore waters
Fish Species				
Atherinomorus insularum	Hawaiian Silverside	ʻIao	SGCN	Confirmed
Caranx ignobilis	Giant Trevally	ʻUlua Aukea	SGCN	Confirmed
Carcharhinus longimanus	Oceanic Whitetip Shark	-	FT	Within 5 miles nearshore waters
Chlorurus perspicillatus	Spectacled Parrotfish	Uhu Uliuli, Uhu ʻAhuʻula	SGCN	Confirmed
Coris venusta	Elegant Coris	Hinālea	SGCN	Confirmed
Elops hawaiensis	Hawaiian Tenpounder	Awa ʻaua	SGCN	Confirmed
Encrasicholina purpurea	Hawaiian Anchovy	Nehu	SGCN	Confirmed
Hippocampus kuda	Smooth Seahorse	-	SGCN	Confirmed
Kuhlia xenura	Hawaiian Flagtail	Āholehole	SGCN	Confirmed
Manta birostris	Giant Manta Ray	Hāhālua	FT	Within 5 miles nearshore waters
Oxyurichthys lonchotus	Goby	Oʻopu	SGCN	Confirmed
Parupeneus porphyreus	Whitesaddle Goatfish	Kūmū	SGCN	Confirmed
Coral Species				
Cyphastrea ocellina	Ocellated Coral	ʻākoʻakoʻa	SGCN	Confirmed
Leptastrea bewickensis	Crust coral	ʻākoʻakoʻa	SGCN	Within 5 miles nearshore waters
Leptastrea purpurea	Crust Coral	koʻa, ʻākoʻakoʻa	SGCN	Confirmed
Leptoseris incrustans	Swelling Coral	koʻa, ʻākoʻakoʻa	SGCN	Confirmed
Coral Species (continued)				
Montipora capitata	Rice Coral	koʻa, ʻākoʻakoʻa	SGCN	Confirmed
Montipora dilatata	Purple Rice Coral-	ʻākoʻakoʻa	SGCN, RT	Confirmed

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence*
Montipora flabellata	Blue Rice Coral	koʻa, ʻākoʻakoʻa	SGCN, RT	Confirmed
Montipora patula	Spreading Coral	-	SGCN	Confirmed
Montipora tuberculosa	Pore Coral	ʻākoʻakoʻa	SGCN	Within 5 miles nearshore waters
Montipora turgescens	Pore Coral	ʻākoʻakoʻa	SGCN, RT	Confirmed
Montipora verrilli	Pore Coral	ʻākoʻakoʻa	SGCN	Within 5 miles nearshore waters
Pavona duerdeni	Flat Lobe Coral	ʻākoʻakoʻa	SGCN	Confirmed
Pavona varians	Corrugated Coral	ʻākoʻakoʻa	SGCN	Confirmed
Pocillopora damicornis	Lace Coral	koʻa, ʻākoʻakoʻa	SGCN	Confirmed
Pocillopora ligulata	Hawaiian Cauliflower Coral	ʻākoʻakoʻa	SGCN	Within 5 miles nearshore waters
Pocillopora meandrina	Cauliflower Coral	-	SGCN, RT	Confirmed
Pocillopora verrucosa	Warty Bushcoral	-	SGCN	Confirmed
Porites compressa	Finger Coral	pō haku puna, ʻākoʻakoʻa	SGCN	Confirmed
Porites evermanni	Evermann's Coral	pō haku puna, ʻākoʻakoʻa	SGCN	Confirmed
Porites lobata	Lobe Coral	pō haku puna, ʻākoʻakoʻa	SGCN	Confirmed
Psammocora nierstraszi	-	-	SGCN	Within 5 miles nearshore waters
Non-Coral Invertebrates				
Nerita picea	Black Nerite	Pipipi Kai	SGCN	Confirmed
Octopus cyanea	Octopus	Heʻe Mauli	SGCN	Within 5 miles nearshore waters
Pinctada margaritifera	Black-lipped Pearl Oyster	-	SGCN	Confirmed

Notes: DPS = distinct population segment; FE = federally-listed endangered; FT = federally-listed threatened; MBTA = Migratory Bird Treaty Act; MMPA = Marine Mammal Protection Act; SE = state-listed endangered; SGCN = State of Hawaiʻi Species of Greatest Conservation Need; ST = state-listed threatened; RT = resolved taxon; - = not available. *Definitions provided in Appendix I.

Bird Species

As shown in Table ES-2, numerous federally- and state-listed birds are known to occur within the study area. At JBPHH Main Base and throughout Oʻahu, ducks (*Anas* sp.) are commonly observed. Although suitable habitat for Hawaiian duck or koloa maoli (*Anas wyvilliana)* is present at JBPHH Main Base, mallards and Hawaiian duck hybrids are most dominant throughout Oʻahu (U.S. Geological Survey, 2007). Hawaiian ducks can be difficult to identify with certainty due to their resemblance to Hawaiian duck-mallard hybrids. Pearl Harbor and its shoreline also provide habitat for the Hawaiian coot or ʻalae keʻokeʻo (*Fulica alai*), Hawaiian gallinule or ʻalae ʻula (*Gallinula chloropus sandvicensis*), and Hawaiian stilt or aeʻo (*Himantopus mexicanus knudseni)*.

While band-rumped storm petrel or ʻakēʻakē (*Oceanodroma castro*), Hawaiian petrel or ʻuaʻu (*Pterodroma sandwichensis*), and Newell's shearwater or ʻaʻo (*Puffinus newelli*) do not nest at JBPHH Main Base or surrounding areas, they may fly over the study area from suitable nesting habitat in the Waiʻanae and Koʻolau Mountains to the ocean. These species are particularly vulnerable to fallout – when fledglings or occasional migrating adult birds are disoriented by artificial light and become grounded. Due to the occasional flyovers and groundings, they have the potential to occur in the study area.

There are numerous migratory bird species protected under the MBTA that occur at JBPHH Main Base and Surrounding Areas and are discussed further in Chapter 4, *JBPHH Main Base and Surrounding Areas*.

Marine Mammals

There is one federally-listed marine mammal that has been observed in Hawaiian waters at Pearl Harbor, the endangered Hawaiian monk seal or īlioholoikauaua *(Neomonachus schauinslandi*). The endangered humpback whale or koholā (*Megaptera novaeangliae*) is not federally-listed in Hawaiʻi but is protected under the MMPA and has been seen on occasion in Pearl Harbor. One additional federally-listed species has been observed outside Pearl Harbor, within the Nearshore Training Areas, the Main Hawaiian Islands insular false killer whale (*Pseudorca crassidens*). In addition, the spinner dolphin or naia (*Stenella longirostris*), a State of Hawaiʻi Species of Greatest Conservation Need (SGCN) species, has also been observed within the Nearshore Training Areas.

The remainder of the marine mammals listed in Table ES-2 are known to occur in Hawaiian waters but are not observed with regularity in or around the study area.

Terrestrial Mammals

The federally-listed Hawaiian hoary bat or ʻōpeʻapeʻa (*Lasiurus cinereus semotus*) is known to occur at JBPHH Main Base and Surrounding Areas.

Reptilian Species

Two sea turtle species have been documented in Pearl Harbor and the Nearshore Training Areas, the federally threatened green sea turtle or honu (*Chelonia mydas*) and the federally endangered hawksbill turtle or honuʻea (*Eretmochelys imbricata*). Three other species of sea turtles have the potential to occur but have not been observed within Pearl Harbor or the Nearshore Training Areas. These include the loggerhead turtle (*Caretta caretta*), the Olive Ridley turtle (*Lepidochelys olivacea),* and the leatherback turtle *(Dermochelys coriacea).*

Fish Species

Of the species of fish that have been observed in Pearl Harbor and the Nearshore Training Areas, none are federally- or SOH-listed, and 10 are SGCN species. These SGCN species include the giant trevally (*Caranx ignobilis*), the Hawaiian anchovy or nehu (*Encrasicholina purpurea*), Hawaiian flagtail or āholehole (*Kuhlia xenura*), the goby or ʻoʻopu (*Oxyurichys longhotus*), the Hawaiian silverside or ʻiao *(Atherinomorus insularum*), the spectacled parrotfish or uhu uliuli (*Chlorurus perspicillatus*), the elegant coris or hinālea (*Coris venusta*), the Hawaiian tenpounder or awa ʻaua (*Elops hawaiensis*), the white saddle goatfish or kūmū (*Parupeneus porphyreus*), and the smooth seahorse (*Hippocampus kuda*). The giant manta ray or hāhālua (*Manta birostris*) and the oceanic whitetip shark (*Carcharhinus longimanus*) are federally threatened fish species that occur within the open ocean areas of the Nearshore Training Areas and have the potential to occur but have not been observed within Pearl Harbor.

Corals

No federally- or SOH-listed coral species have been observed within Pearl Harbor or the Nearshore Training Areas. Sixteen coral species found within Pearl Harbor are considered SGCN and 21 SGCN coral species are found within the open ocean areas of the Nearshore Training Areas (see Table ES-2).

Non-Coral Invertebrates

No federally- or SOH-listed non-coral invertebrate species have been observed within Pearl Harbor or the Nearshore Training Areas. Three non-coral invertebrate species found within Pearl Harbor or the Nearshore Training Areas are considered SGCN (see Table ES-2). These species include the black nerite or pipipi kai (*Nerita picea*), octopus or heʻe mauli (*Octopus cyanea*), and the black-lipped pearl oyster (*Pinctada margaritifera*).

Plant Species

No federally- or SOH-listed plant species are known to occur naturally at JBPHH Main Base. Koʻoloaʻula *(Abutilon menziesii)* occurs at PHNWR Honouliuli Unit due to a previous planting effort by USFWS and DLNR. The species is cared for by USFWS and therefore is not further discussed as part of natural resources for JBPHH Main Base.

ES.1.4.2 JBPHH Lualualei Annex

Table ES-3 provides a list of the federal- and SOH-listed species that have potential to occur at NAVMAG PH Lualualei and NRTF Lualualei within the JBPHH Lualualei Annex.

Table ES-3 Federally- and SOH-Listed Species with Potential to Occur at JBPHH Lualualei Annex

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence*
Bird Species				
Anas wyvilliana	Hawaiian Duck	Koloa maoli	FE, SE	Potential
Asio flammeus sandwichensis	Hawaiian Short-eared Owl	Pueo	SE	Confirmed
Chasiempis ibidis	Oʻahu ʻElepaio	ʻElepaio	FE, SE, CH	Potential
Chlorodrepanis flava	Oʻahu Amakihi	O’ahu Amakihi	SC	Potential
Fulica alai	Hawaiian Coot	ʻAlae keʻokeʻo	FE, SE	Confirmed
Bird Species (continued)				
Gallinula chloropus sandvicensis	Hawaiian Gallinule	ʻAlae ʻula	FE, SE	Potential
Himantopus mexicanus knudseni	Hawaiian Stilt	Aeʻo	FE, SE	Confirmed
Himatione sanguinea	ʻApapane	ʻApapane	SC	Potential
Oceanodroma castro	Band-rump Storm Petrel	ʻAkēʻakē	FE, SE	Offsite, within 5 miles
Pterodroma phaepygia sandwichensis	Hawaiian Petrel	ʻUaʻu	FE, SE	Offsite, within 5 miles
Puffinus newelli	Newell’s Shearwater	ʻAʻo	FT, ST	Offsite, within 5 miles

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence*
Terrestrial Mammal Species				
Lasiurus cinereus semotus	Hawaiian Hoary Bat	ʻŌpeʻapeʻa	FE, SE	Confirmed
Terrestrial Mollusks				
Achatinella mustelina	Oʻahu Tree Snail	Kāhuli	FE	Potential
Amastra cylindrica	-	-	SC	Potential
Arthropod Species				
Drosophila montgomeryi; and other spp.	Hawaiian Picture-wing Flies	-	FE	Potential
Hylaeus anthracinus and other spp.	Hawaiian Yellow-faced Bees	Nalo Meli Maoli	FE	Potential
Megalagrion xanthomelas	Orangeblack Hawaiian Damselfly	-	FE	Potential
Plant Species				
Abutilon menziesii	Red ʻIlima	Koʻoloaʻula	FE, SE	Confirmed
Abutilon sandwicense	Greenflower Indian Mallow	Koʻolua maʻomaʻo	FE, SE	Confirmed
Alectryon macrococcus var. *macrococcus*	Hawaiʻi Alectryon	ʻAlaʻalahua, Māhoe	FE, SE	Confirmed
Asplenium dielfalcatum	Sickle Island Spleenwort	-	FE, SE	Potential
Asplenium unisorum	Singlesorus Island Spleenwort	-	FE, SE	Confirmed
Bobea sandwicensis	Hawaiʻi Dogweed	Ahakea	SSC	Potential
Bonamia menziesii	Hawaiʻi Lady's Nightcap	-	FE, SE	Confirmed
Cenchrus agrimonioides var. *agrimonioides*		Kamanomano	FE, SE	Offsite, within 5 miles
Cyanea calycina	Waiʻanae Range Rollandia	Hāhā	FE, SE	Potential
Cyanea grimesiana ssp. obatae	Splitleaf Cyanea	Hāhā	FE, SE	Offsite, within 5 miles
Cyanea membranacea	Papery Cyanea	Hāhā	SSC	Potential
Plant Species (continued)				
Cyanea pinnatifida	Sharktail Cyanea	Haha	FE, SE	Offsite, within 5 miles
Cyanea superba ssp. *Superba*	Mt. Kaʻala Cyanea	-	FE, SE	Offsite, within 5 miles
Cyperus trachysanthos	Sticky Flatsedge	Puʻukaʻa	FE, SE	Confirmed
Chrysodracon forbesii	Forbes' Hala Pepe	Hala Pepe	FE, SE	Confirmed
Delissea waianaeensis	-	-	FE, SE	Offsite, within 5 miles
Dissochondrus biflorus	False Bristlegrass	-	SSC	Potential
Dracaena forbesii	Waianae Range Hala Pepe	Hala Pepe	FE, SE	Offsite, within 5 miles
Dubautia sherffiana	-	-	SSC	Potential
Euphorbia herbstii	-	-	FE, SE	Offsite, within 5 miles
Euphorbia kuwaleana	-	ʻAkoko, Kōkōmālei	FE, SE	Confirmed

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence*
Exocarpos gaudichaudii	-	-	SC	Offsite, within 5 miles
Flueggea neowawraea	Mēhamehame	Mēhamehame	FE, SE	Confirmed
Gardenia brighamii	Hawaiian Gardenia	Naʻu	FE, SE	Offsite, within 5 miles
Gardenia mannii	Oahu Gardenia	Nanu	FE, SE	Offsite, within 5 miles
Hesperomannia arbuscula	Maui Island-Aster	-	FE, SE	Offsite, within 5 miles
Hibiscus brackenridgei mokuleianus	Mokulei Rosemallow	-	FE, SE	Offsite, within 5 miles
Joinvillea ascendens subsp. *ascendens*	-	ʻOhe	FE, SE	Potential
Kadua parvula	Rockface Star-Violet	-	FE, SE	Confirmed
Labordia kaalae	-	Kāmakahala	SSC	Confirmed
Lepidium arbuscula	Waiʻanae Range Pepperwort	ʻĀnaunau, Naunau, Kūnānā	FE, SE	Confirmed
Lipochaeta lobata var. *leptophylla*	Shrubland Nehe	Nehe	FE, SE	Confirmed
Lobelia niihauensis	Niʻihau Lobelia	ʻŌhā, Hāhā, ʻŌhā wai	FE, SE	Confirmed
Lobelia yuccoides	-	Pānaunau	SC	Confirmed
Marsilea villosa	Villous Waterclover	ʻIhi ʻihi, ʻIhi lāʻau	FE, SE	Confirmed
Melanthera tenuis	Waiʻanae Range Nehe	Nehe	SSC	Confirmed
Melicope christophersenii	Waiʻanae Range Melicope	Alani	FE, SE	Confirmed
Melicope (Platydesma) cornuta var. *decurrens*	-	-	FE, SE	Confirmed
Plant Species (continued)				
Melicope pallida	Pale Melicope	Alani	FE, SE	Offsite, within 5 miles
Melicope saint-johnii	St. John's Melicope	Alani	FE, SE	Offsite, within 5 miles
Neraudia angulata var. *angulata*	Angular-Fruit Maʻoloa	Maʻaloa, ʻOloa	FE, SE	Confirmed
Neraudia melastomifolia	Angularfruit Maʻoloa	Maʻaloa, ʻOloa	SSC	Confirmed
Nototrichium humile	Kaʻala Rockwort	Kuluʻī	FE, SE	Confirmed
Phyllostegia hirsuta	Molokai Phyllostegia	-	FE, SE	Offsite, within 5 miles
Phyllostegia kaalaensis	Kaala Phyllostegia	-	FE, SE	Offsite, within 5 miles
Phyllostegia mollis	Waianae Range Phyllostegia	-	FE, SE	Offsite, within 5 miles
Plantago princeps var. *princeps*	-	Ale	FE, SE	Confirmed
Platydesma cornuta var. *decurrens*	Oahu Pilo Kea	Alani	FE, SE	Offsite, within 5 miles
Pritchardia kaalae	-	-	FE, SE	Offsite, within 5 miles

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence*
Pritchardia martii	-	-	SSC	Confirmed
Pteralyxia macrocarpa	-	Kaulu	FE, SE	Potential
Schiedea hookeri	Hooker's Schiedea, Sprawling Schiedea	-	FE, SE	Confirmed
Schiedea kaalae	Oahu Schiedea	-	FE, SE	Offsite, within 5 miles
Schiedea ligustrina	-	Maʻoliʻoli	SSC	Potential
Schiedea mannii	Ridgetop Schiedea	-	SC	Offsite, within 5 miles
Schiedea pentandra	Hairy Schiedea	-	SC	Confirmed
Sicyos lanceoloideus	-	ʻAnunu	SC	Offsite, within 5 miles
Silene perlmanii	Cliff Face Catchfly	-	FE, SE	Offsite, within 5 miles
Solanum sandwicense	Hawaii Horsenettle	ʻAiakeakua, Popolo	FE, SE	Offsite, within 5 miles
Spermolepis hawaiiensis	Hawaiʻi Scaleseed	-	FE, SE	Confirmed
Stenogyne kanehoana	Oahu Stenogyne	-	FE, SE	Offsite, within 5 miles
Strongylodon ruber	Hawaiʻi Jadevine	-	SC	Offsite, within 5 miles
Tetramolopium filiforme var. *filiforme*	Ridgetop Tetramolopium	-	FE, SE	Confirmed
Plant Species (continued)				
Tetramolopium lepidotum subsp. *lepidotum*	Waiʻanae Range Tetramolopium	-	FE, SE	Potential
Urera kaalae	-	Ōpuhe	FE, SE	Offsite, within 5 miles
Viola chamissoniana subsp. *chamissoniana*	-	ʻOlopū, Pāmakani	FE, SE	Confirmed

Notes: Candidate = candidate for listing; CH = critical habitat; FE = federally-listed endangered; FT = federally-listed threatened; SE = state-listed endangered; SSC = state species of special concern; SC = species of concern; SOH = State of Hawaiʻi; ST = state-listed threatened; - = not available. *Definitions provided in Appendix I.

Bird Species

Critical habitat for the Oʻahu ʻelepaio (*Chasiempis ibidis*) totals 1,695 acres (686 hectares) within NAVMAG PH Lualualei installation lands. Historical records show Oʻahu ʻelepaio presence in the area; however, the area is currently unoccupied. Recent surveys recorded Oʻahu ʻelepaio occupying habitat within Lualualei State Forest Reserve, approximately 650 feet (200 meters) from the NAVMAG PH Lualualei boundary (Naval Facilities Engineering Systems Command Pacific [NAVFAC PAC], 2019).

Suitable habitat for scarlet honeycreeper or ʻiʻiwi (*Drepanis coccinea*) is present within the study area; however, this species has not been observed during recent survey efforts. It is not currently known to occur within the study area (Sundance-EA Associates, 2019).

Hawaiian short-eared owl or pueo (*Asio flammeus sandwichensis*) monitoring at Lualualei have identified at least two resident individuals that spend most of their time within the study area. The species is known to hunt, rest, and nest within the study area (Research Corporation of the University of Hawaiʻi [RCUH], 2020).

At Niuliʻi Ponds on NRTF Lualualei, Hawaiian stilt, Hawaiian gallinule, and Hawaiian coot are known to occur. Ducks are observed at Niuliʻi Ponds; however, Hawaiian duck-mallard hybrids are most common throughout Oʻahu and Hawaiian ducks can be difficult to identify with certainty due to their resemblance to Hawaiian duck-mallard hybrids (U.S. Geological Survey [USGS], 2007).

Band-rumped storm petrel, Hawaiian petrel, and Newell's shearwater have potential to occur in the study area. These species are not known to nest at NAVMAG PH Lualualei or NRTF Lualualei but have potential to fly over the study area from suitable nesting habitat in the Waiʻanae Mountains to the ocean. In 2017, a study confirmed presence of Newell's shearwater at two locations on the leeward slope of Mount Kaʻala and Hawaiian petrel at one location on the windward slope of Mount Kaʻala which occurs adjacent to the study area (Young et al., 2019). These species are particularly vulnerable to fallout – when fledglings or occasional migrating adult birds are disoriented by artificial light and become grounded. Due to the occasional flyovers and groundings, they have the potential to occur in the study area.

There are numerous migratory bird species protected under MBTA that have potential to occur at NAVMAG PH Lualualei and NRTF Lualualei and are discussed further in Chapter 5, *JBPHH Lualualei Annex*.

Terrestrial Mammal Species

Hawaiian hoary bat is known to occur at Kolekole Pass Lualualei (Naval Facilities Engineering Systems Command Hawaii [NAVFAC HI], 2014).

Snail Species

Suitable habitat for the Oʻahu tree snail or kāhuli (*Achatinella mustelina*) occurs at NAVMAG PH Lualualei Branch. The species has been recorded in the study area; however, the species was not observed during the most recent survey effort in 2018 by NAVFAC HI Natural Resources staff (N. Dunn, personal communication, 2021).

Arthropod Species

Potentially suitable habitat for six Hawaiian picture-wing fly (*Drosophila* spp.) and six yellow-faced bee species or nalo meli maoli (*Hylaeus* spp.) occurs in the study area. Additionally, potentially suitable habitat for the federally-listed orangeblack Hawaiian damselfly (*Megalagrion xanthomelas*) occurs within the study area. Little is known about the current range of these species on Oʻahu; therefore, there is potential they occur within the study area.

Plant Species

There are 32 ESA-listed endangered plant species and 8 USFWS designated state species of special concern with potential to occur at NAVMAG PH Lualualei and NRTF Lualualei.

ES.1.4.3 JBPHH Wahiawa Annex

There are no critical habitats, natural resource research areas, or ecological reserves at NCTAMS PAC Wahiawa, Camp Stover Housing Community, or Opana within the JBPHH Wahiawa Annex. Table ES-4 provides a list of the federally- and SOH-listed species that have potential to occur at NCTAMS PAC Wahiawa, Camp Stover Housing Community, and Opana study area.

Bird Species

Hawaiian short-eared owl may utilize the wooded gulches and open grass habitat at NCTAMS PAC Wahiawa, but none have been observed during field surveys going back to 1986. A single Oʻahu ʻelepaio was heard calling during point count surveys at NCTAMS PAC Wahiawa in 2015; however, the observation was questionable, and the area does not support suitable habitat for the species (Hamer Environmental, 2016).

The band-rumped storm petrel, Hawaiian petrel, and Newell's shearwater are not known to inhabit NCTAMS PAC Wahiawa, Camp Stover, or Opana but have potential to fly over from suitable nesting habitat in the Koʻolau and Waiʻanae Mountains to the ocean. These species are particularly vulnerable to fallout – when fledglings or occasional migrating adult birds are disoriented by artificial light and become grounded. Due to the occasional flyovers and groundings, they have the potential to occur in the study area.

Table ES-4 Federally- and SOH-listed Species with Potential to Occur at JBPHH Wahiawa Annex

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence*
Bird Species				
Asio flammeus sandwichensis	Hawaiian Short-eared Owl	Pueo	SE	Potential
Oceanodroma castro	Band-rump Storm Petrel	ʻAkēʻakē	FE, SE	Offsite, within 5 miles
Pterodroma sandwichensis	Hawaiian Petrel	ʻUaʻu	FE, SE	Offsite, within 5 miles
Puffinus newelli	Newell's Shearwater	ʻAʻo	FT, ST	Offsite, within 5 miles
Terrestrial Mammal Species				
Lasiurus semotus	Hawaiian Hoary Bat	ʻŌpeʻapeʻa	FE, SE	Confirmed

Notes: Candidate = candidate for listing; CH = critical habitat; FE = federally-listed endangered; FT = federally-listed threatened; SE = state-listed endangered; SC = species of concern; SOH = State of Hawaiʻi; ST = state-listed threatened; - = not available. *Definitions provided in Appendix I.

Terrestrial Mammal Species

Hawaiian hoary bat is known to occur at NCTAMS PAC Wahiawa. Additionally, Hawaiian hoary bat has potential to occur at Opana as suitable foraging and roosting habitat occur adjacent to Opana.

Plant Species

Federally- and/or SOH-listed plant species are not known to occur at NCTAMS PAC Wahiawa (Hawaiʻi Natural Heritage Program, 2004), Opana, or Camp Stover Housing Community.

ES.1.4.4 Kalaeloa

Table ES-5 provides a list of the federally- and SOH-listed species with potential to occur at the Kalaeloa study area, including Pearl Harbor and Nearshore Training Areas.

Table ES-5 Federally- and SOH-listed Species with Potential to Occur at Kalaeloa, Pearl Harbor and Nearshore Training Areas

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence*
Bird Species				
Anas wyvilliana	Hawaiian Duck	Koloa maoli	FE, SE	Potential
Fulica alai	Hawaiian Coot	ʻAlae keʻokeʻo	FE, SE	Potential
Gallinula chloropus sandvicensis	Hawaiian Gallinule	ʻAlae ʻula	FE, SE	Potential
Gygis alba	White Tern	Manu-o-kū	ST	Potential
Himantopus mexicanus knudseni	Hawaiian Stilt	Aeʻo	FE, SE	Confirmed
Oceanodroma castro	Band-rumped Storm Petrel	ʻAkēʻakē	FE, SE	Within 5 miles of installation
Bird Species (continued)				
Pterodroma sandwichensis	Hawaiian Petrel	ʻUaʻu	FE, SE	Within 5 miles of installation
Puffinus newelli	Newell's Shearwater	ʻAʻo	FT, ST	Within 5 miles of installation
Terrestrial Mammal Species				
Lasiurus cinereus semotus	Hawaiian Hoary Bat	ʻŌpeʻapeʻa	FE, SE	Potential
Marine Mammal Species				
Neomonachus schauinslandi	Hawaiian Monk Seal	Īlioholoikauaua	FE, SE, SGCN, MMPA	Confirmed
Reptilian Species				
Chelonia mydas	Green Sea Turtle (Central North Pacific DPS)	Honu	FT, ST	Confirmed
Eretmochelys imbricata	Hawksbill Sea Turtle	Honuʻea	FE, SE, SGCN	Potential
Arthropod Species				
Hylaeus spp.	Hawaiian Yellow-faced Bee	Nalo Meli Maoli	FE	Unconfirmed, Potential

Notes: DPS = distinct population segment; FE = federally-listed endangered; FT = federally threatened; MMPA = Marine Mammal Protection Act; SE = state-listed endangered; SGCN = State of Hawaiʻi Species of Greatest Conservation Need; SOH = State of Hawaiʻi; ST = state-listed threatened. *Definitions provided in Appendix I.

Bird Species

Hawaiian stilt has been reported at the Biosolids Treatment Facility, Barbers Point Golf Course, in wetland areas adjacent to DON-retained lands of Kalaeloa (RCUH, 2017a-d; Hamer Environmental, 2016; SOH Department of Transportation [DOT], 2020); and is known to nest at Ordnance (Ordy) Pond (RCUH, 2020). Ordy Pond is on Base Realignment and Closure (BRAC) land and BRAC land is not covered under the jurisdiction of this INRMP.

Hawaiian duck (suspected Hawaiian duck-mallard hybrid, see Section 4.3.3.2, *Fauna*), Hawaiian coot, and Hawaiian gallinule have been observed in habitat directly adjacent to Kalaeloa. Hawaiian coot have been observed nesting at Ordy Pond (RCUH, 2017; SOH DOT, 2020) and in large numbers at Wai Kai Wetland and Lagoon directly east of White Plains Beach and Cottages (SOH DOT, 2020). Hawaiian duck and Hawaiian gallinule have been observed at Saratoga Canal directly west of the Biosolids Treatment Facility (SOH DOT, 2020).

The band-rumped storm petrel, Hawaiian petrel, and Newell's shearwater are not known to inhabit Kalaeloa but have potential to fly over the study area from suitable nesting habitat in the Waiʻanae Mountains to the ocean.

The white tern or manu-o-kū (*Gygis alba)* was observed during a point count survey conducted at Kalaeloa Airport, directly adjacent to the Biosolids Treatment Facility, in 2019 (SOH DOT, 2020). Potentially suitable nesting habitat (e.g., large monkeypod [*Samanea saman*] trees) is present at the Biosolids Treatment Facility and Barbers Point Golf Course.

Terrestrial Mammal Species

Potentially suitable habitat for Hawaiian hoary bat is present at Kalaeloa (vegetation greater than 15 feet [4.6 meters] in height), but it has not been confirmed if the species is present at Kalaeloa.

Marine Mammal and Reptilian Species

The Hawaiian monk seal and green sea turtle are known to haul out along the beaches of Kalaeloa.

Arthropod Species

Potentially suitable habitat for Hawaiian yellow-faced bees is present at Nimitz Beach and Cottages, and White Plains Beach and Cottages in the form of coastal strand, but it has not been confirmed if Hawaiian yellow-faced bees are present in these areas.

Plant Species

ʻAkoko (*Euphorbia skottsbergii* var*. skottsbergii*) and round-leaf chaff flower shrub or ʻewa hinahina (*Achyranthes splendens* var. *rotundata*) are known to occur within the Kalaeloa District. The ʻakoko shrub occurs within Lot 13058-D, which is currently categorized as BRAC land and as such will not be further discussed as part of natural resources for Kalaeloa. The round-leaf chaff flower shrub occurs outside of the Navy-retained lands at Kalaeloa. Pua pilo (*Capparis sandwichiana* var. *zoharyi*), an endemic shrub that is a SOH species of concern, has been documented along the southern boundary of the Kalaeloa District but not within the Navy-retained lands.

ES.1.5 The Way Ahead

This INRMP reflects the mutual agreement between the USFWS, NMFS, and SOH DLNR representatives concerning the conservation of the natural resources under their respective legal authorities, consistent with a 2013 Memorandum of Understanding (MOU) between DoD, U.S. Department of the Interior, and the association of fish and wildlife agencies for a cooperative integrated natural resources management program on military installations. In order to evaluate the effectiveness of INRMP implementation, a Natural Resources Conservation Metrics Meeting is held annually. These meetings enable installation natural resources staff and agency partners to measure both successes and shortcomings of INRMP implementation. In addition to facilitating annual coordination with the resource agency partners, natural resource managers use the results of the evaluation to support the ESA expenditure reporting to

Congress, inform DoD and DON chains of command regarding the status of natural resources programs, and to provide data for the Navy portion of the DoD annual report to Congress.

The annual Natural Resources Conservation Metrics Meeting, along with other meetings between NRH and resource agency partners will identify necessary modifications to the INRMP resulting from changes in mission, existing baseline natural resources conditions, and the status of listed species. In addition, the meetings are intended to facilitate “adaptive management” with respect to ongoing actions or new data regarding species or habitats by providing an opportunity for the parties to review the goals and objectives of the INRMP. Any modifications that emerge from the meetings will be incorporated into annual updates that will be incorporated internally (i.e., NRH and agencies will apply them as part of the INRMP) on an ongoing basis and will then be incorporated into ensuing 5-year INRMP updates, which are available for public review. It is through this process that NRH will ensure the continued support of DoD’s current and evolving mission requirements while conserving and managing the natural resources at JBPHH.

ES.1.6 Organization

Chapters 1 and 2 of this INRMP describe the purpose and scope of the INRMP, as well as the management strategies for its implementation. Natural resources management uses an ecosystem management approach, with special consideration given to protected species and rare habitats. An adaptive management strategy is described, whereby ongoing natural resources surveys are used to guide, and potentially change, the management actions required. The natural resources staff at NAVFAC HI are responsible for implementing the INRMP. The INRMP is developed, updated, and reviewed in cooperation with the Sikes Act partners: USFWS, NMFS, and SOH DLNR.

Chapter 3 addresses climate adaptation as directed by DoDI and Manuals to describe historical regional trends and future projections of climate change and use a vulnerability assessment approach to identify potential mission impacts and management (adaptation and/or mitigation) priorities.

Chapters 4 through 7 detail the natural resources, military activities, and current management actions and policies for JBPHH at JBPHH Main Base and Surrounding Areas, JBPHH Lualualei Annex, JBPHH Wahiawa Annex, and Kalaeloa, respectively. Each area has unique natural resources and operational activities; therefore, management goals and objectives are detailed separately for each site.

Chapter 8 provides an implementation plan for JBPHH’s natural resources projects. Chapter 9 provides a summary of the references used to prepare the INRMP. Chapter 10 provides a listing of the preparers and contributors to the plan.

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FIGURES

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1 Overview

This Integrated Natural Resources Management Plan (INRMP) has been developed for the United States (U.S.) Department of the Navy (DON), Navy Region Hawaii[1] (NRH) for Joint Base Pearl Harbor-Hickam (JBPHH) to meet the statutory requirements of the Sikes Act (16 U.S. Code [U.S.C.] 670a et seq.), as amended (2015). This document revises and combines previous INRMPs and natural resources management plans for JBPHH lands and submerged areas.

This INRMP complies with the Sikes Act, which requires the preparation, implementation, and review for operation and effect of an INRMP at all U.S. Department of Defense (DoD) installations in the U.S. and its territories that contain significant natural resources. Section 101(a)(2) of the Sikes Act (as amended) requires the Secretary of the Navy (SECNAV) to prepare INRMPs in cooperation with the U.S. Fish and Wildlife Service (USFWS) and appropriate state and territorial fish and wildlife agencies. DoD Instruction (DoDI) 4715.03 (2018) instructs military installations to identify, address, and resolve INRMP issues with the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) when matters of essential fish habitat (EFH), listed marine species, and/or marine fisheries are involved.

DON has partnered with the USFWS, NMFS, and State of Hawaiʻi (SOH) Department of Land and Natural Resources (DLNR) to provide technical assistance, review, and expert guidance regarding terrestrial and marine resources addressed in this INRMP, in particular, species listed under the Endangered Species Act (ESA) (16 U.S.C. 1531 et seq.), Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703-712), Marine Mammal Protection Act (MMPA) (16 U.S.C. 1361 et seq.), and species and habitats covered under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (16 U.S.C. 1801 et seq.). Furthermore, this INRMP reflects mutual agreement between DON and its partnering agencies on the conservation of natural resources.

The JBPHH INRMP provides DON with an implementable framework for managing the natural resources on the land and nearshore areas it owns, leases, or controls (Table 1-1). INRMPs are the primary means by which natural resources compliance and stewardship priorities are set and funding requirements are determined for DoD installations. In accordance with DoDI 4715.03 (2018), the INRMP provides for no net loss in the capability of installation lands to support the military mission, pursuant to section 670a(b)(1)(I) of the Sikes Act.

[1] Diacritical marks are used in Hawaiian names throughout the INRMP except for military installation names which do not use diacritical marks.

Table 1-1 JBPHH-administered and Leased Terrestrial and Submerged Lands

<table>
<tr><th>INRMP Study Area</th><th>Terrestrial Lands</th><th>Submerged Lands</th></tr>
<tr><td>JBPHH Main Base (combines Pearl Harbor Naval Complex and Hickam AFB) and Surrounding Areas</td><td>10,728 acres
(4,341 hectares)</td><td>40,199 acres
(16,268 hectares)</td></tr>
<tr><td>Naval Magazine Pearl Harbor Lualualei Branch</td><td rowspan="2">9,220 acres
(3,731 hectares)</td><td rowspan="2">NA</td></tr>
<tr><td>Naval Radio Transmitter Facility Lualualei</td></tr>
<tr><td>Naval Computer and Telecommunications Area Master Station Pacific Wahiawa, Camp Stover Family Housing Community, and Opana Radar Site</td><td>726 acres
(294 hectares)</td><td>NA</td></tr>
<tr><td>Kalaeloa (formerly Naval Air Station Barbers Point)</td><td>416 acres
(168 hectares)</td><td>NA</td></tr>
<tr><td>Total Managed Acreage</td><td>21,090 acres
(8,535 hectares)</td><td>40,199 acres
(16,268 hectares)</td></tr>
</table>

Notes: AFB = Air Force Base; INRMP = Integrated Natural Resources Management Plan; JBPHH = Joint Base Pearl Harbor-Hickam; NA=Not Applicable

1.1 Organization

Chapters 1 and 2 describe the purpose and scope of the INRMP, as well as the management strategies for its implementation. Natural resources management uses an ecosystem management approach, with special consideration given to protected species and rare habitats. An adaptive management strategy is described, whereby ongoing natural resources surveys are used to guide, and potentially change management actions, as needed. The natural resources staff at Naval Facilities Engineering Systems Command[2] Hawaii (NAVFAC HI) are responsible for implementing the INRMP.

Chapter 3 addresses climate adaptation as directed by DoD Instructions and Manuals to describe historical regional trends and future projections of climate change and uses a vulnerability assessment approach to identify potential mission impacts and management (adaptation and/or mitigation) priorities.

Chapters 4 through 7 detail the natural resources, military activities, and current management actions and policies for JBPHH at JBPHH Main Base and Surrounding Areas, JBPHH Lualualei Annex, JBPHH Wahiawa Annex, and Former Naval Air Station Barbers Point (NASBP) (referred to as Kalaeloa), respectively. Each area has unique natural resources and operational activities; therefore, management goals and objectives are detailed separately for each study area.

Chapter 8 provides an implementation plan for JBPHH's natural resources projects. Chapter 9 provides a summary of the references used to prepare the INRMP. Chapter 10 provides a listing of the preparers and contributors to the plan.

Appendix A provides a list of acronyms and abbreviations.

Appendix B provides the complete list of relevant environmental laws, regulations, policies, guidance, instructions, and Executive Orders (EOs) that guided the preparation of this INRMP.

Appendix C provides the Environmental Assessment of the INRMP.

Appendix D provides the Blanket Section 401 Water Quality Certification.

[2] Previously Naval Facilities Engineering Command. Official name changed in 2019.

Appendix E provides a copy of DON's correspondence with the SOH Coastal Zone Management (CZM) Program regarding DON and U.S. Marine Corps De Minimis Activities under the Coastal Zone Management Act (CZMA).

Appendix F provides the Notice of Availability and public review comments received.

Appendix G provides the Memorandum of Understanding (MOU) for the implementation of INRMPs and correspondence with Working Group members.

Appendix H provides a list of the stakeholder names.

Appendix I contains definitions of species' regulatory status definitions.

Appendix J contains key biological reference documents for Main Base and Surrounding Areas.

Appendix K contains key biological reference documents for Lualualei Annex.

Appendix L contains key biological reference documents for Wahiawa Annex.

Appendix M contains key biological reference documents for Kalaeloa.

Appendix N provides copies of biological opinions and example best management practices (BMPs).

1.2 Purpose

The purpose of this INRMP is to maintain long-term ecosystem health and operational requirements of the DoD's mission while minimizing impacts to natural resources at JBPHH. The INRMP provides a framework where natural resources are managed in accordance with the Sikes Act mandate to provide "no net loss in the capability of military installation lands to support the military mission of the installation." This INRMP serves three main functions: (1) as an information repository for natural resource information, assets, and constraints; (2) as guidance on how JBPHH is to comply with regulatory and planning processes, such as those required by the National Environmental Policy Act (NEPA) (42 U.S.C. 4321-4370h), ESA, Clean Water Act (CWA) (33 U.S.C. 1251 et seq.), MSFCMA, and DoD and DON policies and legal requirements regarding natural resources planning; and (3) it identifies management goals, required actions, and resources necessary to protect and manage the installation's natural resources to provide the flexibility required to maintain "no net loss capability." This document is a long-term planning document to guide the Installation Commanding Officer in the management of natural resources to support the installation's mission, while protecting and enhancing installation resources.

This INRMP provides technical guidance to persons planning and/or preparing installation approvals, management projects, orders, instructions, guidelines, standard operating procedures, and other plans for integrating natural resources management efforts into JBPHH's planning and decision-making processes. This INRMP does not dictate land use decisions but, rather, provides information relevant to support sound land use decisions and natural resources management.

1.3 Scope

DON installations, including JBPHH, that control land and water assets with significant natural resources requiring conservation and management are required to prepare and implement an INRMP. Additionally, the INRMP must be reviewed for operation and effect regularly by the primary parties, "not less often than every five years" per Section 101(b)(2) of the Sikes Act. The annual review process is broadly guided by DoDI 4715.03, *Natural Resources Conservation Program* (DoD, 2018); Office of the Chief of Naval Operations Instruction (OPNAVINST) 5090.1, *Environmental Readiness Program* (DON, 2021); and USFWS *Guidelines for Coordination on INRMPs* (USFWS, 2018). The INRMP and its updates are to include all elements of natural resources management applicable to the installation. The INRMP and its updates must address compliance with federal mandates protecting specific natural resources. INRMPs are intended as living documents that are continually updated and revised in accordance with DON policies. This INRMP outlines conservation efforts at JBPHH and establishes procedures to ensure compliance with applicable environmental laws and regulations.

OPNAVINST 5090.1 (DON, 2021) Section 12-3.4b states that "Navy INRMPs must address installation watersheds, shorelines, and nearshore areas such that benefits are provided to aquatic species and habitats in waters adjacent to Navy installations." Therefore, in addition to terrestrial natural resources, this INRMP also addresses marine natural resources associated with JBPHH-administered and submerged lands or nearshore waters. For the purposes of this INRMP and in accordance with OPNAVINST 5090.1 (Section 12-5.38) (DON, 2021) and DoDI 4715.03 (DoD, 2018), nearshore waters are defined as those waters and submerged lands adjoining the installation from the mean high water mark (i.e., the line on the shore established by the average of all high tides) to the boundaries of installation waterfront activities where DON controls access, and that are subject to the immediate authority of the JBPHH Installation Commanding Officer or tenant command.

1.4 Responsibilities

Environmental stewardship is the responsibility for managing and caring for natural resources to ensure that these resources are sustainably managed for current and future generations. Stewardship of the environment can include recycling, conservation, regeneration, and restoration. It is an ethic whereby natural resources managers and personnel participate in the careful and responsible management of air, land, water, and biodiversity to ensure healthy ecosystems for present and future generations. Stewardship embodies cooperative planning and management of environmental resources with agencies, community organizations, and others to actively engage in the prevention of loss of habitat and to facilitate habitat recovery in the interest of long-term stability.

NAVFAC HI Natural Resources staff are responsible for the preparation and implementation of the INRMP under direction of the Installation Commanding Officer. Naval Facilities Engineering Systems Command Pacific (NAVFAC PAC) and the JBPHH Installation Environmental Program Director (IEPD) provide additional support. NAVFAC HI and NAVFAC PAC natural resources staff work as a liaison for DON with USFWS, NMFS, the U.S. Department of Agriculture (USDA), and SOH DLNR personnel to adaptively manage these resources and to comply with the pertinent laws, regulations, and guidance presented in Section 1.6, *Authority*. Additionally, NAVFAC HI Natural Resources staff provide annual project budget implementation schedules with program and budget oversight from NAVFAC HI Natural Resources Branch Supervisor.

The IEPD ensures coordination among facilities planners, resource managers, federal, SOH, and City and County of Honolulu (CCH) officials. The JBPHH Natural Resources Manager is the designated point of contact for providing relevant information on issues with potential to affect protected species, direct habitat loss due to clearance and construction, proximity to neighboring habitats, and sensitivity of species to disturbance. NAVFAC HI supports JBPHH with natural resources expertise and serves as the point of contact for natural resources issues.

NAVFAC HI and NAVFAC PAC, on behalf of JBPHH, reviews and submits natural resources-related consultations and permits for projects occurring on Navy property.

1.5 Military Mission

1.5.1 Achieving No Net Loss to the Military Mission

INRMPs are principally intended to help the Installation Commanding Officer and natural resources staff manage natural resources more effectively to ensure that installation lands and waters remain available and in good condition to support the military mission (i.e., provide for “no net loss in the capability of the military installation lands to support the military mission of the installation”). Through implementing effective planning and conservation measures, the INRMP also provides a guide for meeting natural resources and conservation compliance requirements.

Appropriate management objectives to protect mission capabilities of installation lands (from which annual projects are developed) must be clearly articulated in the planning process and be high in INRMP resourcing priorities. The effectiveness of the INRMP in providing for “no net loss” is evaluated annually. Where applicable, mission requirements and priorities identified in the INRMP are integrated in other environmental programs and policies. It is not the intent of the DoD to exploit or destroy natural resources to achieve mission requirements, but rather to sustain natural resources in order to support mission requirements. In order to achieve this, environmental programs and policies must have the goal of controlling environmental encroachment and preserving an unencumbered environment for the purpose of the mission.

1.5.2 Defining Impact to the Military Mission

Impacts to the military mission can be defined by a loss of or reduction in ability to use land areas and facilities required to meet the operational requirements of the installation. This could include loss in training areas, base support, airfield operations, infrastructure, costly workarounds, missed training and maintenance availabilities (e.g., ship berthing space), and/or delays in the mission due to lack of permits or violations of pertinent laws, regulations, and/or requirements.

Natural resources are managed to support the military mission and to provide sustainable environments for training, education, and operations. Ecosystem management recognizes that people are an integral component of ecological systems, and it supports maintaining natural resources and sustainable development. Within the safety and operational constraints, the installations work to provide outdoor recreational opportunities. These outdoor recreational opportunities are consistent with demand from installation personnel, residents, military retirees in nearby communities, and the general public.

1.6 Authority

The Sikes Act is the basis for the preparation of the INRMP. In addition, other legal requirements governing federal actions are followed, including laws for protected species and habitat, wetlands, water quality, and environmental contamination. The following subsections provide a summary of these legal requirements as they pertain to this INRMP. Appendix B provides the complete list of relevant environmental laws, regulations, policies, guidance, instructions, and EOs that guided the preparation of this INRMP.

1.6.1 Sikes Act (as amended) and Related Guidance

The Sikes Act requires that the Secretary of Defense carry out a program for the conservation and rehabilitation of natural resources on military installations. To facilitate the program, the Secretary of each military department is required to prepare and implement an INRMP and its updates for each installation. Furthermore, the Sikes Act requires that, consistent with the use of the military installations to ensure the preparedness of the Armed Forces, each INRMP shall, where appropriate and applicable, provide for:

- conservation and rehabilitation of natural resources;
- sustainable, multi-purpose use of resources;
- public access that is necessary and appropriate for the use described above, subject to safety and military security requirements;
- specific natural resources goals and objectives, and timeframes for acting on them;
- fish and wildlife management, land management, and forest management;
- fish and wildlife habitat enhancement or modifications;
- wetlands protection, enhancement, and restoration where necessary for support of fish, wildlife, and/or plants;
- integration of and consistency among various activities conducted under the INRMP;
- sustainable use by the public of natural resources to the extent that use is not inconsistent with the needs of fish and wildlife resources;
- enforcement of natural resources laws and regulations;
- no net loss in the capability of the military installation lands to support the military mission of the installation; and
- such other activities as the SECNAV determines appropriate.

Development and implementation of this INRMP fulfills the statutory requirements under the Sikes Act, which is viewed as an umbrella law with regard to management of natural resources on military lands. Thus, this INRMP helps ensure JBPHH compliance with applicable federal and SOH laws, as appropriate, as well as DoD and DON guidelines, instructions, and directives that require military installations to manage and protect sensitive biological and other natural resources.

1.6.2 National Environmental Policy Act

NEPA (42 U.S.C. 4321-4370h) requires an environmental analysis of major federal actions, including actions that occur with federal funding or on federal lands. NEPA requires the evaluation of the environmental effects of proposed land use and development, and military training activities. The Council on Environmental Quality (CEQ) defines an INRMP as a major federal action requiring NEPA analysis. As a result, DON Office of General Counsel has determined that Sikes Act requirements for INRMP implementation necessitates the preparation of NEPA documentation prior to INRMP approval. Although annual updates and revisions would be covered under the original NEPA documentation, this INRMP revision includes major updates that require additional NEPA analysis.

The NEPA process requires coordination with appropriate federal and state agencies and the general public. The public review process scopes or identifies significant issues to develop and evaluate alternatives. If an Environmental Assessment (EA) finds “no significant impacts,” DON would complete the preparation of a formal Finding of No Significant Impact (FONSI) and make it available for public review. The preparation of an Environmental Impact Statement (EIS) occurs only if significant impacts are identified.

The Office of the Chief of Naval Operations (OPNAV) N4I54, *INRMP Guidance for Navy Installations* (DON, 2017), and OPNAVINST 5090.1 (DON, 2021) provide additional guidance on NEPA compliance for the development of INRMPs. DoDI 4715.03 (2018) states that installations should offer members of the public an opportunity to comment on an INRMP revision, as appropriate (although not expressly required by the Sikes Act). In addition, if the proposed revisions reflect changes in the natural resource management projects described in the existing INRMP, NEPA review must, in most cases, be performed before the new INRMP may be adopted. Installations should afford the appropriate USFWS and state or territorial fish and wildlife management offices the opportunity to review all public comments received on any revised INRMP.

DON uses the NEPA planning processes and documentation to guide specific management projects, and document choices and enforce mitigation measures proposed in those NEPA documents. An EA has been developed in association with this INRMP to comply with CEQ and NEPA requirements. The EA evaluated the INRMP to ensure that there will be no significant negative environmental or social consequences for implementing the plan and its associated management projects. The full EA can be found in Appendix C.

1.6.3 Endangered Species Act

Under the ESA (16 U.S.C. Part 1531-1544 [Public Law (PL) 93-205] Section 1.5.5), all federal agencies are required to carry out programs to protect and conserve federally-listed threatened and endangered species in consultation with the USFWS and/or NMFS, which each have responsibilities in administering the Act.

DON’s guidance for federal ESA-listed threatened and endangered species is found in OPNAVINST 5090.1 (DON, 2021). Specifically, DON shall consult with the USFWS and/or NMFS when any action authorized, funded, or to be carried out by DON may affect any federal ESA-listed threatened or endangered species or primary constituent elements of designated critical habitat. Some species (e.g., sea turtles and anadromous fishes) are jointly managed by both the USFWS and NMFS, so it is important to identify the life stage of the species potentially affected by a proposed action, as this will determine the agency with which to consult. The required processes are detailed in 50 Code of Federal Regulations (CFR) Part 402.

If a proposed action may affect federal ESA-listed species or designated critical habitat, the action proponent must request ESA section 7 consultations with the USFWS and/or NMFS per reference (40 CFR 1700). Consultation is required even if the action is wholly beneficial to ESA-listed species. There is no statutory obligation to consult with USFWS and/or NMFS if a proposed action does not affect federal ESA-listed species or designated critical habitat.

The INRMP is programmatic in nature and is a planning document. As such, an action’s potential to affect listed and proposed species and designated and proposed critical habitat will be assessed on a project-specific basis. When appropriate, a programmatic consultation on all natural resource management actions in the INRMP may be considered instead of separate, project-specific consultations. Any required consultation with the USFWS and/or NMFS must be completed prior to undertaking an action affecting such species and/or habitats.

As a matter of policy, actions to protect species listed as threatened or endangered under the ESA are given top priority in the INRMP. As defined by the ESA, endangered species are species in danger of extinction throughout all or a significant portion of their range. Threatened species are those which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range. ESA defines “critical habitat” as the specific areas within the geographical area occupied by the species at the time it is listed on which are found those physical or biological features essential to the conservation of the species and which may require special management considerations or protection. Critical habitat may also include areas unoccupied by the species where the Secretary of the Interior has determined that such areas are essential for the conservation of the species.

Proposed species for listing under the ESA are those candidate species that were found to warrant listing as either threatened or endangered, after completion of a status review and consideration of other protective conservation measures.

Candidate species are those species that are actively being considered for listing as endangered or threatened under the ESA, as well as those species that USFWS and/or NMFS has initiated an ESA status review announced in the Federal Register. Neither “candidate species” nor “species of concern” carries any procedural or substantive protections under the ESA (50 CFR §424.02 and 69 Federal Register 19975).

1.6.3.1 Critical Habitat

As required by the ESA, when a species is proposed for listing as endangered or threatened, USFWS and/or NMFS identifies critical habitat: specific areas that contain the physical or biological features essential to that species conservation. The ESA requires USFWS and/or NMFS to designate critical habitat when it is both prudent and determinable (USFWS, 2017).

DON installations with federally-listed threatened or endangered species, proposed federally-listed threatened or endangered species, candidate species, or unoccupied habitat (as defined in Section 3 of the ESA) for a listed species where critical habitat may be designated, must structure the installation’s INRMP to avoid the designation of critical habitat. The INRMP may obviate the need for designating critical habitat if it specifically addresses both the benefit provided to the listed species and the provisions made for the long-term conservation of the species and habitat. Pursuant to Section 4(a)(3)(B)(i) of the ESA, the Secretaries of the Departments of the Interior and Commerce shall not designate as critical habitat any lands owned or controlled by the DoD, or designated for its use, that are subject to an INRMP prepared pursuant to Section 101 of the Sikes Act (16 U.S.C. 670), if it can be determined in writing that the INRMP provides a benefit to the species for which critical habitat is proposed for designation. The species benefit must be clearly identified in the document and should be referenced as a specific topic in the INRMP table of contents.

In 2012, the USFWS determined that DON’s 2011 JBPHH INRMP and 2012 addendum provided conservation benefits to the 60 federally-listed plant species that occur or have potential to occur within NAVMAG PH Lualualei and NRTF Lualualei. Therefore, USFWS exempted 380 acres (154 hectares) of DON lands at NAVMAG PH Lualualei and NRTF Lualualei from critical habitat designation for those species under section 4(a)(3)(b)(i) of the ESA (USFWS, 2012). However, critical habitat designated for the Oʻahu ʻelepaio (*Chasiempis ibidis*) in 2001 does include lands within NAVMAG PH Lualualei. During the revisions of critical habitat for Hawaiian monk seals or īlioholoikauaua *(Neomonachus schauinslandi*), NMFS found that the 2011 JBPHH INRMP contained measures that benefit the Hawaiian monk seal (580 Federal Register 50925 and 50 CFR 226). Conservation measures include debris removal, prohibitions against lay nets and gill nets, enforcement of rules via a conservation law enforcement officer, interagency cooperation for rehabilitation events; use of established procedures for seal haul-out and pupping events; educational outreach (including classroom briefs, web page, news articles, brochures, service projects, and on-site signage and monitoring); ecological assessment and inventories; and water quality projects (minimizing erosion and pollution) (Federal Register, 2011). NMFS concluded that all areas subject to the JBPHH INRMP (including Nimitz Beach and Cottages, White Plains Beach and Cottages, and Puʻuloa Underwater Training Range) are precluded from Hawaiian monk seal critical habitat designations. Figure 1-1 depicts the Hawaiian monk seal critical habitat within the vicinity of JBPHH.

In addition, NMFS found that the JBPHH INRMP also provided conservation measures and management efforts that benefit the Main Hawaiian Islands insular false killer whale (*Pseudorca crassiens*) and determined that the Naval Defensive Sea Area and the Ewa Training Minefield were ineligible for critical habitat destination (83 Federal Register 35062; 50 CFR 224; 50 CFR 226). The NMFS considered these areas to be low use (low-density) areas and found that measures taken by the DON such as improving water quality, removing feral animals, and mitigation measures taken to avoid or reduce acoustic or physical disturbance benefit the species and habitat (Federal Register, 2018). The Navy Shipboard Electronic Systems Evaluation Facility was provided an exclusion from critical habitat designation due to National Security under section 4(b)(2) of the ESA. Figure 1-2 depicts the Main Hawaiian Islands insular false killer whale critical habitat within the vicinity of JBPHH.

1.6.4 Management of Migratory Birds on DoD Lands

The MBTA of 1918 implements four bilateral treaties between the U.S. and Canada, Japan, Mexico, and the former Soviet Union (now Russia) for the protection of migratory birds. Under the MBTA, pursuing, hunting, taking, capturing, killing, and/or possessing (or attempting to do so) migratory birds, their eggs, parts, and nests, are prohibited unless permitted by regulations (e.g., salvage permit, depredation permit, issued by the USFWS).

An exemption to the MBTA that allows incidental take of migratory birds by DoD during military readiness activities, known as the DoD Military Readiness Rule, was finalized in February 2007 (USFWS, 2007). As directed by Section 315 of the 2003 National Defense Authorization Act, this rule authorizes such take, with limitations, that result from military readiness activities. If the DoD determines that a proposed or an ongoing military readiness activity might result in a significant adverse effect on a population of a migratory bird species, they must confer and cooperate with the USFWS to develop appropriate and reasonable conservation measures to minimize or mitigate identified significant adverse effects. MBTA-listed species known to occur on JBPHH are listed in Table 4-9 and addressed specifically in Chapters 4 through 7.

DoD installations must ensure that INRMPs and NEPA analyses adequately address migratory bird management and the potential impacts of proposed military activities—readiness and non-readiness related alike—on migratory birds. Section 315 of the 2003 National Defense Authorization Act and the Military Readiness Rule (50 CFR Part 21) authorize, with certain limitations, the incidental take of migratory birds during military readiness activities. Nonetheless, the DoD must give appropriate consideration to protecting migratory birds when planning and executing military readiness activities; however, implementing protections must not diminish the effectiveness of those activities.

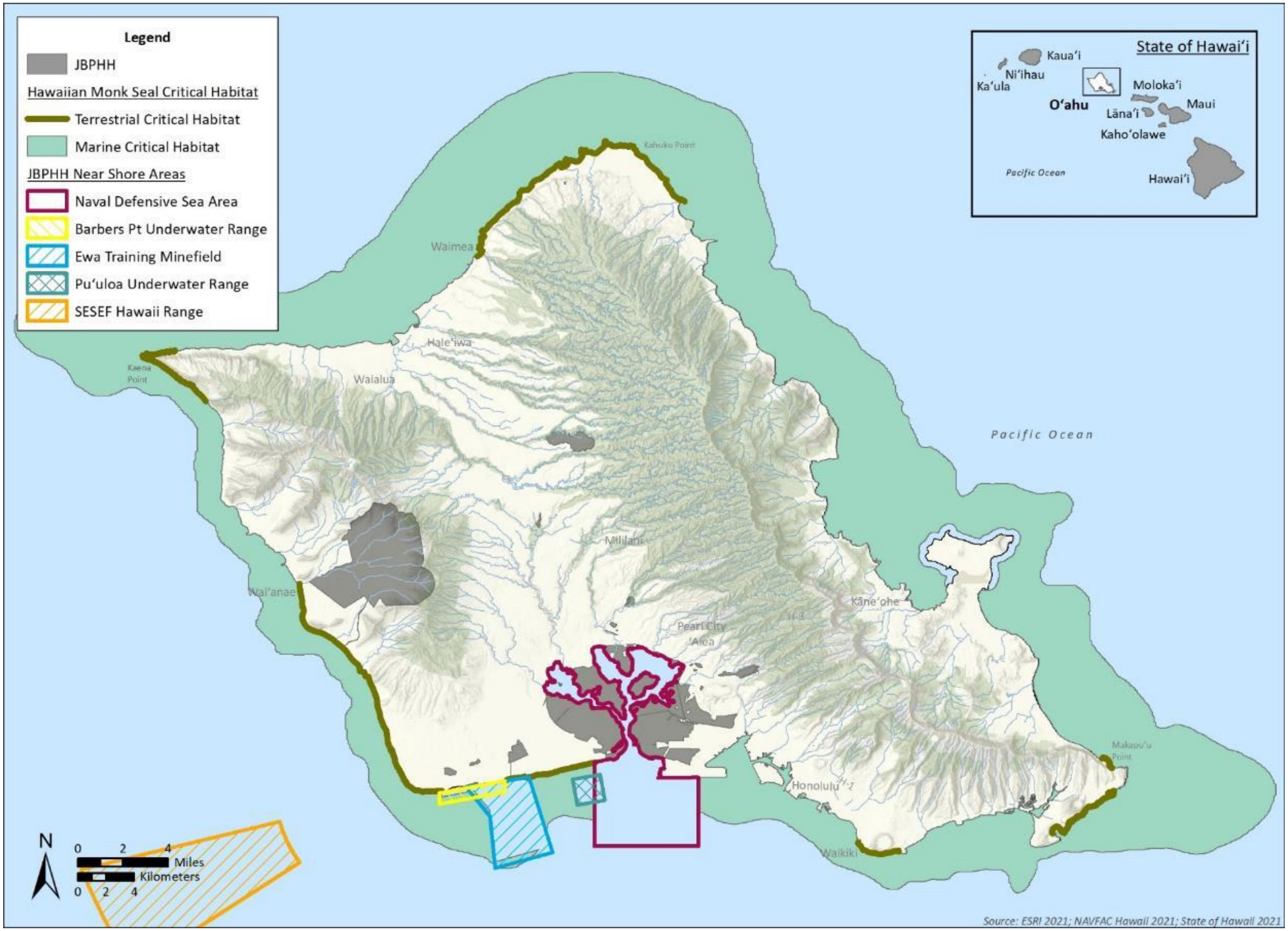


Figure 1-1 Hawaiian Monk Seal Critical Habitat within the Vicinity of JBPHH

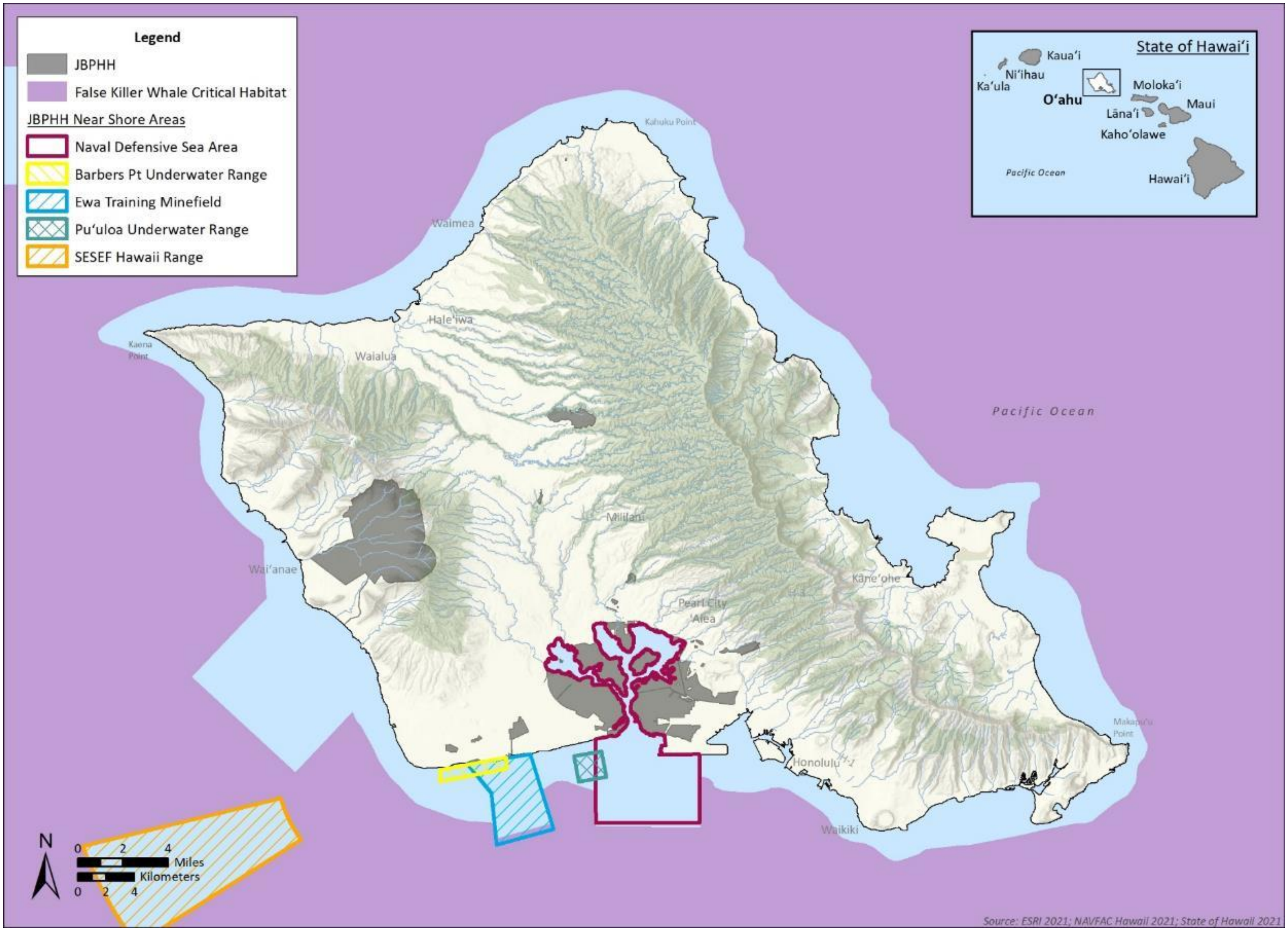


Figure 1-2 Main Hawaiian Islands Insular False Killer Whale Critical Habitat within the Vicinity of JBPHH

This requirement pertains to all military readiness activities, not just those that may result in a significant adverse effect on a population of a migratory bird species (see Preamble to Final Rule on the Take of Migratory Birds by the Armed Forces, 72 Federal Register 8931-8950 [February 28, 2007] [USFWS, 2007]). Military Readiness Rule Part 21.15 (DON, 2019) authorizes incidental take of migratory birds for military readiness activities provided DON action proponent confers with USFWS to develop and implement appropriate conservation measures to minimize or mitigate negative effects of the proposed action if the action will have a significant negative effect on the sustainability of a population of a migratory bird species. Potential impacts to migratory bird populations and MBTA compliance shall be addressed in NEPA analysis using information from the appropriate INRMP where applicable, and the best scientific data available.

EO 13186 outlines responsibilities of federal agencies to protect migratory birds. The 2014 MOU between the DoD and USFWS to Promote the Conservation of Migratory Birds includes specific measures to promote the conservation of migratory bird populations while sustaining the use of military managed lands and airspace for testing, training, and operations. These measures include, but are not limited to, developing policies and procedures for facilities designs that integrate bird safe building glass, strategic siting to avoid important habitats, maximizing the use of native landscaping to promote migratory bird habitat (except in areas subject to Bird/Wildlife Aircraft Strike Hazards [BASH]), turning off interior building lighting at night, implementing the Dark Skies Instruction (Commander, NRH Instruction [COMNAVREGHIINST] 5090.9), and following best practices in coordination with USFWS when planning construction of new utility and energy systems and associated infrastructure.

1.6.5 Magnuson-Stevens Fishery Conservation and Management Act

MSFCMA of 1976, amended in 1996, is the primary law governing marine fisheries management in U.S. federal waters. Its purpose is to prevent overfishing, rebuild overfished stocks, ensure conservation, facilitate long-term protection of EFH, and to realize the full potential of U.S. fishery resources. Authority to implement the MSFCMA is given to the Secretary of Commerce.

The MSFCMA sets mandates for NMFS, regional fishery management councils, and federal action agencies to identify, delineate, and protect important marine and anadromous fish habitat as EFH in fishery management plans or fishery management plan amendments. The EFH is the legal tool that NMFS uses to manage marine habitat through collaboration with regional fishery management councils and federal action agencies to ensure that federally managed fisheries have a healthy future.

EFH is defined in 50 CFR 600.10 as, “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” For the purpose of interpreting the definition of EFH, ‘‘waters’’ include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; ‘‘substrate’’ includes sediment, hard bottom, structures underlying the waters, and associated biological communities; ‘‘necessary’’ means the habitat required to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem; and ‘‘spawning, breeding, feeding, or growth to maturity’’ covers a species’ full life cycle. In addition, the MSFCMA defines “fish” to include finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds (16 U.S.C. 1802 § 3). EFH can apply to and be designated for any of these assemblages of species.

Important EFH that require additional protection are designated as Habitat Areas of Particular Concern (HAPCs). HAPCs meet various criteria including major ecological function, sensitivity to decline, stress from development, and rare habitat.

The MSFCMA requires federal agencies to consult with NMFS on activities that could adversely affect EFH or when NMFS independently learns of a federal activity that could adversely affect EFH. The MSFCMA defines an adverse effect as "any impact which reduces quality and/or quantity of EFH [and] may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey, reduction in species' fecundity), site-specific or habitat wide impacts, including individual, cumulative, or synergistic consequences of actions" (50 CFR 600.810). OPNAVINST 5090.1 (DON, 2021) describes DON policy on EFH assessments and consultations and clarifies the MSFCMA consultation requirements with NMFS. JBPHH Instruction 5510.3, *Pearl Harbor Naval Defensive Sea Area Entry Regulations for Recreation* describe JBPHH's installation-specific instructions (DON, 2016).

All of the water column and benthic nearshore resources and submerged lands under the management responsibility of JBPHH are designated as EFH under the MSFCMA.

1.6.6 Marine Mammal Protection Act

The MMPA established a federal responsibility to protect and manage marine mammals. The MMPA prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens in international waters, and the importation of marine mammals and marine mammal products into the U.S. "Take" of marine mammals is defined as the harassment, hunting, capturing, killing, or the attempt of such actions. USFWS is responsible for the following marine mammals: sea otters, walrus, polar bear, manatees, and dugong. Those mammals that are wholly marine inhabitants, cetaceans and pinnipeds, other than walrus, are the responsibility of NMFS.

OPNAVINST 5090.1 (DON, 2021) and DoDI 4715.03 (2018) require that activities affecting marine species and DON-administered submerged lands be addressed in the INRMP.

Unlike the ESA, there is no consultation requirement under the MMPA. If take (lethal and non-lethal) is reasonably foreseeable, DON must obtain a Letter of Authorization (LOA; for potential lethal take) or an Incidental Harassment Authorization (IHA; no potential for lethal take) from NMFS. Obtaining a LOA takes 12 to 18 months, while an IHA can take as little as 6 to 9 months. An IHA may be issued if, (a) there is no potential for serious injury or mortality; or (b) the potential for serious injury or mortality can be negated through mitigation requirements.

1.6.7 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (FWCA) (16 U.S.C. 661-667e) ensures that water resources development projects must consider wildlife conservation in order to avoid or minimize impacts to those natural resources and/or habitats. Under this Act, federal agencies proposing actions that result in the control or modification of a natural stream or body of water, including issuance of permits, must consult with the USFWS, NMFS, and the affected state or territory's fish and wildlife management agency. Typical actions that would fall under the jurisdiction of the FWCA include dredging or filling of federal and state waters, replacement or installation of stormwater/surface runoff structures, improvements to harbor/shoreline structures and facilities, shoreline protection measures, coastal and/shoreline nourishment, discharges of pollutants, including industrial and municipal wastes or dredged and fill material into a body of water or wetlands; and projects involving construction of impoundments, stream relocation, and water-diversion structures. Consultation is to be undertaken for the purpose of "preventing loss of and damage to wildlife resources." The FWCA provides a basic procedural framework for the orderly consideration of fish and wildlife conservation measures to be incorporated into federal and federally permitted or licensed water development projects.

1.6.8 Clean Water Act

The CWA is the primary federal statute regulating the protection of the waters of the U.S. The CWA aims to prevent, reduce, and eliminate pollution in the nation's waters in order to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters," as described in CWA section 101(a). A stated goal of the CWA is to eliminate discharge of pollutants into navigable waters, as that term is defined in CWA section 502(7) and corresponding case law.

Federal facilities have regulatory responsibilities under the CWA, including:

- preventing water pollution,
- obtaining discharge permits,
- providing necessary mitigation and compensation for permitted impacts,
- meeting applicable water quality standards,
- developing risk and resiliency management plans, and
- maintaining records.

Waters below the marine high tide line (high water mark), and the ordinary high water mark on intermittent and perennial freshwater drainages that are navigable are considered waters of the U.S. In addition, wetlands (e.g., salt marsh) and vegetated shallows (e.g., eelgrass and surf grass stands) are considered Special Aquatic Sites under Section 404 of the CWA; therefore, any type of in-water construction that affects substrate or causes discharge of dredge or fill material must be permitted and impacts mitigated.

The U.S. Army Corps of Engineers (USACE) and U.S. Environmental Protection Agency (EPA) specifically define wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under natural circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." The USACE Wetland Delineation Manual (Environmental Laboratory, 1987) defines wetlands as areas having all three of the following parameters present:

1. Hydrophytes (i.e., water-loving plants)
2. Substrate of predominantly undrained hydric soil
3. Substrate that is saturated with water or covered by shallow water at some time during the growing season of each year

In 2012, USACE developed the Regional Supplement to the USACE Wetland Delineation Manual, which includes the Hawaiʻi and Pacific Island Region to help further define wetland parameters on a regional basis (USACE, 2012). On April 21, 2020, EPA and USACE published the Navigable Waters Protection Rule in the Federal Register to finalize a revised definition of "waters of the United States" under the CWA. The final rule became effective on June 22, 2020. On September 3, 2021, the EPA announced that the EPA and the USACE have halted the Navigable Waters Protection Rule and are applying the pre-2015 "waters of the United States" definition. OPNAVINST 5090.1 requires "no overall net loss" of wetlands (DON, 2021). All DON facilities and operational actions must avoid, to the maximum degree feasible, wetland destruction and degradation.

1.6.8.1 Clean Water Act Section 404

Section 404 of the CWA establishes a program to regulate the discharge of dredged or fill material into waters of the U.S., including wetlands. Activities in waters of the U.S. regulated under this program include fill for development, waterfront and in-water structures, water resource projects (such as dams and levees), infrastructure development (such as utility lines, road and highways, and airports), and mining projects. Section 404 requires a permit before dredged or fill material may be discharged into waters of the U.S., unless the activity is exempt from Section 404 regulation (e.g., certain farming and forestry activities). These impacted areas also require a Section 401 water quality permit for certain discharges.

In 2008, USACE and EPA issued regulations (33 CFR Parts 325 and 332 and 40 CFR Part 230) identifying compensation requirements for impacts to wetlands, streams, and other aquatic resources authorized by permits issued under Section 404 of the CWA and/or Section 10 of the Rivers and Harbors Act of 1889. The rule included a 'watershed approach' to guide mitigation efforts and recommendations for improved planning, design, construction, and monitoring of compensatory mitigation efforts. It also recognized the benefits of mitigation banking and in lieu fee programs for providing compensation.

1.6.8.2 Clean Water Act Section 401

Congress enacted Section 401 of the CWA to provide states and authorized tribes with an important tool to help protect water quality within their borders in collaboration with federal agencies. For the waters of Pearl Harbor, the State of Hawai'i Department of Health (HDOH) Clean Water Branch (CWB) is the state agency tasked with implementing section 401 of the CWA. Under Section 401, a federal agency may not issue a permit or license to conduct any activity that may result in any discharge into waters of the U.S. unless the state where the discharge would originate issues a Section 401 water quality certification verifying compliance with existing water quality requirements or waives the certification requirement. Section 401 envisions a robust state role in the federal permitting or licensing process.

Section 401 water quality certification (WQC) is required for an activity when: (1) a federal permit, license, certificate, approval, registration, or statutory exemption is required and (2) the activity may result in a discharge into State waters. The term "discharge" is defined in CWA, §502(16), 502(12), and 502(6). Examples of "discharge" include, but are not limited to, allowing the following pollutants to enter State waters from the surface or in water: dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemicals, biological material, radioactive materials, heat, wrecked or discarded equipment, rock, sand, dirt, soil, sediment, construction debris, fugitive dust, spray paint, industrial wastes, concrete, sealant, epoxy, any underwater work, agricultural wastes, washing/cleaning effluent, and agricultural waste.

The HDOH CWB issued the Blanket Section 401 WQC (WQC0901), which became effective March 2, 2018, and was modified effective June 11, 2020, to the USACE for certain 2017 Department of the Army Nation Wide Permits (NWPs). The modified Blanket WQC now specifies general conditions including BMPs for projects and activities that shall be incorporated into the permit or license issued by the USACE. The complete list of NWPs and activities covered under the modified Blanket WQC and those not requiring a Section 401 WQC can be found in Appendix D.

Applicants no longer request coverage under the Blanket WQC by applying to HDOH CWB. The conditions of the modified Blanket WQC will be included in the permit or license issued by the USACE. USACE will determine whether the proposed project or activity is eligible for coverage under the modified Blanket WQC. If the project or activity is not covered under the Blanket WQC and a WQC is still required, the proponent will need to apply for an individual WQC with HDOH CWB.

1.6.9 Coastal Zone Management

The CZMA of 1972 (16 U.S.C. 1451-1464 [PL 92-583]) requires that all federal facilities ensure that their activities are consistent to the maximum extent practicable with the enforceable policies of an approved state CZM plan. The CZMA requires DON to consult with the SOH CZM Program when a proposed action has the potential for reasonably foreseeable direct or indirect effects on any coastal use or resource of the SOH's coastal zone. Copies of the agency review draft JBPHH INRMP were sent to the SOH CZM Program for review on March 21, 2022. As specific natural resource projects are proposed and screened for applicability, they will be submitted to the SOH CZM Program for consistency review, if required. Appendix E provides a copy of DON's correspondence with the SOH CZM Program regarding DON and U.S. Marine Corps De Minimis Activities under the CZMA.

1.6.10 Cultural Resources

DON is aware that there may be circumstances under which the protection and enhancement of natural resources could affect cultural resources. Appendix B summarizes applicable cultural resources laws, regulations, and requirements. When natural resources projects resulting from this INRMP have been precisely defined, they will be evaluated for potential effects on cultural resources. Section 106 consultation will be initiated with the State Historic Preservation Officer and native Hawaiian organizations, if appropriate, in accordance with the National Historic Preservation Act, 16 U.S.C. 470 (f), as amended, and its implementing regulations, 36 CFR part 800. In addition, other potentially applicable federal cultural resource statutes include the Archaeological Resources Protection Act of 1979 (16 U.S.C. 470aa-470ll) and Native American Graves Protection and Repatriation Act (25 U.S.C. 3001 et seq.). There are existing Integrated Cultural Resource Management Plans for various properties from the U.S. Air Force (USAF) and Navy properties that fall under JBPHH. These plans are to be updated in the future and consolidated into one overall Integrated Cultural Resource Management Plan.

1.6.11 Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 (42 U.S.C. §9601 et seq.), assigns the EPA the responsibility for regulating the uncontrolled release of hazardous substances nationwide. The Superfund Amendments and Reauthorization Act of 1986 amended CERCLA so that it applies to all federal facilities. CERCLA requires that existing areas of contamination must be identified and remediated to levels protective of human health and the environment.

DON recognizes that the release of hazardous substances, pollutants, and contaminants into the environment may result in adverse impacts to natural resources addressed in this INRMP. DON's Installation Restoration Program (IRP) is responsible for identifying CERCLA releases, considering risks and assessing impacts to human health and the environment (including impacts to endangered species, migratory bird species, and biotic communities), as well as developing and selecting response action(s) when it is likely that a release could result or has resulted in an unacceptable risk to human health or the environment. When appropriate, the regional or installation natural resources management staff will assist the IRP Remedial Project Manager in identifying potential impacts to natural resources caused by the release of these contaminants.

Regional or installation natural resources staff will also participate, as appropriate, in the IRP decision-making process by communicating natural resources issues on the installation to the Remedial Project Manager, attending Restoration Advisory Board meetings, reviewing and commenting on IRP documents (e.g., Remedial Investigation, Ecological Risk Assessment), and ensuring that response actions are undertaken in accordance with all applicable or appropriate and relevant environmental laws to avoid and minimize impacts to natural resources on the installation.

Other applicable statutes include the Oil Pollution Act of 1990, 33 U.S.C. §2701 et seq.; and Federal Insecticide, Fungicide, and Rodenticide Act of 1972, 7 U.S.C. 136 et seq. Appendix B provides a summary of the applicable environmental contamination laws, regulations, and requirements.

1.6.12 Marine Protection, Research and Sanctuaries Act

Under section 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA), USACE is the federal agency that decides whether to issue a permit authorizing the ocean disposal of dredged materials. USACE may implement MPRSA directly in federal navigation projects involving ocean disposal of dredged materials. USACE relies on EPA's ocean dumping criteria when evaluating permit requests for (and implementing federal projects involving) the transportation of dredged material for the purpose of dumping it into ocean waters. MPRSA permits and federal projects involving ocean dumping of dredged material are subject to EPA review and concurrence.

According to USACE regulations (33 CFR 325.6), MPRSA permits for, and federal projects involving the transportation of dredged material for the purpose of dumping it into ocean waters may not exceed 3 years.

USACE District Offices are responsible for coordination of all federal actions, including EPA concurrences, pertaining to MPRSA section 103 applications (permit applications for ocean dumping of dredged material). All MPRSA section 103 applications are coordinated with the appropriate EPA Regional Office.

An MPRSA permit evaluation will involve the following considerations (during the associated **application steps**):

1. **Pre-application Consultation**: Includes discussion of alternatives to minimize volume of material proposed for disposal in the ocean, including potential beneficial uses of the dredged material (e.g., sand for beach nourishment or fine grain sediments for marsh restoration), and the information and testing required to evaluate the proposed dredged material.
2. **Evaluation of Dredged Material Proposed for Ocean Disposal**: Includes development, approval, and implementation of a sampling and analysis plan and an assessment of compliance with the ocean dumping criteria.
3. **Permit Application**: 33 CFR 325.1 describes the requirements of the permit application under the MPRSA. In addition, the application should include:
    a. an evaluation of dredged material disposal alternatives including an examination of potential beneficial uses of the proposed dredged material;
    b. written documentation of the site dredging history and a general survey of other prior or current dredging activities at or near the site; and
    c. references to existing or prior MPRSA Section 103 permits.

1.7 Encroachment

The Fiscal Year (FY) 03 Defense Authorization Act involves a provision, codified as Title 10 U.S.C. 2684a. The Act provides DON with a new tool to help control environmental encroachment through executing agreements with public and private partners to acquire real estate interests near installations to help preclude environmental restrictions on military training and testing operations. A JBPHH Encroachment Action Plan was prepared in 2021 (NAVFAC HI, 2021).

1.8 INRMP Development

Installation objectives are established, prioritized, and revisited on a regular basis. This includes consideration of natural resources management to meet both installation (mission) and regional objectives. If there are any conflicts, they are resolved through periodic regional workshops and stakeholder discussions.

1.8.1 Revision and Review Process

The first INRMPs for Pearl Harbor Naval Complex (PHNC), NAVMAG PH Lualualei, NRTF Lualualei, and NCTAMS PAC Wahiawa were completed in 2001 (DON, 2001a, b, c) and the Natural Resources Management Plan for Former NASBP (now known as Kalaeloa) (DON, 1997) was completed in 1997. The Hickam INRMP was completed in 2007 (USAF, 2007). A JBPHH INRMP was completed in 2011 that included the 2007 Hickam INRMP as an insert and included a dedicated chapter to corals (NAVFAC PAC, 2011). These plans were adopted after preparation of NEPA EAs that resulted in FONSIs. This INRMP is considered a major revision and therefore triggers the need for additional NEPA analysis. An EA has been developed in association with this INRMP to comply with CEQ and NEPA requirements and can be found in Appendix C.

The Sikes Act requires that INRMPs be continually monitored, reviewed annually, updated if necessary, and re-approved at least every 5 years. This document builds upon and revises the information from the previous INRMPs, including the Hickam INRMP (USAF, 2007) and the 1997 INRMP (for Kalaeloa). This plan integrates climate change adaptation, and the most recent natural resources surveys available for each resource considered and discussed by location in Chapters 4 through 7. The INRMP is intended for use by installation personnel in managing natural resources at JBPHH. It is a tool to guide and prioritize short (immediate to 2 years) and middle range (3 to 5 years) actions and projects, as well as longer term (6 to 10 years) resource conservation planning. During this period, changes could occur in the activity's mission, operational and security requirements, or the condition of the natural resources. For these reasons, the INRMP has been revised to ensure it reflects current requirements and management priorities.

1.8.1.1 Annual Metrics Review

Per DoD and DON policy, DON natural resources staff review the natural resources program and INRMPs annually and complete the Natural Resources Conservation Metrics (formerly known as INRMP Conservation Metrics, Annual Reviews, or INRMP Metrics) using DON Conservation Web. Metrics ensure that DON installations comply with the Sikes Act, and that each region or installation is preparing, maintaining, and implementing its INRMP. Metrics support ESA expenditure reporting to Congress by USFWS and other media-related data collection. Metrics also inform and contribute to information collected for the Defense Environmental Program Annual Report to Congress and the Office of the Secretary of Defense Environmental Management Review. Metrics inform briefings up the DoD and DON chains of command regarding the status of DON's natural resources programs. DoD policy requires that installations review their INRMP each year via an "adaptive management" approach. As detailed in Section 1.11, adaptive management is an iterative cycle of planning, monitoring, evaluation, adjustment, and implementation, which is best used to assess ecosystem function, health, and the effectiveness of management practices. Annual metrics reviews provide an opportunity for stakeholders to review the goals and objectives of the INRMP and establish a realistic schedule for undertaking proposed management projects. Metrics provide the essential information required by Congress, EOs, existing laws, and DoD policies and instructions. INRMP Metrics consist of seven focus areas:

1. *Ecosystem Integrity* – Defines the status and integrity of ecosystems, natural resources, and management effectiveness of the INRMP program of each installation.
2. *Listed Species and Critical Habitat* – Evaluates the effectiveness of the INRMP in providing conservation benefits to federally- and state-listed species and their habitats.
3. *Recreational Use and Access* – Evaluates the availability and adequacy of public recreational use opportunities, such as fishing and hunting, and access for handicapped and disabled persons, given security, safety, and wildlife protection requirements for each installation.
4. *Sikes Act Cooperation* – Evaluates the efficacy of cooperation between DON, USFWS, NMFS, and SOH DLNR in the management of natural resources addressed by the INRMP.
5. *Team Adequacy* – Evaluates the effectiveness of DON natural resources professional staff, and each installation's subject matter experts (SMEs) in accomplishing INRMP goals and objectives.
6. *INRMP Implementation* – Evaluates the efficacy of the management projects and activities prescribed and executed to achieve INRMP goals and objectives.
7. *INRMP Support of the Installation Mission* – Evaluates the ability of each installation to support natural resource objectives and sustain the military mission, ensuring "no net loss" of mission capability to be consistent with the rest of the document.

INRMPs are intended to be living, long-term planning documents, not static 5-year plans. Accordingly, INRMPs are reviewed, updated, and revised as necessary to accommodate adaptive management. This process aims to achieve goals and objectives, incorporate relevant new information as it becomes available, and address changing environmental conditions and mission requirements on an installation.

Section 101(b)(2) of the Sikes Act requires the INRMP to undergo a review as to operation and effect on a regular basis, or not less often than every 5 years by all stakeholders—DoD, USFWS, NMFS, and state and territory fish and wildlife agencies—to determine compliance with the requirements of the Sikes Act. These reviews must be documented and signed by these parties. The review must: (1) determine whether the existing INRMP is meeting the Sikes Act requirements, and (2) contribute to the conservation and rehabilitation of natural resources on military installations and lands.

In addition, DoD and DON policy requires yearly evaluations by Naval Facilities Engineering Systems Command (NAVFAC) to determine the effectiveness of management projects in achieving the goals and objectives of the INRMP. The annual review process also facilitates adaptive management decisions and project funding and schedule adjustments. This annual review is a cooperative effort between NAVFAC, installation SMEs, USFWS, NMFS, and SOH DLNR. DoDI 4715.03 (2018) and OPNAVINST 5090.1 (DON, 2021) provide guidance for the yearly INRMP review process. Additional guidance appears in the following:

- Deputy Under Secretary of Defense Installations and Environment Policy Memorandum October 10, 2002
- DoDI 4715.17, Environmental Management Systems (April 15, 2009, incorporating Change 1, November 16, 2017)
- Supplemental DoD INRMP Guidance (September 2005)

The September 2005 Supplemental DoD INRMP Guidance requires that all INRMPs also address resource management of DoD lands occupied by tenants or lessees, or lands being used under permit, license, or right-of-way. Installations may require that tenants, lessees, permittees accept responsibility for natural resources management actions and projects, as appropriate, on these lands. The INRMP must refer to previous formal and informal listed species consultations with the USFWS and NMFS, including any incidental take statements affecting the management of these lands.

1.8.2 Beneficial Partnerships and Collaborative Resource Planning

EO 13352 (August 26, 2004) "Facilitation of Cooperative Conservation" mandates cooperation and involvement of federal agencies with all other levels of government, non-government organizations, local interest groups, and individuals in the public involving environmental programs and planning activities. Several natural resources initiatives at JBPHH involved cooperative conservation initiatives (e.g., predator control, endangered and threatened species monitoring, alien plant removal, MBTA bird protection, and habitat restoration). Cooperating agencies have included USFWS, NMFS, SOH DLNR, USDA, and SOH Department of Agriculture.

1.8.3 Commitment of USFWS, NMFS, and SOH DLNR

Preparation of this INRMP, as required by the Sikes Act, has been accomplished in cooperation with partners including USFWS, NMFS, and SOH DLNR. This cooperation ensured that this INRMP reflects the mutual agreement of these parties concerning conservation, protection, and management of fish and wildlife resources on JBPHH. Also, as required by the Sikes Act, this INRMP reflects comments received by DON following public review of this document (Appendix F).

1.8.4 Working Group

The Sikes Act requires that DON prepare INRMPs in cooperation with appropriate federal and SOH fish and wildlife agencies. The JBPHH INRMP Working Group is composed of USFWS, NMFS, SOH DLNR, and SOH Department of Business, Economic Development, and Tourism CZM Program. An agency charrette was held in November 2020 with representatives of the Working Group in attendance. Additionally, natural resources management planners maintained open lines of communication with identified Working Group members throughout the planning process. Working Group members were asked to evaluate and comment on the agency review draft INRMP documents.

This INRMP was developed in accordance with the Sikes Act as well as the Deputy Under Secretary of Defense (Installations and Environment) Memorandum, October 10, 2002, "Implementation of Sikes Act Improvement Act" and OPNAVINST 5090.1 (DON, 2021). In accordance with the Sikes Act, management options reflect the mutual agreement of USFWS, NMFS, SOH DLNR, and other interested agencies in the conservation, protection, and management of natural resources. All such management options have the potential to conflict with JBPHH's daily operations should the military mission or security requirements change in the future. Re-evaluation of and adjustments to these management actions may be necessary should such mission changes occur. Appendix G provides the MOU for the implementation of INRMPs and correspondence with Working Group members.

1.8.5 Stakeholders

Stakeholders in the public and private sectors were identified early in the process of updating the INRMP (Appendix H). NAVFAC HI requested they fill out a questionnaire in preparation for a stakeholder charrette that was held in October 2020. The questionnaire responses and charrette discussion informed the development of this INRMP. Additionally, stakeholders were asked to evaluate and comment on the public review draft INRMP document.

1.8.6 Public Participation

Through public notices in the *Honolulu Star-Advertiser* on November 17–19, 2023 the general public was encouraged to provide comments on the public review draft INRMP. In addition, a Notice of Availability was provided to the SOH Office of Environmental Quality Control's Environmental Notice in November 2023. The Notice of Availability is provided in Appendix F.

1.9 Goals and Objectives

Goals for the INRMP represent the long-term intentions of NRH with respect to natural resources under its responsibility. The objectives define specific actions to accomplish the identified goals of the INRMP. The JBPHH INRMP goals and objectives are detailed in Table 1-2.

Table 1-2 JBPHH Goals and Objectives

Goals	*Objectives*
I. The primary goal of the INRMP is to support and sustain the military mission of JBPHH while managing, protecting, and enhancing biological diversity and ecosystem integrity of military lands and waters and all associated threatened and endangered species and their habitats.	a. Integrate climate change considerations like sea level rise, temperature variations, and changes in precipitation into adaptive management strategies, missions, and operations to ensure long-term sustainability of marine and terrestrial ecosystems.
	b. Develop and encourage coordination, communication, outreach, and partnerships between JBPHH, Government Agencies, and other stakeholders, including but not limited to researchers, educational institutions, Native Hawaiian Organizations, citizen science projects, non-governmental organizations, and volunteer groups through collaborative projects.
II. Apply ecosystem-based adaptive management strategies to ensure the long-term health, restoration, protection, and recovery of marine and terrestrial natural resources and biodiversity.	c. Maintain and update inventories of marine and terrestrial ecosystems and resources.
	d. Manage, maintain, and enhance native habitats and ecosystems, prioritizing areas where threatened and endangered species are known to be present.
	e. Provide a conservation benefit for threatened and endangered species.
	f. Control, eradicate, and/or prevent the establishment of invasive species.

Goals	Objectives
III. Ensure the management, conservation, recreation, and protection of natural resources is meeting or exceeding regulatory requirements through enforcement and outreach.	g. Promote and enhance opportunities for engagement in natural resources management-related activities.
	h. Assess and monitor recreational activities and their potential impact on natural resources.
	i. Improve communication, education, and enforcement of conservation laws and regulations.

Notes: INRMP = Integrated Natural Resources Management Plan; JBPHH = Joint Base Pearl Harbor-Hickam.

1.10 Cooperative Management

The operations and natural resources management teams at JBPHH share a common goal: a sustainable landscape that can accommodate continued operations with minimal restrictions. This shared value is attainable only through cooperation and collaboration between NRH and each activity. Open communication and information sharing is crucial to their respective missions. The JBPHH Natural Resource Manager is the primary point of contact for all JBPHH natural resources issues.

Because ecosystems do not follow political or social boundaries, a coordinated approach at JBPHH includes: (1) early and regular coordination with Working Group members; (2) incorporation of ecosystem management goals into strategic, financial, and program planning and design budgets for JBPHH; and (3) the prevention of duplication of effort and minimization of inefficiencies.

Ecosystem management depends upon participation by diverse Working Group members and stakeholders and their ability to develop a shared vision of what constitutes a desirable future condition for the region of concern. At JBPHH, this means considering the mission as well as the relationship of the installation to surrounding communities and regional environmental efforts.

1.11 Adaptive Management

Adaptive management is an iterative cycle of planning, monitoring, evaluation, adjustment, and implementation that is best used to assess ecosystem function and health and the effectiveness of management practices. Adaptive management is addressed through regulatory processes and the annual Natural Resources Conservation INRMP Metrics review (see Section 1.8.1, *Revision and Review Process*), and partly through DON's Environmental Management System (EMS). The EMS is used to integrate environmental considerations into day-to-day activities across all levels and functions of DON enterprise. The EMS is a formal management framework that provides a systematic way to review and improve operations, create awareness, and improve environmental performance.

The understanding of ecosystems and natural communities is constantly evolving through science and adaptive management. DON is committed to the collection, maintenance, and use of scientific data required for making sound natural resources and land use management decisions. NAVFAC natural resources staff continue to update botanical and wildlife surveys in order to understand how these communities are changing over time and to better manage these resources in a sustainable manner.

Management practices must accommodate changes in both the ecosystem and the understanding of these systems. NRH Natural and Cultural Resources Program Managers, NAVFAC HI Installation Environmental Coordinators, and NAVFAC PAC natural resources staff continue to adapt environmental management efforts when new information is available or significant changes to the ecosystem occur.

1.12 Ecosystem Management

Management of installation natural resources supports sustainable military use through the application of an integrated approach to ecosystem management. Ecosystem management is an interdisciplinary planning and management process that focuses on identifying, restoring, and maintaining natural communities in support of the military mission and other sustainable activities. The principles of ecosystem management have been incorporated in DoDI 4715.03 (2018).

The ecosystem approach to natural resources management has the overarching goal of protecting the properties and functions of natural ecosystems. Ecosystem management for JBPHH includes inventory and monitoring; protection and damage prevention; soil, water, and vegetation management; wildlife population management; research; enforcement; and awareness.

The ecosystem management approach depends on specific and measurable objectives and criteria with which to evaluate activities in the ecosystem. This INRMP includes specific measurable goals and objectives, and task schedules for JBPHH (Chapter 8).

1.13 Training of Natural Resources Personnel

OPNAVINST 5090.1 (DON, 2021) provides a summary of the Formal Navy Environmental, Natural and Cultural Resources Training Courses. DON natural resources personnel receive training based on the billet or job that they fulfill. Required training for the NAVFAC HI Natural Resources Program Manager, JBPHH Environmental Coordinators, NAVFAC HI Natural Resources staff, and NAVFAC PAC natural resources staff includes courses on environmental protection, basic and advanced environmental law, environmental negotiation, NEPA application, health and environmental risk communications, natural resources management, DoD MBTA training, DoD water and air quality management, environmental laws and regulations, and air installation compatible use zones.

In addition, the NAVFAC HI Natural Resources Program Manager also receives training for DON's environmental restoration program, uniform federal policy for quality assurance, environmental background analysis, ecological and human health risk assessment, environmental geographical information system/geostatistics, optimizing remedy selection and site closeout process, munitions response site management, historic preservation law and Section 106 Compliance, cultural resources management laws and regulations, and health and environmental risk communication.

1.14 Management Strategy

The intent of this INRMP is to utilize adaptive management to maintain long-term ecosystem health and minimize impacts to natural resources consistent with the operational requirements of the DoD's mission. SECNAV Instructions (SECNAVINST) 5090.6A and 5090.8A require DON to ensure ecosystem management is the basis for all management of its lands (DoD, 2018) (Sikes Act, as amended; DoDI 4715.03 2018). It is also the intent of this INRMP to provide a conservation benefit to existing federally protected species and their designated critical habitats under the ESA by providing adequate special management or protections. In accordance with USFWS policy, adequate special management may be provided by an INRMP that addresses the maintenance and improvement of habitat (and/or essential features) important to the species and manages for the long-term conservation of the species. Three criteria are used to determine whether such special management or protections are provided and are described in Sections 1.14.1 through 1.14.3.

1.14.1 Criteria 1: Conservation Benefit

The plan provides a conservation benefit to the species. The cumulative benefits of the management activities identified in a management plan, for the length of the plan, must maintain or provide for an increase in a species' population, or the enhancement or restoration of its habitat within the area covered by the plan (i.e., those areas deemed essential to the conservation of the species). A conservation benefit may result from reducing fragmentation of habitat, maintaining or increasing populations, ensuring against catastrophic events, enhancing and restoring habitats, buffering protected areas, or testing and implementing new conservation strategies.

1.14.2 Criteria 2: Implementation of the Plan

The plan provides assurances that the management plan will be implemented. Persons charged with plan implementation are capable of accomplishing the objectives of the management plan and have adequate funding for the management plan. They have the authority to implement the plan and have obtained all the necessary authorizations or approvals. An implementation schedule (including completion dates) for the conservation effort is provided in the plan.

1.14.3 Criteria 3: Management Effectiveness

The plan provides assurances that the conservation effort will be effective. The following criteria will be considered when determining the effectiveness of the conservation effort. The plan includes: (1) biological goals (broad guiding principles for the program) and objectives (measurable targets for achieving the goals); (2) quantifiable, scientifically valid parameters that will demonstrate achievement of objectives, and standards for these parameters by which progress will be measured; (3) provisions for monitoring and, where appropriate, adaptive management; (4) provisions for reporting progress on implementation (based on compliance with the implementation schedule) and effectiveness (based on evaluation of quantifiable parameters) of the conservation effort are provided (this goal will be accomplished at the annual INRMP review and update, in coordination with the appropriate state fish and wildlife agency and USFWS); and (5) a duration sufficient to implement the plan and achieve the benefits of its goals and objectives. The INRMPs are 5-year plans but may be extended further than 5 years if installation mission or natural resources do not change, or changes are minimal. This is a period of time long enough to seek funding for projects, implement those projects, and monitor and report progress. At the end of the 5-year period, the INRMP will be reviewed and updated or rewritten if necessary, to continue protection and enhancement for threatened and endangered species and habitats.

2 General Installation Description

2.1 Description of JBPHH Facilities

Naval Station Pearl Harbor and Hickam Air Force Base (AFB) were combined to form JBPHH on January 31, 2010. The DON acts as the Component Lead for JBPHH; therefore, NRH, the landowner, oversees all Base Operating Support. This responsibility involves 21,090 acres (8,535 hectares) of land and approximately 40,199 acres (16,268 hectares) of water.

2.1.1 Areas Included in the INRMP

2.1.1.1 Land Areas

This INRMP includes those JBPHH lands that are owned, leased, or otherwise controlled by the DON. These areas are summarized in Table 2-1 and shown in Figure 2-1.

2.1.1.2 Navy Defensive Sea Area and Nearshore Training Areas

The Navy Defensive Sea Area (NDSA) Oʻahu is shown in Figure 2-2 and includes Pearl Harbor and Pearl Harbor Entrance Channel, and waters immediately south of the Pearl Harbor Entrance Channel. NDSAs are reserved zones established by EO 10104 to protect certain coastal facilities of military significance. The DON has exclusive use of the outer Pearl Harbor NDSA. The DON follows strict Standard Operating Procedures (SOPs) and mitigation measures developed in consultation with resource agencies to ensure that the DON can maintain mission-essential operations by using prudent measures to protect sensitive resources while operating in the outer Pearl Harbor NDSA. The DON has management authority over natural resources in the outer Pearl Harbor NDSA and it is included in the scope of this document.

The DON has natural resource management authority for four Nearshore Training Areas associated with JBPHH (Figure 2-2): Barbers Point Underwater Range, Ewa Training Minefield, Puʻuloa Underwater Range, and the Shipboard Electronics Systems Evaluation Facility Hawaii Range (SESEF). Authorized activities are described in 33 CFR 334.1360 and 33 CFR 334.1370.

Naval Undersea Warfare Center (NUWC) SESEF Hawaii Range, located off Barbers Point, provides testing and evaluation of combat systems. These activities are subject to DON requirements for compliance with the MMPA and ESA as revised on an ongoing basis with NMFS.

2.1.2 Areas Not Included in the INRMP

Very small, noncontiguous DON sites are not included in the INRMP as they consist of leased building space only or have no significant resources within their own boundaries. DON utilizes support facilities operated by others on Oʻahu; however, these facilities are not managed or operated by DON and, therefore, are not included in the scope of this document.

2.2 General Physical Environment

The discussion of the general physical environment is divided into five subsections (2.2.1 through 2.2.5): physical geography, topography, climate, geology, and hydrology. Figure 2-3 provides a high-level overview of geological features, topography, watershed boundaries, and ephemeral streams of Oʻahu.

Table 2-1 Lands and Waters Owned, Leased, or Otherwise Controlled by JBPHH

JBPHH INRMP Study Area	*Land Use and Types of Operations*	*Requires a Natural Resources Management Plan*
JBPHH Main Base and Surrounding Areas (Chapter 4)	**Main Base** (i.e., Pearl Harbor Shipyard, Intermediate Maintenance Facility, and former Hickam AFB) is largely developed and includes industrial areas. Hickam Airfield supports the Pacific Air Forces' strategic air operations. Main Base also includes family and troop housing, community support, administrative buildings, recreation areas, and managed grass and landscape. The Main Base shoreline along the Southeast Loch of Pearl is industrial. Hickam Beach and Āhua Reef Wetland are located on the southern shoreline of Main Base adjacent to the Reef Runway at Daniel K. Inouye International Airport. **Surrounding Areas** **Ford Island** includes administrative facilities; community support and military housing; recreation areas; and historical landmarks, memorials, and a museum. **Pearl City Peninsula** includes administrative and logistic facilities, laydown and storage areas, family housing, and a leased agricultural area. Natural resource features of Pearl City Peninsula include wetlands, open space, and the PHNWR, Waiawa Unit. **Waipiʻo Peninsula** includes administrative and operational facilities, training areas, and open spaces. The northern portion of the peninsula is leased to the CCH as a soccer complex. There are wetlands present along the shorelines of Waipiʻo Peninsula.	Yes, includes federally-listed bird species, marine mammals, and sea turtles; SOH-listed birds; MBTA-protected birds; wildlife refuges; wetlands; mature and significant trees; agricultural leased areas; and outdoor recreation areas. Includes Pearl Harbor, Naval Defensive Sea Area (Figure 2-2), Nearshore Training Areas (Figure 2-2), and shorelines/coastal areas of Pearl Harbor.

JBPHH INRMP Study Area	*Land Use and Types of Operations*	*Requires a Natural Resources Management Plan*
JBPHH Main Base and Surrounding Areas (Chapter 4) **(continued)**	**NAVMAG PH/West Loch Annex** includes magazines, operations and maintenance buildings, community and personnel support. The PHNWR, Honouliuliu Unit is located along the northeastern border of NAVMAG PH/West Loch Annex. **Red Hill Fuel Annex** includes logistics and supply infrastructure. The area is primarily open space. **The areas of Makalapa, ʻOhana Nui, and McGrew Point; Mānana and Hālawa Housing; and Special Area Honolulu** serve primarily as family and community support. These areas provide housing, commercial areas, schools, child development centers, and recreation. These areas are largely developed with limited open areas consisting of managed grass and landscaping. Waiawa Watershed is primarily used for water supply and public works. The area is primarily open space.	
Total acreage (hectares) for JBPHH Main Base and Surrounding Areas	<u>**Land**</u> **10,728 acres (4,341 hectares)** <u>**Water**</u> **40,199 acres (16,268 hectares)** <u>**Combined**</u> **50,927 acres (20,609 hectares)**	
JBPHH Lualualei Annex (Chapter 5)	**NAVMAG PH Lualualei** Branch is a munitions magazine complex that includes storage and operational facilities, community and personnel support facilities, and large areas of open space. **NRTF Lualualei** is used to transmit state-of-the-art high and low frequency radio signals for the navigation of Navy vessels throughout the Pacific.	Yes, includes federally-listed plants, snails, arthropods, and bird species critical habitat, SOH-listed birds, MBTA-protected birds, wetlands, a wildlife refuge, and agricultural leased areas.
Total acreage (hectares) for JBPHH Lualualei Annex	<u>**Land**</u> **9,220 acres (3,731 hectares)**	

JBPHH INRMP Study Area	*Land Use and Types of Operations*	*Requires a Natural Resources Management Plan*
JBPHH Wahiawa Annex (Chapter 6)	**NCTAMS PAC Wahiawa** includes operations, open space, and family housing and community support facilities. In the valleys surrounding NCTAMS PAC Wahiawa, open areas including mixed forest are present. **Camp Stover Hosing Community** is located on Wheeler Army Airfield. **Opana Radar Site** is the location of an active United States State Department telecommunications station. The area includes facilities and managed lawns and landscaping.	Yes, includes mature and significant trees and landscapes and MBTA-protected birds.
Total acreage (hectares) for JBPHH Wahiawa Annex	**Land** **726 acres (294 hectares)**	
Kalaeloa (Chapter 7)	**Kalaeloa** includes five noncontiguous DON-retained lands from the former NASBP. The DON-retained lands are largely developed. Land cover types include industrial areas, recreation, and disturbed open space. The shorelines along Nimitz Beach and Cottages, and White Plains Beach and Cottages are coastal wetlands.	Yes, includes federally-listed animals (arthropods, bird, marine mammal, and reptilian species), MBTA-protected birds, SOH-listed birds, and outdoor recreational facilities.
Total acreage (hectares) for Kalaeloa	**Land** **416 acres (168 hectares)**	
Total acreage (hectares) for Joint Base Pearl Harbor-Hickam	**Land Total** **21,090 acres (8,535 hectares)** **Water Total** **40,199 acres (16,268 hectares)** **Combined Total** **61,289 acres (24,803 hectares)**	

Notes: AFB = Air Force Base; CCH = City and County of Honolulu; DON = Department of the Navy; JBPHH = Joint Base Pearl Harbor-Hickam; MBTA = Migratory Bird Treaty Act; NASBP = Naval Air Station Barbers Point; NAVMAG PH = Naval Magazine Pearl Harbor; NCTAMS PAC = Naval Computer and Telecommunications Area Master Station, Pacific; NRTF Lualualei = Naval Radio Transmitter Facility Lualualei; PHNWR = Pearl Harbor National Wildlife Refuge; SOH = State of Hawaiʻi.

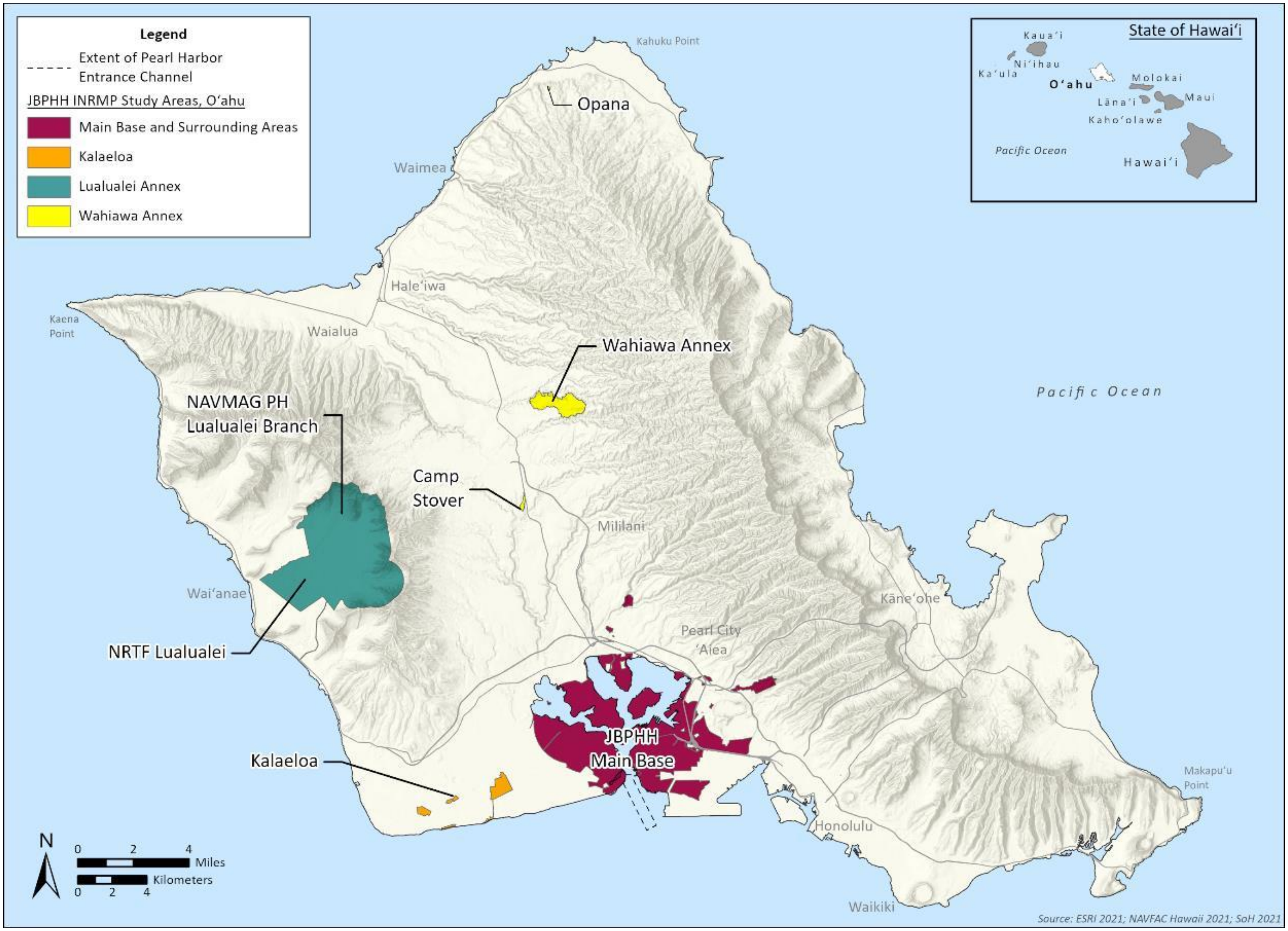


Figure 2-1 JBPHH INRMP Study Area

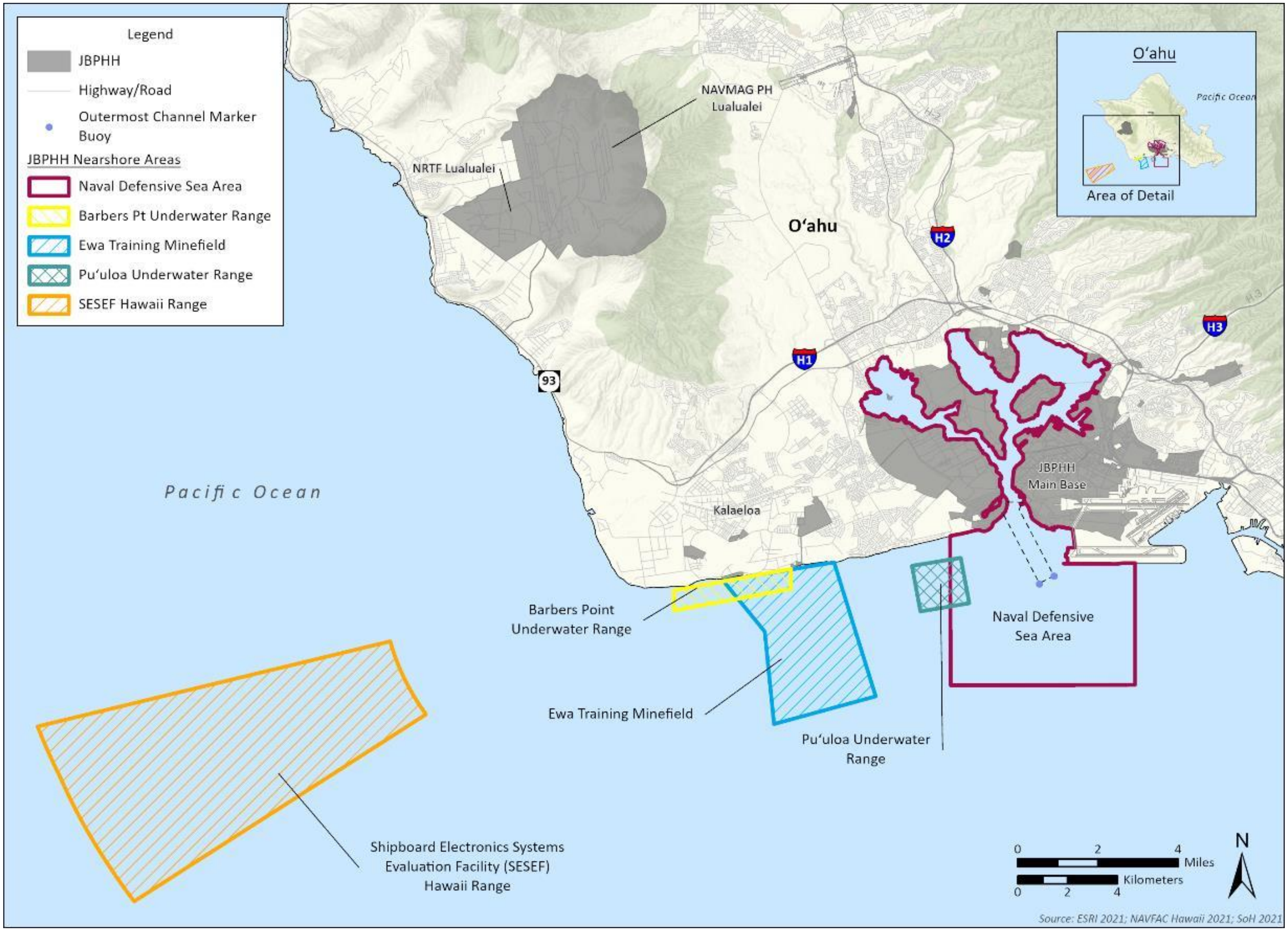


Figure 2-2 JBPHH Nearshore Areas

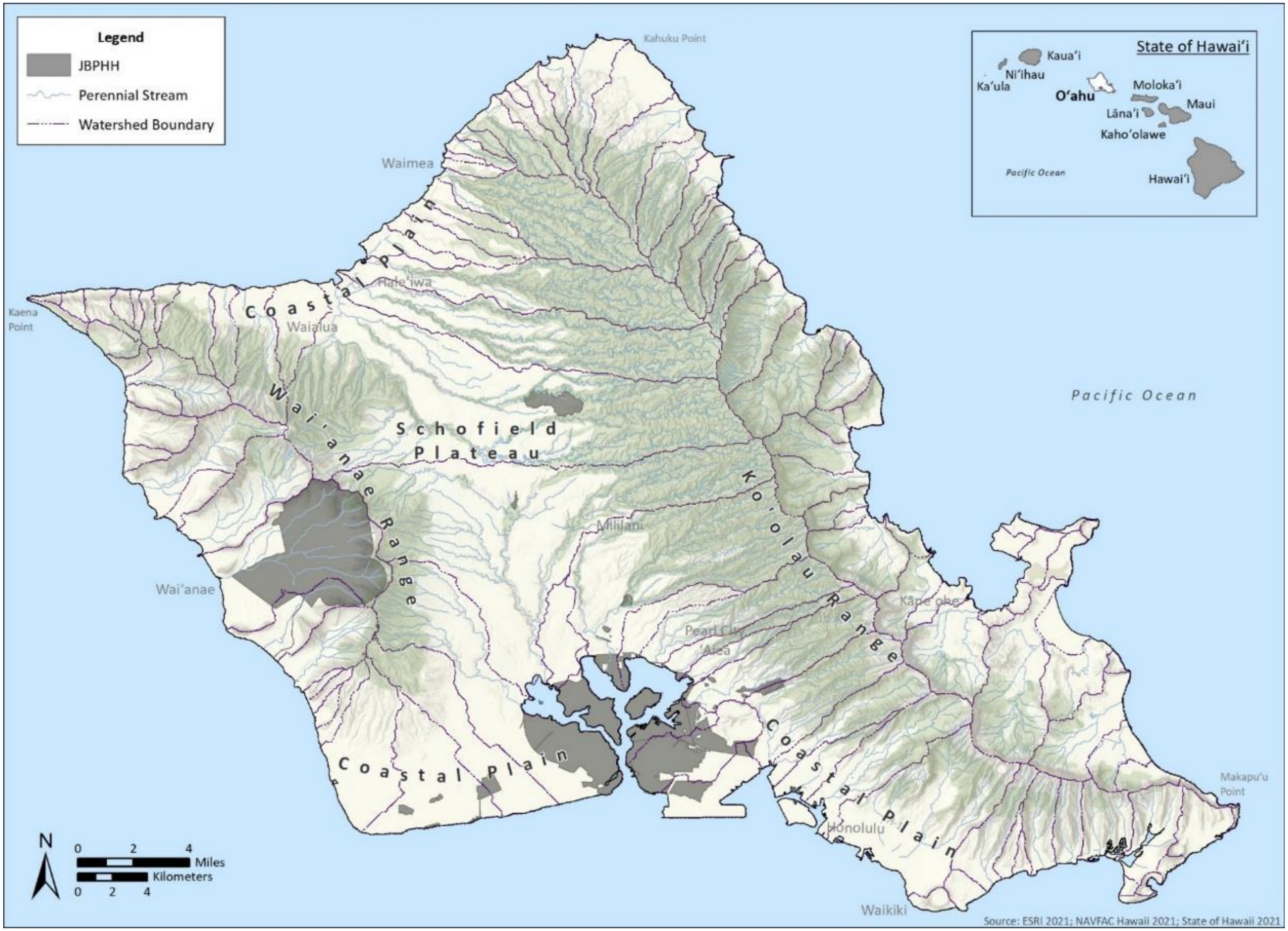


Figure 2-3 Oʻahu Physical Environment Overview

2.2.1 Physical Geography

2.2.1.1 Hawaiian Islands

The Hawaiian Islands form an archipelago of 19 islands and atolls, numerous small islets, and undersea seamounts trending northwest to southeast in the North Pacific Ocean between latitudes 19 degrees (°) North and 29° North. The archipelago extends 1,500 miles (2,400 kilometers [km]) from the Island of Hawaiʻi in the south to northernmost Kure Atoll (Juvik et al., 1998).

2.2.1.2 Oʻahu

There are four major geomorphic provinces on the Island of Oʻahu: Koʻolau Range, Waiʻanae Range, Schofield Plateau, and Coastal Plain. Two massive shield volcanoes, which arose from the floor of the Pacific Ocean, initially formed the island: Waiʻanae Volcano and Koʻolau Volcano. Eroded remnants of these shield volcanoes, the Koʻolau and Waiʻanae Ranges, compose the island and are exposed as long, narrow, nearly parallel mountain ridges, which are separated by the Schofield Plateau. The Coastal Plain overlies the Koʻolau Volcano at the north and south ends of the Schofield Plateau. The majority of JBPHH Main Base is located on the coastal plain south of Schofield Plateau (Stearns, 1985).

Koʻolau Range

The Koʻolau Range forms the eastern part of the island and lies behind Honolulu. Puʻu Kōnāhuanui, the highest point, is 3,105 feet (946 meters) high. The range is 37 miles (60 km) long and is deeply eroded by streams (Stearns, 1985).

Waiʻanae Range

The Waiʻanae Range, forming the western part of the island, is 22 miles (35 km) long. Mount Kaʻala, the highest point on Oʻahu, is 4,025 feet (1,227 meters) high (Stearns, 1985).

Schofield Plateau

Banking of the younger Koʻolau flows against the older Waiʻanae Range and erosion of the two mountain ranges formed the Schofield Plateau in the central portion of Oʻahu (Stearns, 1985).

Coastal Plain

The Coastal Plain lies mostly on the ponded lavas of the Koʻolau Volcano north and south of the Schofield Plateau. The ʻEwa Plain, lying west of Pearl Harbor, is the most extensive part of the Coastal Plain. The Waipiʻo and Pearl City Peninsulas project into Pearl Harbor. The Honolulu Plain extends eastward from Pearl Harbor and is occupied by the city of Honolulu including Waikīkī. The northern sector of the Coastal Plain is called the Waialua-Haleʻiwa Plain and the northeastern sector is the Kahuku Plain (Stearns, 1985).

2.2.2 Topography

The Island of Oʻahu consists of two nearly parallel mountain ranges, Koʻolau and Waiʻanae, that trend northwest and southwest and are separated by the Schofield Plateau. A large, relatively flat, gently sloping coastal plain borders the plateau on the south. Largely located on the south-central shore of Oʻahu, JBPHH Main Base lies primarily within this coastal plain.

2.2.3 Climate

Hawaiʻi is located approximately 2,100 miles (3,380 km) south and west of California at the edge of the Tropical Zone within the belt of cooling northeasterly trade winds. The climate in Hawaiʻi is notably mild with low day-to-day and month-to-month variability. Two seasons are generally recognized in Hawaiʻi: (1) summer, which commonly is defined as the period from May through September; and (2) winter, which is defined as the period from October through April (Juvik et al., 1998).

On the Island of Oʻahu, a combination of dominant prevailing northeasterly tradewinds and occasional milder southerly winds provide for virtually constant air movement on the windward side of the island, while the leeward side is often hotter due to less consistent prevailing winds. Generally, the warm moist winds are forced to rise over windward coasts and slopes, thereby causing cloudiness and substantial rainfall. Descending air in the leeward areas contributes to a sunny and dry climate.

2.2.4 Geology

This subsection includes a general discussion of the geology of Hawaiian Archipelago and Oʻahu, including the four major geomorphic provinces of the island.

2.2.4.1 Hawaiian Archipelago

The Hawaiian Islands are the exposed peaks of large volcanic mountain ranges, most of which lie beneath the sea, that constitute the Hawaiian Ridge. They were produced by a series of volcanic eruptions during the Pliocene Epoch. These volcanic eruptions are a result of a plume of hot rock anchored 100 miles (161 km) beneath the Pacific (Tectonic) Plate and the movement of the plate across that "hot spot." The hot spot has continuously fed magma (molten rock) through the crust to fuel countless volcanic eruptions over the past 40 million years as the Pacific Plate has continued to move west-northwestward at a rate of 3.5 inches (9 centimeter [cm]) a year. The plate has rafted approximately 129 volcanoes in all, including the 19 volcanoes making up the major islands of Hawaiʻi (Juvik et al., 1998).

2.2.4.2 Oʻahu

Oʻahu was initially formed by two massive, extinct shield volcanoes: Waiʻanae on the west and Koʻolau on the east. These volcanoes are separated by the Schofield Plateau of central Oʻahu, which was formed by the lavas from the Koʻolau Range banking against the older Waiʻanae Range. North and south of the Schofield Plateau is Oʻahu's coastal plain, which is composed of marine and terrigenous sediments deposited when the sea stood at a higher level or stand.

Waiʻanae Volcano

Waiʻanae Volcano consists of shield lavas ranging from 3.5 to 3.9 million years old overlain by a thick sequence of postshield stage alkalic basalt (rich in sodium and potassium) (3.2 to 3.5 million years old). A post-erosional sequence of lava is 2.5 million years old and represents a postshield eruption. The erosional unconformity that separates these lavas from the earlier part of the postshield stage has been attributed to a large landslide to the southwest, named the Waiʻanae Slump (Juvik et al., 1998). Huge valleys have been carved by erosion into the Waiʻanae Range; most of them discharge to the southwest. The Waiʻanae Volcano became extinct before the Koʻolau as evidenced by the lava flows of the Koʻolau overlapping the eroded, soil-covered Waiʻanae lava flows. The mountain range is nearly buried in its own waste as a result of submergence and extensive erosion (Stearns, 1985).

Koʻolau Volcano

The Koʻolau Volcano consists of eruptive products of the shield (1.7 to 2.5 million years old) and rejuvenated stages; no postshield lavas are known. Lavas of the Koʻolau Volcanic Series consist entirely of thin, narrow, basaltic lava flows piled one upon the other like shingles, with minor amounts of volcanic ash and numerous dikes (Stearns, 1985). A caldera complex in the Kailua region on the northeast shore of the island was bisected by the catastrophic Nuʻuanu landslide. Rejuvenated-stage lavas mainly erupted in the Honolulu area, hence their name: the Honolulu Volcanic Series. Although some of these rejuvenated lavas could be considerably younger, most lavas, which include flows of alkalic basalt, basanite, nephelinite, and melilite, appear to be older than 100,000 years. These eruptions tended to be explosive, and most vents along the coast produced tuff cones such as Salt Lake, Makalapa, and Āliamanu Craters. Flows from inland eruptions were funneled down valleys such as Mānoa and Nuʻuanu, creating flat valley floors (Juvik et al., 1998).

Schofield Plateau

The lavas from the Koʻolau Range banking against the older Waiʻanae Range formed the Schofield Plateau. Considerable alluvium from the Waiʻanae Range is piled against and interfingers with the Koʻolau lavas on the west side of the plateau and along the rim of Kaukonahua Valley. Much of the area between Pearl Harbor and Waipiʻo is covered with a thin veneer of alluvium (Stearns, 1985).

Coastal Plain

The Coastal Plain lies mostly on the ponded lavas of the Koʻolau Volcano north and south of the Schofield Plateau. The plain is composed chiefly of marine sediments deposited on lavas when sea level was higher in the mid-Pleistocene time. The ʻEwa Plain, lying west of Pearl Harbor, is the most extensive part of the Coastal Plain. The Waipiʻo and Pearl City Peninsulas project into Pearl Harbor. The Honolulu Plain extends eastward from Pearl Harbor and is occupied by the city of Honolulu including Waikīkī. The northern sector of the Coastal Plain is called the Waialua-Haleʻiwa Plain and the northeastern sector is the Kahuku Plain (Stearns, 1985).

2.2.5 Hydrology

The discussion of JBPHH hydrology is divided into three subsections: surface water resources, hydrogeology (groundwater resources), and aquifer characteristics.

2.2.5.1 Surface Water Resources

Surface water resources are discussed by INRMP study area in Sections 4.2.6.1, 5.2.6.1, 6.2.6.1, and 7.2.6.1.

2.2.5.2 Hydrogeology

On Oʻahu, groundwater occurs chiefly as either basal water, a lens of fresh to brackish water that floats on seawater, or high-level water, fresh water that does not rest on sea water. Although they are surrounded by seawater, the Hawaiian Islands are underlain by large quantities of fresh groundwater which are the result of the large island landmasses causing orographic rainfall. The permeable soils and rocks that comprise the uplands allow easy infiltration of the abundant rainfall to accumulate as fresh groundwater. These geologic conditions allow for the subsurface movement of water with low-permeability geologic features impounding large amounts of water in the thick groundwater reservoirs.

The discussion of the hydrogeology includes a description of the four major aquifer types that occur in JBPHH and other parts of Oʻahu: flank, volcanic basal aquifers; dike-impounded, high-level aquifers; perched, high-level aquifers; and sedimentary basal aquifers.

Flank Volcanic Basal Aquifers

Flank volcanic basal aquifers are composed of thousands of thin-bedded (10 feet [3.2 meters] or less), gently sloping (3 to 10 degrees), extrusive basaltic lava flows that comprise the bulk of the islands, including Oʻahu. The structural features associated with these flows, such as an abundance of clinker sections, voids between flow surfaces, shrinkage joints, fractures, lava tubes, and gas vesicles make these rocks porous and highly permeable, thus ideal aquifers (Juvik et al., 1998). Hydraulic properties of the volcanic rock aquifers are determined by the distinctive textures and shape of individual lava flows. Individual lava flows commonly are highly permeable. The stratified nature of lava flows imparts a layered heterogeneity or diversity. Averaged over several lava-flow thicknesses, lateral hydraulic conductivity of dike-free lava flows is approximately 500 to 5,000 feet (152 to 457 meters) per day, with smaller and larger values not uncommon. Systematic areal variations in lava-flow thickness or other properties may impart trends in the heterogeneity.

Because the flanks are the most regionally extensive volcanic formations, basal water is the most abundant form of groundwater on Oʻahu. The height of the basal water table above sea level is called the head. Because of the density difference between fresh and salt water, about 40 feet (13 meters) of fresh water is present below sea level for every foot of fresh water above sea level. That is, the lens thickness below sea level is equal to 40 times the head. This is referred to as the Ghyben-Herzberg freshwater lens. A high basal head (more than 5 feet [1.6 meters]) within 1 mile (1.6 km) of a coast results from the impedance of coastal discharge by a wedge of low-permeability sediments called caprock (Juvik et al., 1998). Throughout much of Oʻahu, groundwater is generally present in unconfined conditions, although artesian conditions exist in locations where low-permeability marine silts and volcanic tuffs (caprock) overlie the aquifer. Water-bearing zones may occur above, below, and within the caprock unit.

Dike-impounded High-Level Aquifers

Dike-impounded high-level aquifers are composed of volcanic dikes which occur in volcanic rift zones. The dikes are dense, poorly permeable, and nearly vertical sheets of basaltic rock which have intruded into the highly permeable extrusive basaltic lava flows. Measuring a few feet (approximately 1 meter) in thickness, these dikes are very important hydrogeologically as they restrict the flow of groundwater. Where dikes make up 10 percent or more of the total rock volume and cut into the permeable basalt flows to form water storage compartments, they are called dike complexes. These are generally located at higher elevations and impound rain-fed, percolating water. High-level groundwater saturates dike complexes in the rift zones. Groundwater accumulates between dikes until it either escapes through fractures or reaches the surface, where it discharges as springs (Juvik et al., 1998).

Perched High-Level Aquifers

High-level groundwater also occurs as local zones of saturation in permeable rock underlain by less permeable formations, such as buried ash or soil layers. Called perched water, such resources are generally of much smaller volume than high-level water impounded by dikes, but they may be adequate for local needs (Juvik et al., 1998).

Sedimentary Basal Aquifers

Groundwater also saturates sediments on coastal plains, particularly layers of limestone. This water is not usually fresh enough for drinking, but it may be acceptable for irrigation. Alluvium in stream valleys also carries small amounts of groundwater (Juvik et al., 1998).

3 Climate Adaptation

3.1 Introduction

DoD recognizes that installations will experience significant risks from climate-driven changes in the environment which could compromise the capacity of those installations to support the military mission. In response, the following instructions direct military installations to address climate change adaptation in their INRMPs:

- Navy Environmental Readiness Program Manual (Office of the Chief of Naval Operations Manual [OPNAV M]-5090.1)
- DoDI Natural Resources Conservation Program (DoDI 4715.03, 2011)
- DoD INRMP Implementation Manual (DoD Manual [DoDM] 4715.03, 2013)
- NAVFAC CLIMATE CHANGE Installation Adaptation and Resilience Planning Handbook (NAVFAC, 2017)

In 2019, the *Climate Adaptation for DoD Natural Resource Managers Guide* was developed to help installation managers with implementing DoDM 4715.03 guidance (Stein et al., 2019). This INRMP incorporates that guidance and climate adaptation actions intended to reduce climate-related vulnerabilities or enhance resilience. Specifically, installations are directed to include historical regional trends and future projections of climate change (see Table 3-1) in their INRMP and use a vulnerability assessment approach to identify potential mission impacts and management (adaptation and/or mitigation) priorities.

DoD defines climate adaptation as “adjustment in natural or human systems in anticipation of or response to a changing environment in a way that effectively uses beneficial opportunities or reduces negative effects” (DoD Directive 4715.21; Stein et al., 2019). At its core, climate adaptation planning can be viewed as a process of iterative risk management consisting of four major components (Stein et al., 2019):

- Assess climate risks (this chapter)
- Develop adaptation responses
- Implement adaptation actions (Chapter 8)
- Monitor and adjust actions as needed (annual metrics, subsequent INRMP updates)

3.1.1 Mission Risks from Natural Resource Vulnerabilities

There is an operational need to ensure that current and future climatic changes do not compromise the ability of JBPHH to serve its essential operational, training, and testing functions. To this end, it is important to understand how the natural and built infrastructure on JBPHH may respond to changing climatic conditions, and to the degree possible, prepare for and manage associated risks. Ecosystems provide the natural infrastructure that supports testing, training, and operational readiness on JBPHH. The installation’s plant and animal communities, soil, water, and terrain constitute a key component of the JBPHH mission capabilities. Installation conservation programs manage a variety of risks from natural hazards, such as erosion and wildfire.

Natural systems such as flood plains and wetlands can provide protective benefits to facilities and other military assets by reducing their exposure to flooding and storm surge. Climate-related impacts on these natural systems, including erosion and land loss, can degrade their ability to provide those protective functions. Wildfire poses a risk to personnel, facilities, and other infrastructure. Another potential concern relates to BASH. As climate change causes shifts in the distribution and abundance of bird species, together with changes in habitats, there may be instances where bird hazards can pose increased risks to runways and JBPHH flight operations.

3.1.2 JBPHH INRMP Goals and Objectives and Climate Adaptation

The INRMP Goals and Objectives described in Section 1.9 represent NRH's long-term natural resource management goals and supporting objectives for JBPHH. Integration of climate change considerations into natural resource management and implementation (see Chapter 8) is essential to achieving NRH's JBPHH INRMP Goals and Objectives and is therefore listed as an objective supporting this INRMP's primary goal:

1. Support and sustain the military mission of JBPHH while managing, protecting, and enhancing biological diversity and ecosystem integrity of military lands and waters and all associated threatened and endangered species and their habitats.
    a. Integrate climate change considerations such as sea level rise (SLR), temperature variations, and changes in precipitation into adaptive management strategies, missions, and operations to ensure long-term sustainability of marine and terrestrial ecosystems.

3.1.3 Existing Plans

Use of regional and local climate change adaptation plans is essential to informing a comprehensive climate adaptation strategy for INRMPs. The Climate Change Brief adopted by the CCH Climate Change Commission on June 5, 2018 established the factual basis and broad impacts of climate change. The brief describes the local, regional, and global impacts of climate change as documented by the peer-reviewed scientific literature and credible empirical data sources. It provides a benchmark for climate adaptation decisions and recommendations in Hawaiʻi and is a key document for informing JBPHH Climate Concerns, Historical Trends, and Future Projections (Table 3-1).

The NOAA Sea Level Rise Viewer is a screening-level tool that shows potential flooding from future SLR. It is based on best available and accessible elevation data and shows relative depth of inundation from 0 to 10 feet (0 to 3 meters) above mean higher high water (MHHW). The mapping approach attempts to account for regional tidal variability and hydrological connection. This NOAA data was used to inform Section 3.2.2, *Sea Level Rise*.

3.2 Climate Science

Observed changes in the climate already affect DoD installations, and these changes are expected to increase over the coming decades (Strategic Environmental Research and Development Program [SERDP], 2016). Changing rainfall patterns may increase stress on native flora and fauna, contribute to the spread of invasive species (IS), and increase the risk of wildfires during drought occurrences. Heavy precipitation contributes to heightened flood risks and erosion. Rising sea levels may lead to inundation and loss of coastal marshes and wetlands and contribute to elevated coastal storm surge during storms. Increased stressors on coral reefs, especially increased ocean temperature, creates risk of widespread coral bleaching, mass mortality, and ultimately, degraded reef systems. A broad collection of climate risks includes various forms of extreme weather, from heat waves, drought, heavy precipitation, flooding and storm surges, to increases in tropical cyclone intensity, as well as increases in seasonal low and high temperatures and increases in ocean acidity. Such climate risks to DoD installations and activities are affected by four primary climate-related factors (NAVFAC, 2017):

- Rising global temperatures (including ocean acidification)
- Changing precipitation patterns
- Increasing frequency or intensity of extreme weather events
- Rising sea levels and associated storm surge

The primary climate-related factors listed influence climate concerns (physical variables and climate change-related impacts or threats to installation or target natural resource) at JBPHH. The mechanism for these impacts can vary. Although some are directly due to changes in physical climatic factors, such as increase in temperature, in many other instances they are due to “indirect impacts” of climate change on ecosystems. Indirect impacts can include shifts in habitats, changes in species interactions, altered ecosystems processes or disturbance regimes (e.g., fire and flooding), or even human response to climate change, such as infrastructure projects (e.g., sea walls). Climate-related impacts often operate through amplifying the impact of existing stressors such as IS, disease, or water pollution.

Table 3-1 details the JBPHH key climate concerns, historical and current conditions and future projections. In addition to an overview of SLR in Table 3-1, SLR is further discussed in Section 3.2.2.

3.2.1 Climate Hazards and Impacts

The JBPHH INRMP natural resources management program elements that may be impacted by the JBPHH climate concerns (Table 3-1, Column 5) include:

- BASH
- EFH
- ESA-/SOH-listed threatened and endangered species
- IS
- MBTA-protected species
- MMPA-protected species
- Wetlands
- Wildland fire

The vulnerability of and climate adaptation strategies for these natural resources management program elements are further evaluated for each of the four geographical areas controlled by JBPHH (Chapters 4 through 7) and can be found in the Climate Change Considerations, Vulnerabilities, and Adaptations section for each JBPHH INRMP study area chapter. The implementation of the associated adaptation strategies is covered in Chapter 8 of this INRMP.

Table 3-1 JBPHH Climate Concerns, Historical Trends, and Future Projections

JBPHH Key Climate Concerns *(Physical variables and climate change-related impacts or threats to installation or target natural resource)*	***Historical/Current Conditions***	***Future Projections*** *(Next 50 Years)*	***Confidence/ Certainty: High, Medium, or Low*** *(Level of confidence or certainty in the trend or magnitude of change for this variable)*	***Potentially Impacted JBPHH Natural Resources Management Program Elements***
Air Temperature	In Hawaiʻi, the rate of warming air temperature has increased in recent decades. The statewide average air temperature has risen by 0.76°F (0.42°C) over the past 100 years (McKenzie, 2016). 2016 was the warmest year on record for Hawaiʻi, 2019 was the second warmest year followed by 2020 (NOAA, 2021).	Currently, the air is warming at 0.3°F (0.18°C) per decade (Lindsey and Dahlman, 2020). Some model projections for the late 21st century indicate that mean surface air temperature over land will increase 1.8° to 7.2°F (2° to 4°C) with the greatest warming at the highest elevations and on leeward sides of the major islands (Zhang et al., 2016). Warmer temperatures will affect the growth of plants and alter food webs, ultimately resulting in changes to ecosystems.	High	• BASH • ESA-/SOH-listed threatened and endangered species • IS • MBTA-protected species • Wildland fire

JBPHH Key Climate Concerns *(Physical variables and climate change-related impacts or threats to installation or target natural resource)*	***Historical/Current Conditions***	***Future Projections*** *(Next 50 Years)*	***Confidence/ Certainty: High, Medium, or Low*** *(Level of confidence or certainty in the trend or magnitude of change for this variable)*	***Potentially Impacted JBPHH Natural Resources Management Program Elements***
Ocean Warming, Acidification and Reefs (e.g., coral bleaching)	Globally averaged SST increased by 1.8°F (1.0°C) over the past 100 years. Half of this rise has occurred since the 1990s. North Central Pacific averaged SST trends follow the globally averaged trend (Marra and Kruk, 2017). Nearly 30 years of oceanic pH measurements, based on data collected from Station ALOHA, Hawaiʻi, show a roughly 8.7% increase in ocean acidity over this time (Marra and Kruk, 2017). Over the last 5 years, almost the entire tropical Pacific, in particular areas along the equator, have seen temperatures warmer than the 30-year average (Marra and Kruk, 2017). In Hawaiʻi, extended periods of coral bleaching did not first occur until 2014 and 2015 (Marra and Kruk, 2017). Three bleaching events occurred from 2014-2020 (Winston et al., 2020). The number of coral reefs impacted by bleaching has tripled between 1985 and 2012 (Heron et al., 2016).	Ocean warming and acidification are projected to cause annual coral bleaching in some areas, like the central equatorial Pacific Ocean, as early as 2030 and almost all reefs by 2050 (Van Hooidonk et al., 2014). By 2050, over 98% of coral reefs will be afflicted by bleaching-level thermal stress annually (Heron et al., 2016). Projected declines in oceanic food sources will widen the gap between the demand of growing human populations and availability, with oceanic food shortages expected in some nations by 2035 (Johnson et al., 2020).	High	• EFH • ESA-/SOH-listed threatened and endangered species • IS • MMPA protected species

JBPHH Key Climate Concerns *(Physical variables and climate change-related impacts or threats to installation or target natural resource)*	***Historical/Current Conditions***	***Future Projections*** *(Next 50 Years)*	***Confidence/ Certainty: High, Medium, or Low*** *(Level of confidence or certainty in the trend or magnitude of change for this variable)*	***Potentially Impacted JBPHH Natural Resources Management Program Elements***
Wildfire	Climate-related changes such as warming air temperatures and drying trends will elevate potential for wildfire globally (Gannon and Steinberg, 2021).	Warming air temperatures will lead to heat waves and thermal stress for native flora and fauna, and increased wildfire (University of Hawaiʻi Sea Grant College Program, 2014).	High	• ESA-/SOH-listed threatened and endangered species • IS • Wildland fire
Disease – Avian Malaria and Botulism	Warming air temperatures are bringing mosquito-borne diseases to previously safe upland forests, driving several native bird species toward extinction (Paxton et al., 2016).	Warming air temperatures lead to expanded pathogen ranges (University of Hawaiʻi Sea Grant College Program, 2014). Warmer air temperatures can increase avian botulism outbreaks especially if combined with decreased precipitation and polluted water, both which support benthic algal blooms (Espelund and Klaveness, 2014). Based on climate change predictions, avian malaria is predicted to expand transmission into higher elevations and intensify and lengthen existing transmission periods at lower elevations, leading to further population declines and potential extinction of highly susceptible honeycreepers in mid- and high-elevation forests (Liao et al., 2017).	Medium	• ESA-/SOH-listed threatened and endangered species

JBPHH Key Climate Concerns *(Physical variables and climate change-related impacts or threats to installation or target natural resource)*	***Historical/Current Conditions***	***Future Projections*** *(Next 50 Years)*	***Confidence/ Certainty: High, Medium, or Low*** *(Level of confidence or certainty in the trend or magnitude of change for this variable)*	***Potentially Impacted JBPHH Natural Resources Management Program Elements***
Precipitation	Hawaiʻi has seen an overall decline in rainfall over the past 30 years, with widely varying precipitation patterns across islands. The period since 2008 has been particularly dry (Frazier and Giambelluca, 2017). Declining rainfall has occurred in both the wet and dry seasons and has affected all the major islands. On Oʻahu, the largest declines have occurred in the northern Koʻolau mountains (Frazier and Giambelluca, 2017). Heavy rainfall events and droughts have become more common, increasing runoff, erosion, flooding, and water shortages (Kruk et al., 2015). Consecutive wet days and consecutive dry days are both increasing in Hawaiʻi (Kruk et al., 2015). Stream flow in Hawaiʻi has declined over the past century, consistent with observed decreases in rainfall (Bassiouni and Oki, 2013).	There is disagreement regarding precipitation at the end of the century (Pacific Islands Regional Climate Assessment, 2016). Model projections range from small increases to nearly 30% increases in wet areas, and from small decreases to almost 60% decreases in dry areas (Zhang et al., 2016; Timm et al., 2015). Generally, windward sides of the major islands will become cloudier and wetter while the dry leeward sides will generally have fewer clouds and less rainfall (Zhang et al., 2016). Variability in projections depends upon the model used (Water Research Foundation, 2019). Further, changing precipitation patterns contribute to habitat loss of T&E species; climatic changes stress these communities through the negative impacts of heat-avoidance behavior, loss of host and pollinator species and positive impacts of climate change on pathogens and competitors, among others (Cahill et al., 2013).	Medium	• EFH • ESA-/SOH-listed threatened and endangered species • IS • MBTA-protected species • Wetlands • Wildland fire

JBPHH Key Climate Concerns *(Physical variables and climate change-related impacts or threats to installation or target natural resource)*	***Historical/Current Conditions***	***Future Projections*** *(Next 50 Years)*	***Confidence/ Certainty: High, Medium, or Low*** *(Level of confidence or certainty in the trend or magnitude of change for this variable)*	***Potentially Impacted JBPHH Natural Resources Management Program Elements***
Soil Erosion/ Sedimentation	Heavy rainfall events and droughts have become more common, increasing runoff, erosion and sedimentation (Marsala et al., 2020; EPA, 2016a).	Areas with heavy precipitation will experience heightened flood risks and resulting erosion (EPA, 2016b).	High	• EFH • ESA-/SOH-listed threatened and endangered species • IS • MMPA protected species • Wetlands
Water Pollution/ Environmental Contamination	Changing climatic conditions may contribute to the spread of environmental contamination.	Changing rainfall patterns may contribute to the spread of environmental contamination through increased runoff (Frey et al., 2015). Eutrophication will increase as a result of changes in precipitation (Sinha et al., 2017) and increased air temperatures (EPA, 2020).	High	• EFH • ESA-/SOH-listed threatened and endangered species • Wetlands
Spread Invasive Species (IS)	Changing rainfall patterns may increase stress on native flora and fauna and contribute to the spread of IS.	Climate-related impacts often operate through amplifying the impact of existing stressors, such as IS. Changing rainfall patterns may increase the spread of IS. Warming air temperatures lead to expanded IS (University of Hawaiʻi Sea Grant College Program, 2014).	Medium	• EFH • ESA-/SOH-listed threatened and endangered species • IS • Wetlands • Wildland fire

JBPHH Key Climate Concerns *(Physical variables and climate change-related impacts or threats to installation or target natural resource)*	***Historical/Current Conditions***	***Future Projections*** *(Next 50 Years)*	***Confidence/ Certainty: High, Medium, or Low*** *(Level of confidence or certainty in the trend or magnitude of change for this variable)*	***Potentially Impacted JBPHH Natural Resources Management Program Elements***
Drought Conditions	Since 2000, the longest duration of drought in Hawaiʻi lasted 388 weeks from April 22, 2008 through September 22, 2015 (NOAA and National Integrated Drought Information System, 2021). Droughts have become more common, increasing runoff, erosion, flooding, and water shortages; stream flow in Hawaiʻi has also declined, consistent with observed decreases in rainfall indicating declining groundwater levels (CCH, 2018).	Over the next century, models predict that drought risk and severity will increase through increased evaporative losses due to warming air temperatures and regional precipitation declines (Cook et al., 2018).	High	• ESA-/SOH-listed threatened and endangered species • IS • MBTA-protected species • Wetlands • Wildland fire

JBPHH Key Climate Concerns *(Physical variables and climate change-related impacts or threats to installation or target natural resource)*	***Historical/Current Conditions***	***Future Projections*** *(Next 50 Years)*	***Confidence/ Certainty: High, Medium, or Low*** *(Level of confidence or certainty in the trend or magnitude of change for this variable)*	***Potentially Impacted JBPHH Natural Resources Management Program Elements***
Extreme Weather and Tropical Cyclone (TC) Activity	There has been a global increase in heatwave intensity, frequency, and duration (Perkins-Kirkpatrick, 2020). The global frequency of TCs appears to be showing a slow downward trend since the early 1970s. Local long-term TC trends are also somewhat flat, with the record showing as many active as inactive years (Marra and Kruk, 2017). Extreme El Niño years bring more hot days, intense rains, windless days, active hurricane seasons, and spikes in sea surface temperature to Hawaiʻi (Keener et al., 2018).	Heatwave metrics are predicted to worsen under increased global warming (Perkins-Kirkpatrick, 2020). More frequent TCs are projected for Hawaiʻi due to new storm tracks that bring them to the region more often (Murakami et al., 2013). Most global climate model simulations show a decrease in the frequency of TCs across the Pacific, but a potential increase in major TCs (Marra and Kruk, 2017). Frequency of El Niño events is projected to double by the end of the century with an extreme event occurring once per decade. This enhances subsequent La Niña events and contributes to annual swings between opposite extremes (Cai et al., 2015).	Medium	• EFH • ESA-/SOH-listed threatened and endangered species • Wetlands

JBPHH Key Climate Concerns *(Physical variables and climate change-related impacts or threats to installation or target natural resource)*	***Historical/Current Conditions***	***Future Projections*** *(Next 50 Years)*	***Confidence/ Certainty: High, Medium, or Low*** *(Level of confidence or certainty in the trend or magnitude of change for this variable)*	***Potentially Impacted JBPHH Natural Resources Management Program Elements***
Sea Level Rise (SLR), Flooding, Storm Surge, Shoreline Erosion or Beach Loss (SLR discussed further in Section 3.2.2)	The mean sea level trend at the Honolulu tide station is 0.06 inch (1.55 millimeters) per year with a 95% confidence interval of ±0.21 per year based on monthly mean sea level data, 1905 to 2020. This is equivalent to a change of 0.51 feet (0.15 meter) over the past century (NOAA, 2020). The frequency of high tide flooding in Honolulu since the 1960s has increased from 6 days per year to 11 per year (Marra and Kruk, 2017). Over 70% of beaches in Hawaiʻi are in a state of chronic erosion (Fletcher et al., 2012). This is likely related to long-term SLR as well as coastal hardening (Romine et al., 2013; Romine and Fletcher, 2012). Coastal hardening of chronically eroding beaches caused the combined loss of 9% (13.4 miles, 21.5 kilometers) of the length of sandy beaches on Kauaʻi, Oʻahu, and Maui over the last century (Fletcher et al., 2012).	With 3.2 feet (0.98 meter) of SLR, 25,800 acres (10,441 hectares) in the state of Hawaiʻi will experience chronic flooding, erosion, and/or high wave impacts (Hawaiʻi Climate Change Commission, 2017). Due to global gravitational effects, estimates of future SLR in Hawaiʻi and other Pacific islands are about 20%–30% higher than the global mean (Marra and Kruk, 2017). Rising sea levels may lead to inundation and loss of coastal marshes and contribute to elevated coastal storm surge during storms (Marra and Kruk, 2017).	High	• EFH • ESA-/SOH-listed threatened and endangered species • MMPA protected species • Wetlands

JBPHH Key Climate Concerns *(Physical variables and climate change-related impacts or threats to installation or target natural resource)*	***Historical/Current Conditions***	***Future Projections*** *(Next 50 Years)*	***Confidence/ Certainty: High, Medium, or Low*** *(Level of confidence or certainty in the trend or magnitude of change for this variable)*	***Potentially Impacted JBPHH Natural Resources Management Program Elements***
Wind	Average daily wind speeds are slowly declining in Honolulu and Hilo, while remaining steady across western and south Pacific sites (Marra and Kruk, 2017).	Decreasing winds under sunny skies can lead to warmer ocean temperatures and potentially enhanced coral bleaching (Marra and Kruk, 2017).	Medium	• ESA-/SOH-listed threatened and endangered species • MMPA protected species

Notes: % = percent; °C = degree Celsius; °F = degree Fahrenheit; BASH = Bird/Wildlife Aircraft Strike Hazard; CCH = City and County of Honolulu; EFH = Essential Fish Habitat; ESA = Endangered Species Act; IS = Invasive Species; JBPHH = Joint Base Pearl Harbor-Hickam; MBTA = Migratory Bird Treaty Act; MMPA = Marina Mammal Protection Act; NOAA = National Oceanic and Atmospheric Administration; pH = potential hydrogen; SLR = Sea Level Rise; SOH = State of Hawaiʻi; SST = Sea Surface Temperature; T&E = Threatened and Endangered; TC = Tropical Cyclone

3.2.2 Sea Level Rise

3.2.2.1 Historical Rate of Sea Level Rise

Global mean sea level (MSL) is rising due to the warming of the oceans and atmosphere. Tide station data from around the world show that the rate of SLR has accelerated over the past century (Fasullo et al., 2016) and global MSL has risen by 8 to 9 inches (approximately 203 to 228 millimeters [mm]) since 1880, with a third of that rise occurring since 1993 (Church and White, 2011; Hay et al., 2015).

Long-term records from tide stations around Hawaiʻi show that sea level is rising around the islands. During the period between 1905 and 2020, relative sea level change for Oʻahu has averaged an increase of 0.06 inch (1.55 mm) per year (NOAA, 2020) (Figure 3-1).

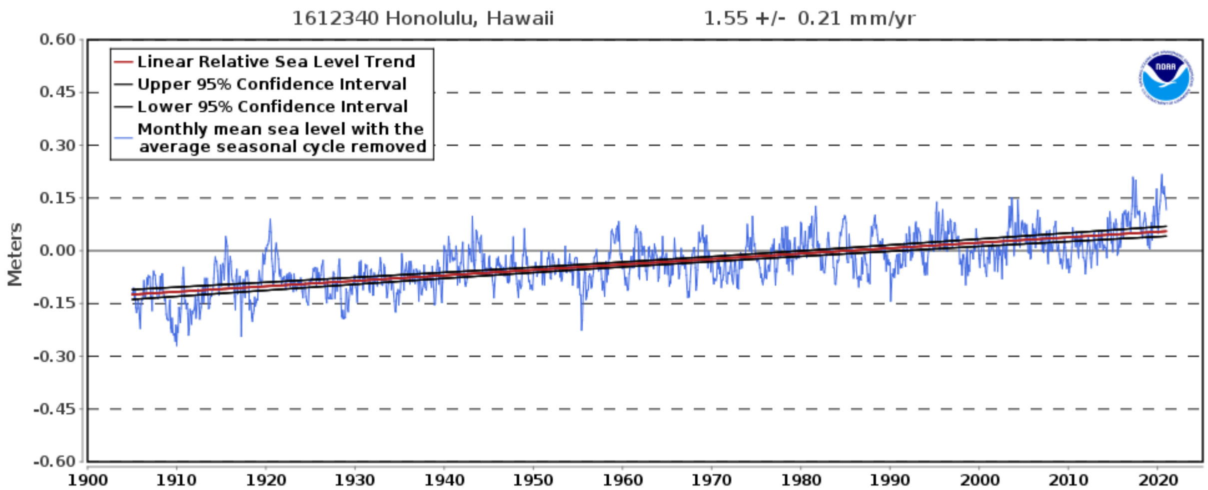


Figure 3-1 Relative Sea Level Change at the Honolulu Tide Station

3.2.2.2 Sea Level Rise Projections

Understanding Sea Level Rise Projections

To project future SLR, climate scientists must develop robust models that incorporate an array of factors. These include emissions scenarios developed by the Intergovernmental Panel on Climate Change which represent a range of possibilities for future emissions patterns. General Circulation Models project future global climate based on the emissions scenarios by simulating interactions between the oceans, atmosphere, and land. The outputs of these models are then incorporated into SLR models which project how sea levels will be impacted by future climate. The latest SLR models incorporate a variety of processes that contribute to SLR including:

- Global factors
- The melting of polar ice sheets and glaciers due to a warming climate
- Thermal expansion of the oceans as they become warmer
- Local factors
- Changes in land-water storage due to human activity (e.g., dam storage or groundwater extraction)

- Glacial isostatic adjustment (the slow but steady upward rebound of land masses previously weighed down by massive ice sheets during the last ice age)
- Plate tectonics and sediment compaction

While the SLR models are rigorously vetted and peer-reviewed, there is inevitable uncertainty surrounding future emissions scenarios and the future response of the global climate system. SLR projections vary greatly based on whether a model assumes that global emissions will be reduced substantially in the future, or if emissions will continue to rise. For the purposes of planning, it is standard practice to select scenarios based on a high future emissions scenario given the world's current trajectory. To reflect these uncertainties, SLR studies often present projections as ranges. To this end the DoD has developed the Defense Regional Sea Level Scenarios and Extreme Water Levels (DRSL) program that includes five global SLR scenarios for three future time horizons (2035, 2065, and 2100) for DoD sites worldwide. Although the scenarios extend only to the year 2100, for all global scenarios considered, sea levels will continue to rise past 2100. For planning purposes, it is common practice to choose a subset of SLR projections based on the time horizon of the planning process and the risk tolerance of project stakeholders.

Incorporation of Storm Surge

When assessing SLR vulnerability, it is important to assess exposure to extreme water levels, which include the effects of the astronomical tide and storm surge, in addition to permanent inundation. Many types of assets, especially facilities with complex electronics, can be critically damaged during just brief periods of flooding. The DRSL provides estimates for extreme event probabilities with the assumption that coastal environments with similar attributes will experience a similar flood frequency.

Selection of Appropriate Sea Level Rise Projections and Storm Surge

Best practices in addressing uncertainties in climate projections focus on considering a range of possible futures for planning and decision-making. To account for situations where long-term risk management is a priority, planners should select a scientifically plausible upper bound for high value infrastructure planning (including military installations) and then an intermediate estimate as a lower bound for lower-value assets and/or to account for the possibility of substantially reduced future emissions. The DRSL includes five scenarios–one at the lower bound, three intermediate, and one at the upper bound of plausible depictions of future conditions (Hall et al., 2016).

For this INRMP, DRSL Medium and Highest projections for horizon years 2035 and 2065 were selected. Table 3-2 includes sea level projections and planning horizons based on the DRSL. These projections include extreme water levels from a 100-year storm surge, which at JBPHH is 2 feet (0.6 meter) above MHHW.

3.2.2.3 Mapping SLR

Publicly available Geographic Information System (GIS)-based SLR layers from NOAA were leveraged to create exposure maps. The NOAA data is available at 1-foot increments and the closest total water level (TWL), defined as the combination of tides, surge, and wave runup, to the DRSL projections were chosen as summarized in Table 3-2.

Table 3-2 Sea Level Rise Planning Horizons, Scenarios, and Mapped Projections

DRSL Projections		*Permanent SLR*		*Storm Surge (+2 feet [+0.6 meters])*	
Timeframe	*SLR Scenario[1, 2]*	*Projection (feet [meters])*	*Closest TWL Mapped (feet [meters])*	*Projection (feet [meters])*	*Closest TWL Mapped (feet [meters])*
2035	Medium	1.9 (0.6)	2 (0.6)	3.9 (1.2)	4 (1.2)
	Highest	2.2 (0.7)		4.2 (1.3)	
2065	Medium	2.5 (0.8)	3 (0.9)	4.5 (1.4)	5 (1.5)
	Highest	4.5 (1.4)	5 (1.5)	6.5 (2.0)	7 (2.1)

Notes: [1]A “scenario” is defined as a description of future potential conditions in a manner that supports decision-making under conditions of uncertainty. By this definition, scenarios are explicitly not predictions about the future and as such are not assigned likelihoods or probabilities; rather, they represent plausible futures that can still be bounded by observations and physical constraints.

[2]Highest scenario is the highest plausible SLR scenario within the bounded range that the DoD recommends for risk-based planning. Medium scenarios represent an intermediate plausible SLR scenario within this range (Hall, 2016).

DRSL = Defense Regional Sea Level Scenarios and Extreme Water Levels; SLR = Sea Level Rise; TWL = Total Water Level

3.2.2.4 Interpreting the Exposure Maps

Figures 3-2 through 3-5 depict the area projected to be exposed to permanent inundation as well as a temporary 100-year storm surge for each horizon year/scenario combination summarized in Table 3-2.

Permanent inundation is defined as exposure to the MHHW coastal water level, which at JBPHH is currently 1.2 feet (0.37 meter) above MSL. Storm surge is defined as exposure to the 100-year storm, defined as MHHW +2 feet (+0.6 meter).

As described in Section 3.1.3, the NOAA Sea Level Rise Viewer data is from a modified bathtub model based on elevation data, and do not provide insight into water flow paths, overtopping locations, riverine flooding associated with precipitation, shoreline change (beach and dune erosion) caused by storms, or other coastal dynamics.

3.2.2.5 Sea Level Rise Impacts

Impacts of rising sea levels to natural resources include inundation and loss of coastal marshes and wetlands, inundation and loss of marine mammal haul-out areas, coastal habitat loss, erosion and beach loss, saltwater intrusion to freshwater courses, and land cover changes and habitat loss. Additionally, exposure to flooding could impact important infrastructure that supports the military mission including roads, airport runways, water and wastewater, communications, and other operations and facilities. Erosion from rising sea levels may lead to landslides which impact natural resources and coastal infrastructure. Table summarizes the area of projected inundation for JBPHH properties for the five selected SLR scenarios.

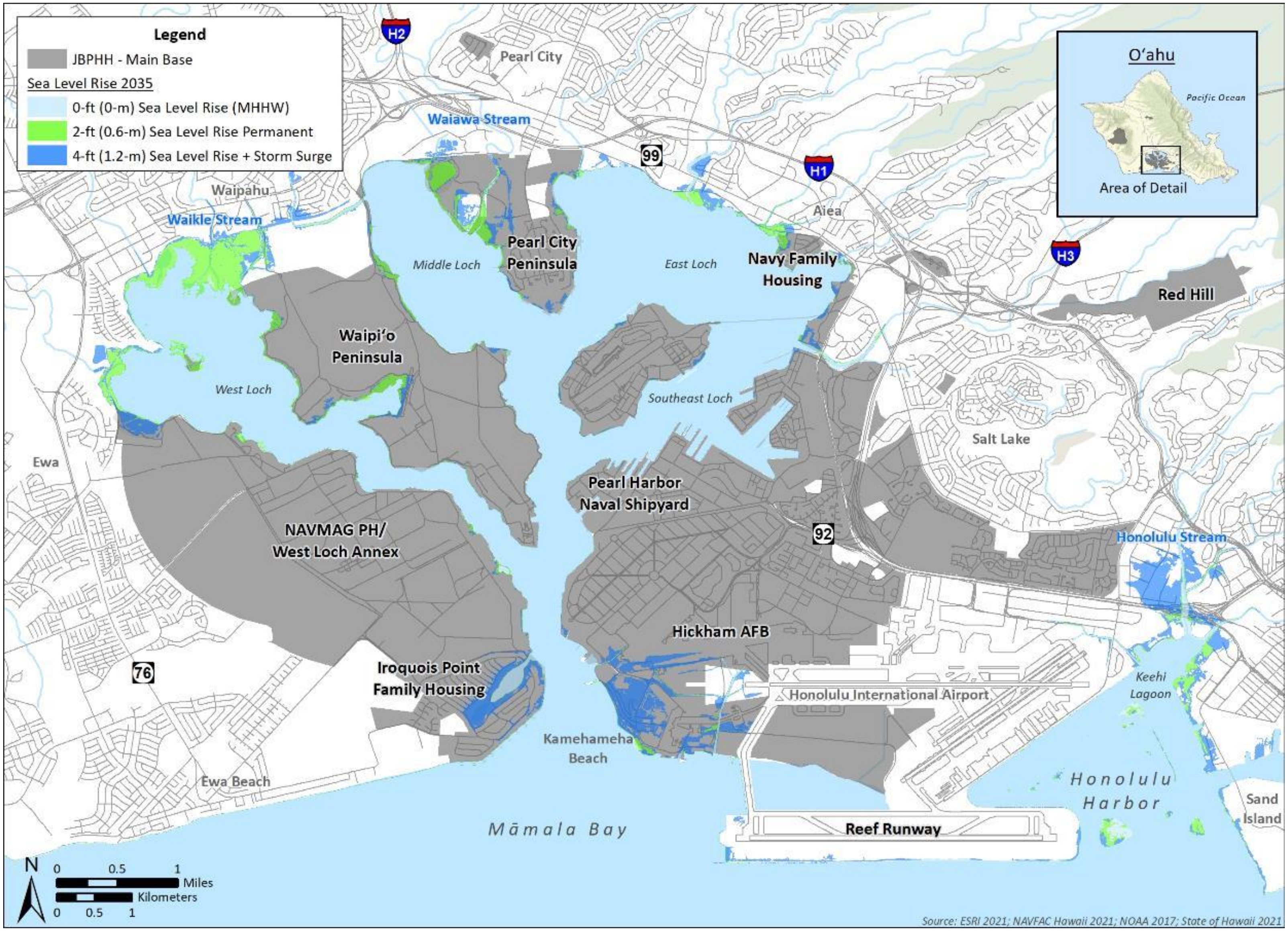


Figure 3-2 Projected Sea Level Rise and Storm Surge Exposure at JBPHH Main Base and Surrounding Areas (2035)

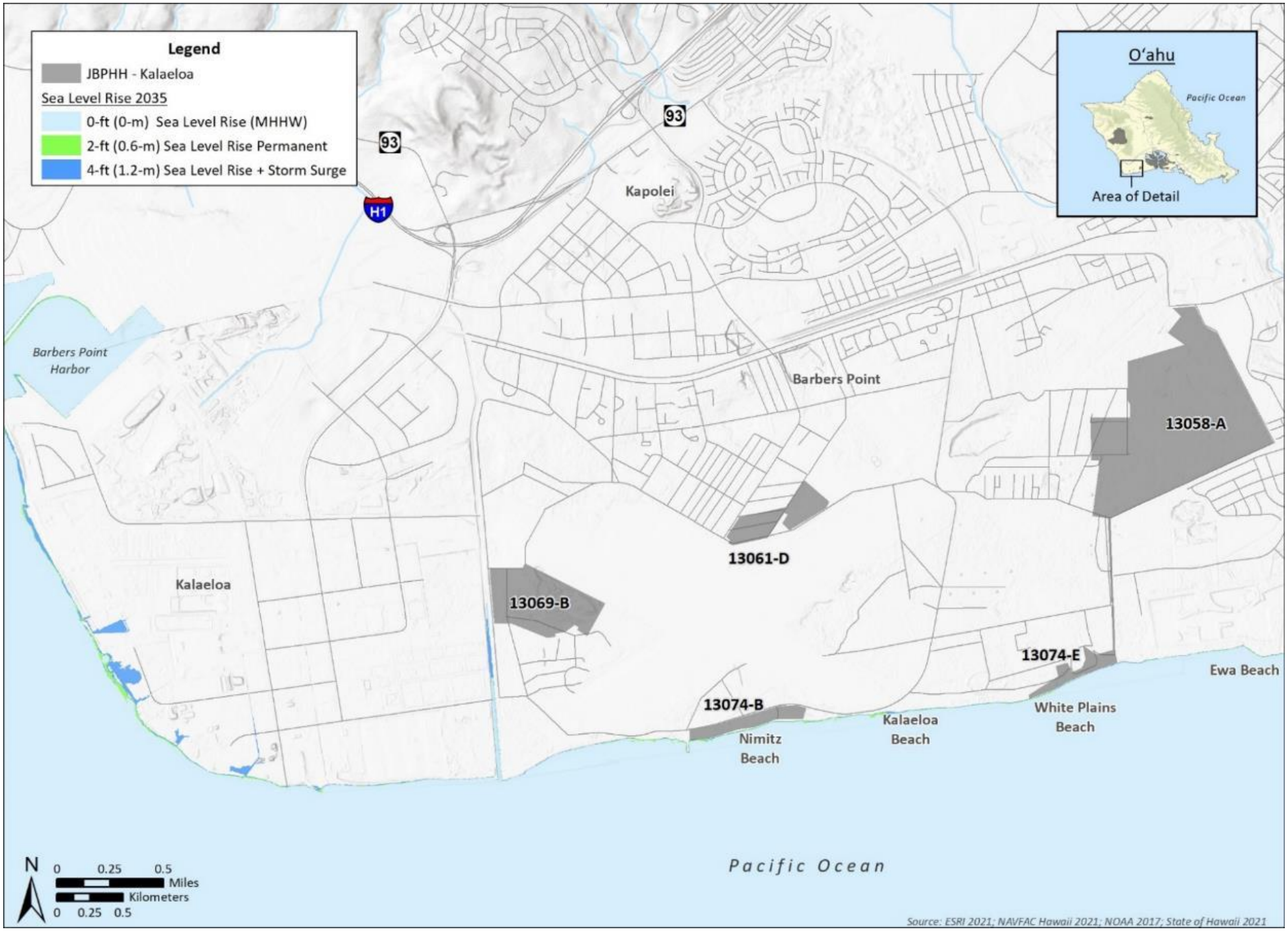


Figure 3-3 Projected Sea Level Rise and Storm Surge Exposure at Kalaeloa (2035)

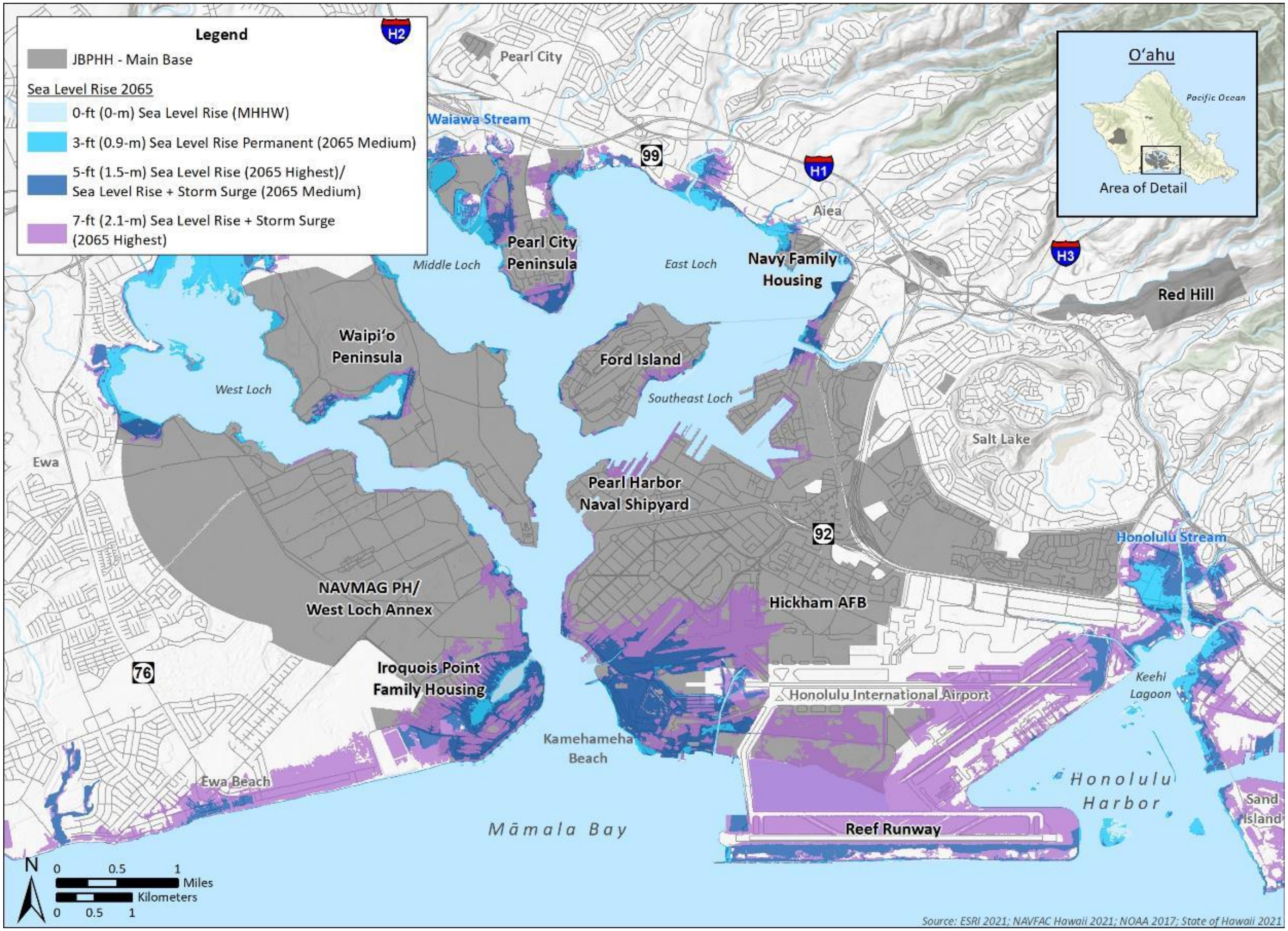


Figure 3-4 Projected Sea Level Rise and Storm Surge Exposure at JBPHH Main Base and Surrounding Areas (2065)

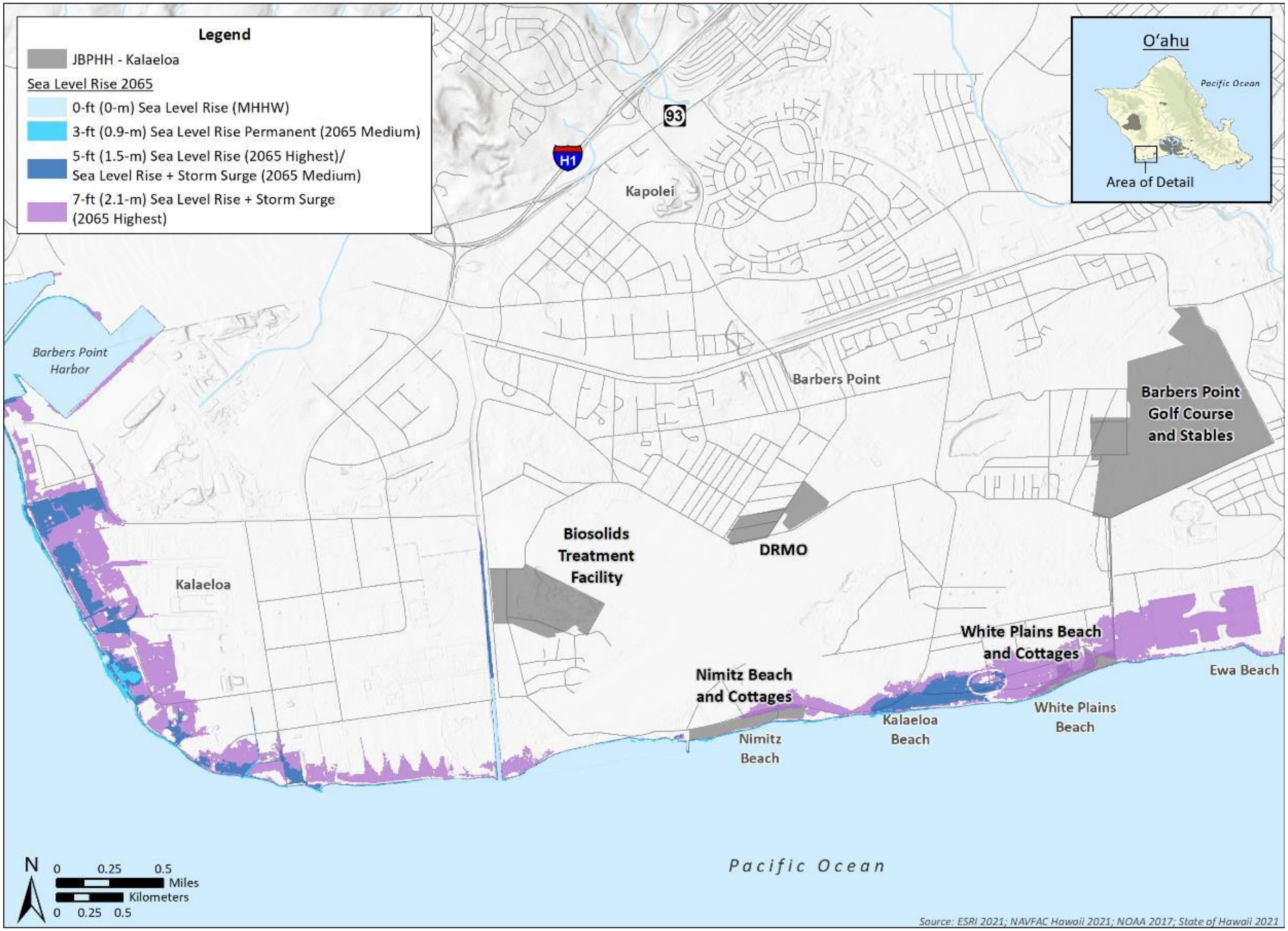


Figure 3-5 Projected Sea Level Rise and Storm Surge Exposure at Kalaeloa (2065)

Table 3-3 Area of Projected Sea Level Rise Exposure of JBPHH Properties

SLR Scenario (feet [meters])	*DRSL Projection*	*Projected Area Exposed*	
		JBPHH Main Base	*Kalaeloa*
2 (0.6)	2035 Permanent SLR (Medium + Highest)	237 acres (96 hectares)	0.00 acre (<0.01 hectare)
4 (1.2)	2035 Permanent SLR + Storm Surge (Medium + Highest)	613 acres (248 hectares)	0.04 acre (0.01 hectare)
3 (0.9)	2065 Permanent SLR Medium	327 acres (132 hectares)	0.01 acre (<0.01 hectare)
5 (1.5)	2065 Permanent SLR Highest/ + Storm Surge Medium	975 acres (395 hectares)	0.08 acre (0.03 hectare)
7 (2.1)	2065 Permanent SLR + Storm Surge Medium	2,133 acres (863 hectares)	14 acres (5.6 hectares)

Notes: DRSL = Defense Regional Sea Level Scenarios and Extreme Water Levels; JBPHH = Joint Base Pearl Harbor-Hickam; SLR = Sea Level Rise

By 2035, more than 230 acres (93 hectares) of JBPHH Main Base and Surrounding Areas are projected to be exposed to permanent inundation, primarily occurring near low-lying areas such as the mouths of streams including Waikele stream, Honolulu stream, and Waiawa stream. Areas near base assets such as Navy Family Housing are also projected to be exposed to permanent inundation by 2035. Additionally, more than 600 acres (243 hectares) of JBPHH Main Base and Surrounding Areas are projected to be exposed to temporary flooding from storm surge, including homes and roads at Iroquois Point Family Housing, portions of the Naval Station on the Pearl City Peninsula, and roads and buildings near Kamehameha Beach. At Kalaeloa, no exposure to permanent inundation is projected to occur by 2035 and only 0.04 acre (0.01 hectare) is projected to be exposed to temporary flooding from storm surge.

By 2065, projected permanent inundation could impact approximately 327 to 975 acres (132 to 395 hectares) at JBPHH Main Base and Surrounding Areas, exposing critical assets such as the wastewater treatment plan and airfield operations. Projected flooding at this stage is much more widespread and natural resources and built assets throughout the study area could be exposed. By 2065, more than 2,000 acres (809 hectares) of JBPHH Main Base and Surrounding Areas are projected to be exposed to temporary flooding from storm surge, including the majority of homes and roads at Iroquois Point Family Housing, nearly all airfield taxiways, dry docks, and portions of Ford Island. At Kalaeloa, 14 acres (5.6 hectares) are projected to be exposed to temporary flooding from storm surge including areas of Nimitz Beach, Kalaeloa Beach, and White Plains Beach.

4 JBPHH Main Base and Surrounding Areas

Photo 4-1: Āhua Reef Wetland

4.1 Current Conditions and Use

4.1.1 Installation Information

JBPHH Main Base and Surrounding Areas (study area) are centered primarily on the Pearl Harbor estuary, located on the south-central coast of Oʻahu, Hawaiʻi (Figures 4-1 and 4-2). JBPHH Main Base and Surrounding Areas cover approximately 10,728 acres (4,341 hectares) of land, approximately 40,199 acres (16,268 hectares) of water, and 36 miles (58 km) of shoreline. The study area includes:

- JBPHH Main Base
  - Pearl Harbor Shipyard
  - Intermediate Maintenance Facility
  - Hickam AFB
- Surrounding Areas
  - Ford Island
  - Pearl City Peninsula
  - Waipiʻo Peninsula
  - NAVMAG PH/West Loch Annex
  - Red Hill Fuel Annex
  - Makalapa
  - Family Housing (ʻOhana Nui, Catlin Park, Doris Miller Park, Ford Island, Hālawa, Hale Aliʻi, Hale Moku, Halsey Terrace, Hōkūlani, Hospital Point, Kapilina Beach Housing, Little Makalapa, Makalapa, Maloelap, Mānana, Marine Barracks, McGrew Point, Moanalua Terrace, and Pearl City)
  - Special Area Honolulu (Public Works Compound, Military Sealift Command [MSC]/Navy Exchange (NEX)/Commissary, Navy-Marine Golf Course, Federal Fire Department [FFD])
  - Waiawa Watershed
- JBPHH Nearshore Areas
  - NDSA
  - Barbers Point Underwater Range
  - Ewa Training Minefield
  - Puʻuloa Underwater Range
  - SESEF Hawaii Range

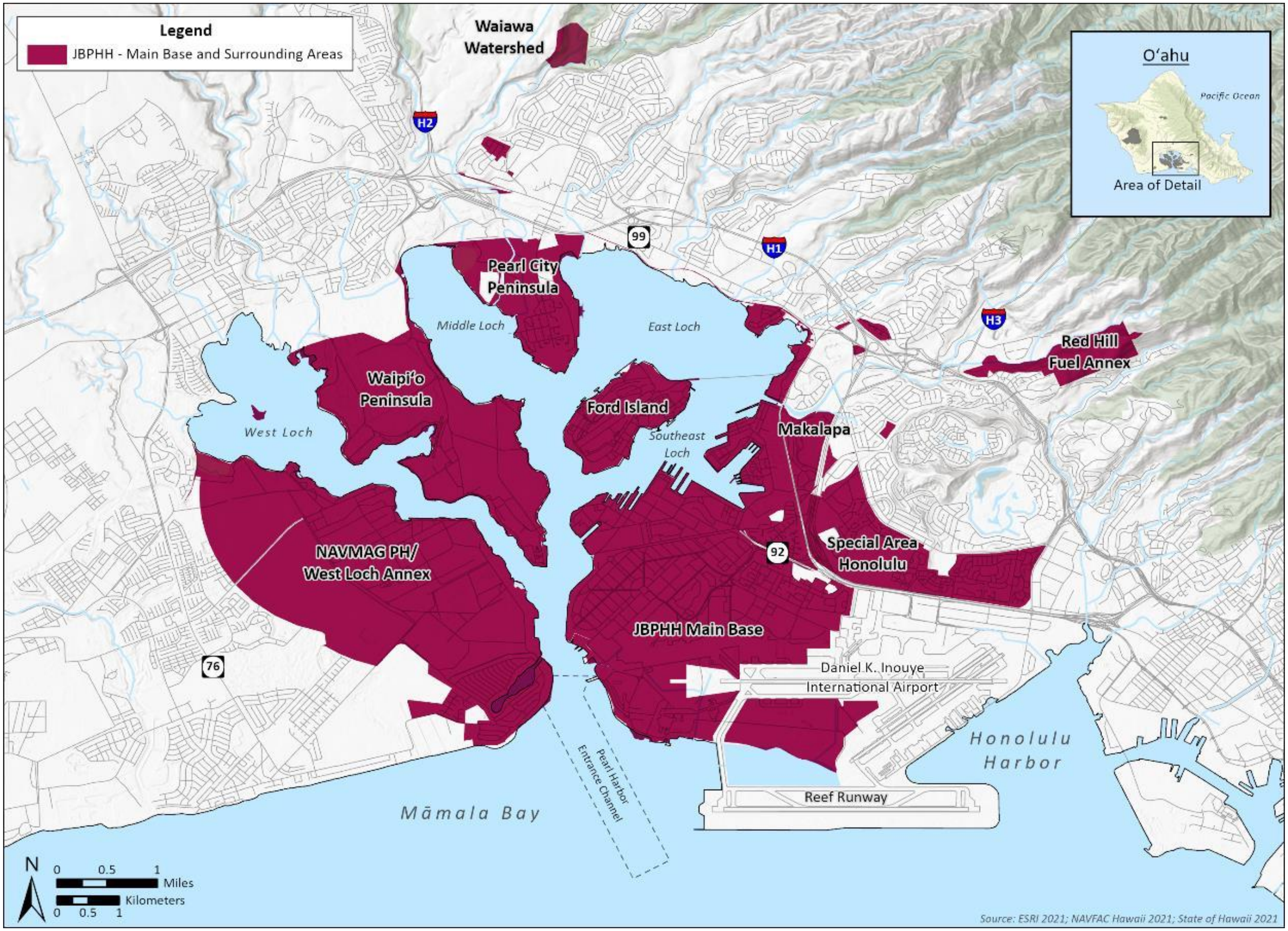


Figure 4-1 JBPHH Main Base and Surrounding Areas Overview

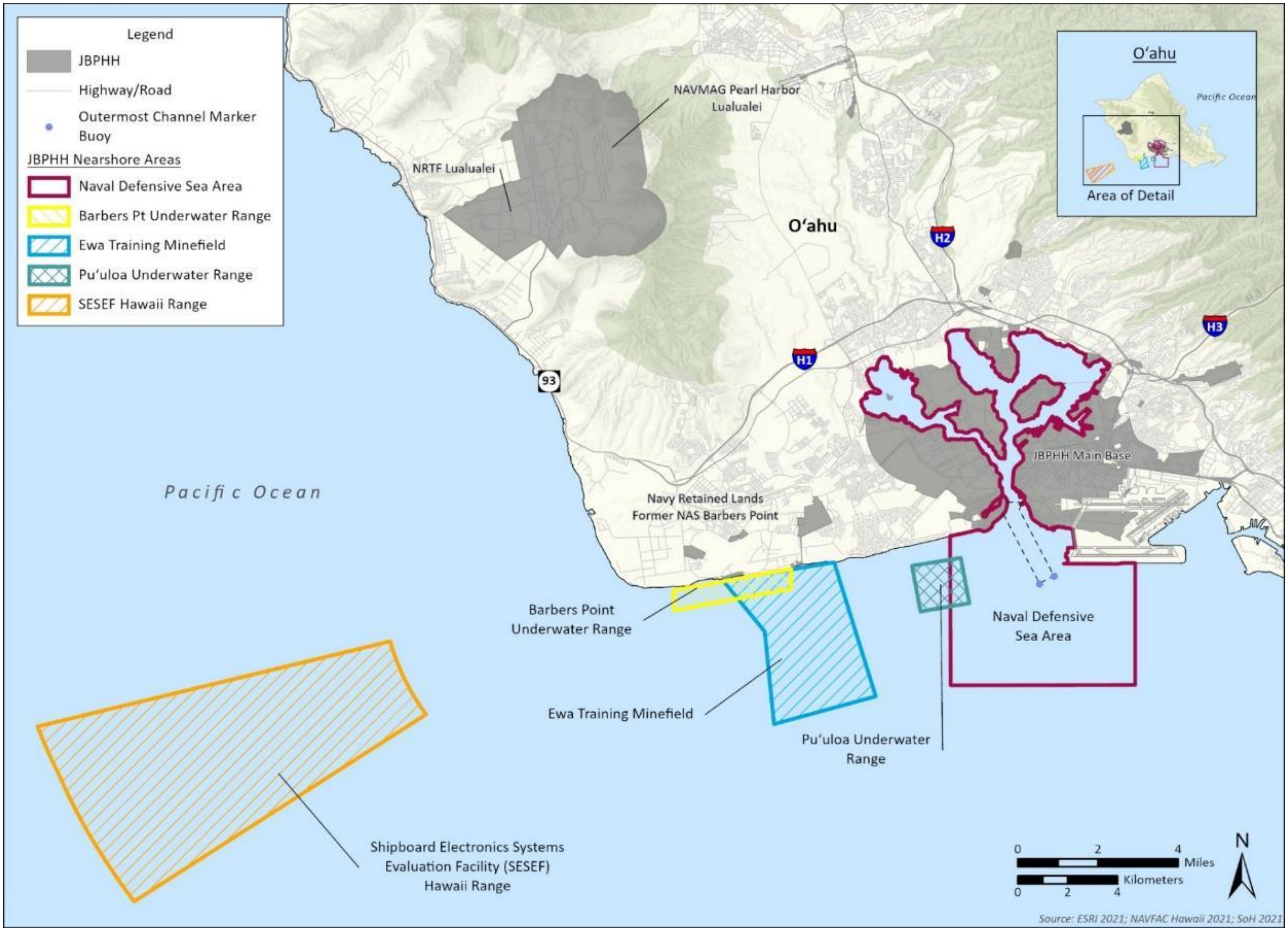


Figure 4-2 JBPHH Nearshore Areas

4.1.1.1 General Description, Operations, and Activities

NRH utilizes JBPHH to coordinate the DON's local support of the Commander U.S. Pacific Fleet (COMPACFLT). The following includes general descriptions of the mission activities performed within JBPHH Main Base and Surrounding Areas.

JBPHH Main Base

JBPHH Main Base mission areas include the Shipyard, Naval Station waterfront, and Submarine Base (DON, 2021a). JBPHH Main Base also includes mission and community support facilities, including headquarters and administrative facilities for various tenants, military housing, naval brig, emergency management services, anti-terrorism/force protection (AT/FP), facility support, medical, dental, environmental management facilities, base security, and parking. Other support infrastructure includes academic facilities, applied institution and lab facilities, simulator facilities, indoor and outdoor training ranges, and ordnance handling areas (DON, 2021a).

Hickam Airfield supports the Pacific Air Forces' strategic air operations. Hickam shares runways with adjacent Daniel K. Inouye International Airport, formerly known as the Honolulu International Airport, under a joint use agreement. The area to the north of the airfield and runway includes community support and services, military housing, administrative buildings, and recreational facilities. Directly adjacent to the airfield are facilities used for the main aircraft operations, including maintenance and training.

Ford Island

Key mission functions of Ford Island include providing headquarters and administration support facilities for the NUWC, the DON Fleet Area Control and Surveillance Facility Detachment Pearl Harbor, and the NOAA Pacific Region Center, as well as facilities for Afloat Training Group Middle Pacific and the U.S. Coast Guard (USCG). Community support facilities located on the island include military housing; bachelor quarters; a conference center; office space; a child development center; and Morale, Welfare, and Recreation (MWR) facilities. Other areas of interest on Ford Island include a historical trail and landmarks, Pearl Harbor Aviation Museum, Battleship Missouri Memorial, USS Oklahoma Memorial, and the World War II Valor in the Pacific National Monument (DON, 2021a).

Pearl City Peninsula

Mission functions at Pearl City Peninsula include administrative and logistic facilities, laydown and storage areas, family housing, and a leased agricultural area. Pearl City Peninsula also includes military housing, MWR facilities, and other community support services (DON, 2021a). The Waiawa unit of the Pearl Harbor National Wildlife Refuge (PHNWR) is located here.

Waipiʻo Peninsula

Mission functions at Waipiʻo Peninsula include administrative and operational facilities, training areas, and open spaces. The northern portion of the peninsula is leased to the CCH as a soccer complex. There are wetlands present along the shorelines of Waipiʻo Peninsula.

Naval Magazine Pearl Harbor/West Loch Annex

Mission functions at West Loch Annex include magazines, operations and maintenance buildings, community, and personnel support. The PHNWR, Honouliuli Unit is located along the northeastern border of NAVMAG PH/West Loch Annex.

Red Hill Fuel Annex

The Red Hill Fuel Annex's primary mission function is logistics and supply infrastructure.

Makalapa, ʻOhana Nui, and McGrew Point; Mānana and Hālawa Housing; and Special Area Honolulu

The primary mission function of Makalapa, ʻOhana Nui, McGrew Point, and Special Area Honolulu is family support. These areas provide housing, commercial areas, schools, child development centers, and recreation (DON, 2021a).

Waiawa Watershed

The Waiawa Watershed is located approximately 2 miles (3.2 km) north of JBPHH Main Base, in the lower reaches of Waiawa Valley. This is the site of NAVFAC HI Waiawa Shaft Pumping Facility, NRH's source of potable water. The Waiawa Watershed serves as a water source and is located north of the Pearl City Industrial Park. The remainder of the area is undeveloped.

JBPHH Nearshore Areas

Navy Defensive Sea Area

The NDSA Oʻahu is shown in Figure 4-2 and includes Pearl Harbor and Pearl Harbor Entrance Channel, and waters immediately south of the Pearl Harbor Entrance Channel. NDSAs are reserved zones established by EO 10104 to protect certain coastal facilities of military significance. The DON has exclusive use of the outer Pearl Harbor NDSA. The DON follows strict SOPs and mitigation measures developed in consultation with resource agencies to ensure that the DON can maintain mission-essential operations by using prudent measures to protect sensitive resources while operating in the outer Pearl Harbor NDSA. The DON has management authority over natural resources in the outer Pearl Harbor NDSA and it is included in the scope of this document.

Nearshore Training Areas

The DON has natural resource management authority for four Nearshore Training Areas associated with JBPHH (see Figure 4-2): Barbers Point Underwater Range, Ewa Training Minefield, Puʻuloa Underwater Range, and the NUWC SESEF Hawaii Range. Authorized activities are described in 33 CFR 334.1360 and 33 CFR 334.1370.

These activities are subject to the DON requirements for compliance with the MMPA and ESA as revised on an ongoing basis with NMFS.

4.1.1.2 Abbreviated History and Pre-Military Land Use

Prior to the 20th century, water quality was reportedly high, and sedimentation and turbidity were low (Commander, Navy Region Hawaii [CNRH], 2008). Native Hawaiians used the wetland areas around Pearl Harbor for subsistence activities such as fishponds and taro (*Colocasia esculenta*) cultivation. It is estimated that at one time there were 26 inland and coastal Hawaiian fishponds comprising 564 acres (228 hectares) in operation in the Pearl Harbor area (DON, 2001). Hawaiians also constructed agricultural features such as wetland pond systems for taro cultivation. Spring-fed areas such as those found at Kalauao, Waimalu, and Waiau were used for taro production.

Maintaining the agricultural and aquacultural features in and around Pearl Harbor required significant manpower; the Native Hawaiian traditional hierarchy of chiefs and stewards controlled the land while members of his community provided the labor. In return, the chief would care for, provide, and protect the people that he ruled over. The Great Mahele of 1848 altered land ownership patterns in Hawaiʻi and distributed lands which were sold in smaller parcels. It was more difficult for the landowners to maintain the large fishponds and keep taro lands in production. Most of the fishponds became the property of the Hawaiian government, and some of the agricultural features fell into disuse. The assimilation of western and eastern diets led to a lower demand for taro, and some farmers converted taro lands into rice production. This conversion to rice farming occurred at Pearl City Peninsula in the late 1800s (USACE, 1999). The area was cultivated for production of taro through the late 1800s and had numerous fishponds (loko), some rice fields, pastureland, and oyster beds offshore in the 19th century (CNRH, 2008). In the 19th century, fishermen and melon growers lived on Ford Island. Various types of livestock, including sheep, goats, hogs, and rabbits were also raised on the island for provisioning visiting ships (CNRH, 2008).

In 1877, King Kalākaua gave the U.S. the exclusive rights to enter Pearl Harbor to establish a coaling station for Navy vessels (eventually constructed within the western portion of the Shipyard), and to improve the entrance to the harbor. Prior to the construction of Pearl Harbor Entrance Channel, the harbor was more restricted from the open ocean by a sandy barrier at the entrance.

An artesian well was drilled on Ford Island in 1889 to make large-scale cultivation of sugarcane possible. By this time, the John ʻIʻi Estate owned the island and had a vacation house on the island. At an unknown date, the ʻIʻi Estate leased much of the acreage on Ford Island to the Oʻahu Sugar Company. In 1893, the Hawaiian Monarchy was overthrown and, in 1898 the U.S. government annexed Hawaiʻi. The U.S. government began condemnation proceedings in 1901 so that the U.S. could acquire land for a Naval Station around Pearl Harbor. The Pearl Harbor shore establishment was created in 1901 with the Fleet and Industrial Supply Center at what is now Kūāhua Peninsula, and a strip on the southeast side of Ford Island. Kūāhua Island (now known as Kūāhua Peninsula), was included in the DON's initial land acquisition in 1902.

By 1914, plantation buildings were located on the west side of Ford Island near the well. Irrigation ditches and a reservoir were located near the northeastern tip of the island. Transportation of sugarcane from the island was done by cable ferry from a landing at the southwest corner of the island to Waipiʻo Peninsula where a plantation railroad line ended (CNRH, 2008).

Initial development of military facilities at Ford Island occurred between 1912 and 1919. During the 1930s, filling of areas along the eastern and northern shores, from the dredging of the harbor channel area, increased the size of Ford Island by 116 acres (47 hectares) or 20 percent (NAVFAC PAC, 2000).

In 1922, the U.S. Army established Fort Weaver military reservation on the water's edge in what became the Iroquois Point Housing area (now known as Kapilina Beach Homes). Between 1929 and 1931, the DON acquired 213 acres (86.2 hectares) at West Loch.

The DON made major additions to the Shipyard in the 1930s. In 1939, the DON acquired an additional 358 acres (144.9 hectares), enlarging the depot to 537 acres (217.3 hectares). Pan American Airways (Pan Am) had regular airline passenger service between Manila and San Francisco, with a mid-flight refueling at Pearl City Peninsula, beginning in October 1936 and ending at the beginning of World War II. Pan Am had facilities on the west side of the peninsula (CNRH, 2008). Prior to World War II, landowners filled fishponds within the Pearl City Peninsula for residential development. After 1930, Loko Welokā, on the east side of the peninsula, and Loko Pāʻauʻau, on the west side had been filled (CNRH, 2008).

Prior to and during World War II, Ford Island provided moorage and support to most of COMPACFLT and was the home of Naval Air Station (NAS) Ford Island. Prior to U.S. participation in World War II, Ford Island was the location of "battleship row," where the DON eventually docked many ships that were damaged during the December 7, 1941 Japanese attack. Naval Station obtained ownership of Ford Island when the NAS was disestablished in 1962. Naval Station controls the waters of Pearl Harbor and land adjacent to Pearl Harbor including Ford Island (CNRH, 2008).

After the outbreak of war in Europe in 1939, extensive construction began at PHNC (NAVFAC PAC, 2003b).

The DON used Pearl City Peninsula for warehousing and fuel storage during World War II. Civilian property owners unofficially turned over their property to the DON within a few days after the attack on Pearl Harbor (December 7, 1941), which coincided with the U.S. entering World War II. A declaration of taking (Civil No. 505, Federal District Court) under the First War Powers Act, which allowed the DON to acquire the properties on the south and west shorelines of the peninsula, was finalized on March 21, 1944. The DON acquired the entire peninsula below the railroad tracks after World War II (CNRH, 2008).

During the 1940s, the DON altered the shape of the peninsula by filling the southern and western shorelines with dredged materials. In the 1940s, 1950s, and 1960s, the DON constructed housing units and recreational facilities on the peninsula (NAVFAC PAC, 2003c).

During World War II, the area housed Shore Intermediate Maintenance Activities (SIMA); this use continued through the 1970s. The function of SIMA was to provide intermediate repairs to ships that were less extensive than those performed in the Shipyard (i.e., pump repairs, steam equipment repairs, air compressor repairs). The DON personnel would bring the equipment off the ships and perform repairs on site. In addition to performing repairs, SIMA was also responsible for training personnel in conducting this type of repair (NAVFAC PAC, 2001).

After World War II, due to the emergence of the Cold War and the growing debate over nuclear versus conventional warfare, little additional construction took place at the Shipyard (NAVFAC PAC, 2003a). On October 1, 2010, the Pearl Harbor Naval Base and Hickam AFB were formally combined into the JBPHH.

4.1.1.3 Land Use and Land Use Constraints

As described in Section 4.1.1.1., land uses at JBPHH Main Base and Surrounding Areas are diverse and range from industrial to open space areas.

There are environmental and safety constraints at JBPHH Main Base and Surrounding Areas. NAVFAC Hawaii conducted a desktop assessment using land cover data to designate natural resource significance values for JBPHH lands. Land cover data covered the upland, wetland, and coastal areas and included types such as kiawe forest, mixed forest, grassland, wetland, and other developed types such as family housing, agriculture, and developed. These lands and significance designations are shown in Figure 4-3. Areas designated as high value include those with wetlands and/or those which provide habitat for terrestrial ESA-listed and MBTA-protected species (see Section 4.3.3.2, *Fauna*). Areas designated with moderate value contain potential suitable habitat for such species, and largely consist of less desirable vegetation including some man-made landscape. Those regions designated with low or little to no value were determined to not provide significant habitat and are significantly disturbed with man-made structures and/or impervious surfaces.

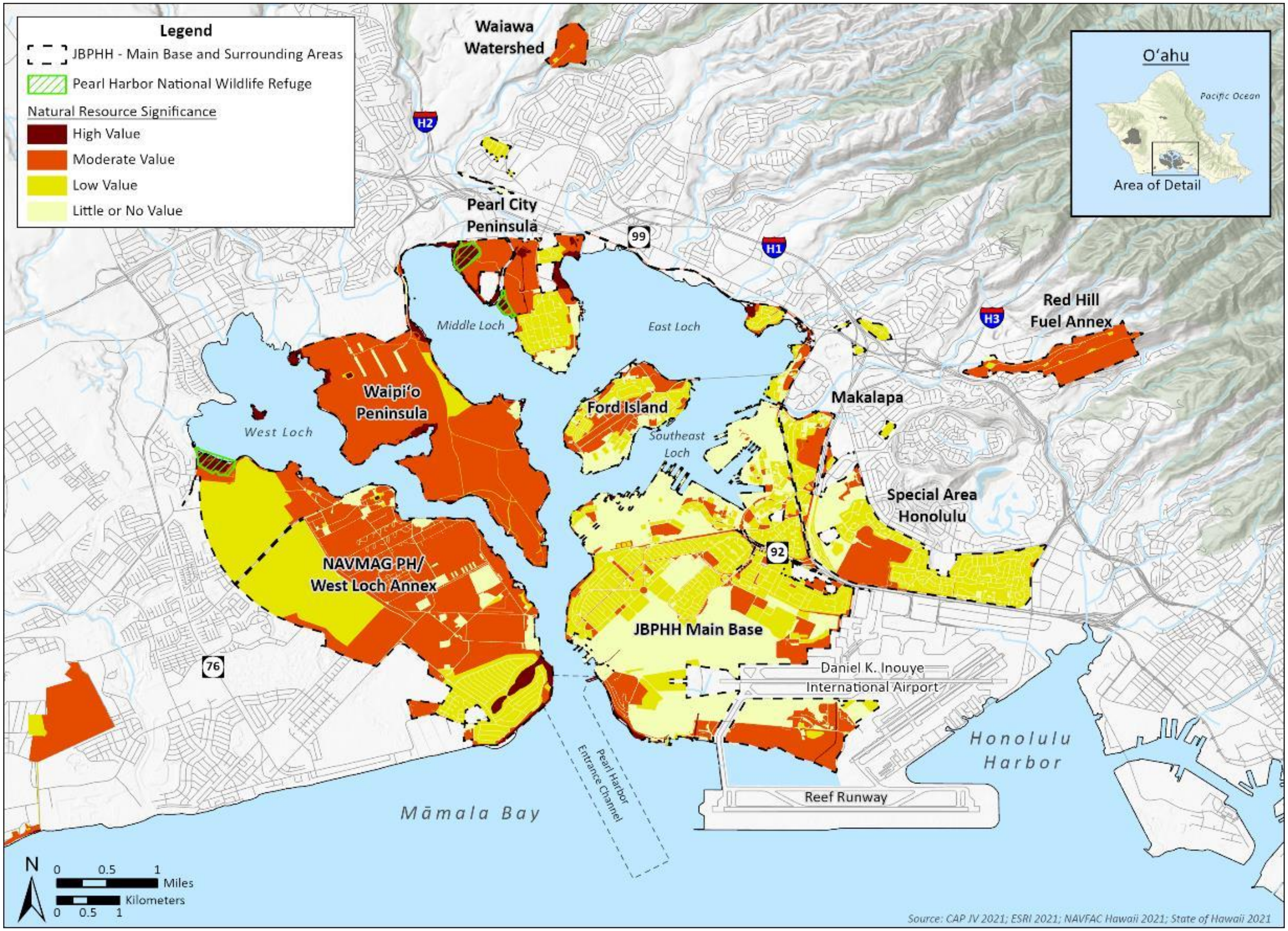


Figure 4-3 JBPHH Main Base and Surrounding Areas Natural Resource Constraints

4.1.1.4 Military Land Use Opportunities

The DON established the Shipyard Infrastructure Optimization Program (SIOP) in 2018. The goal of SIOP is to modernize dry docks, optimize industrial processes, and modernize standard equipment at critical industrial sites such as the shipyard at JBPHH Main Base. There will be no change to land use in the area but the SIOP program will modernize portions of the shipyard in support of the military mission (DON, 2021b).

4.1.1.5 Regional Land Uses

SOH Land Use Commission (LUC) has designated the majority of the study area as within the State Urban District. Exceptions include Waipiʻo Peninsula and portions of NAVMAG PH/West Loch Annex that are within the State Agricultural District. A small portion of Pearl City Peninsula in the vicinity of the PHNWR Waiawa Unit is within the State Conservation District (SOH LUC, 2021).

The CCH has zoned the lands comprising JBPHH Main Base and Surrounding Areas as F-1 District (Federal and Military Preservation District). JBPHH Main Base and Surrounding Areas are bordered by a variety of urban zoning districts including various industrial, commercial, and residential districts, as well as agricultural and preservation zoning districts (CCH, 2021).

4.2 General Physical Environment

The discussion of the general physical environment is divided into six subsections (4.2.1 through 4.2.6): physical geography, topography, climate, geology, soils, and hydrology—including surface water resources and hydrogeology (groundwater resources). General island-wide descriptions of these resources are presented in Section 2.2; the following discussion addresses the study area and environs.

4.2.1 Physical Geography

Section 2.2.1 provides a description of the physical geography of the Hawaiian Islands and the island of Oʻahu. The majority of JBPHH Main Base and Surrounding Areas lies on Oʻahu's southern coastal plain. The surrounding areas of Makalapa Crater and the Makalapa and Little Makalapa Housing Communities as well as the FFD are located in a volcanic crater formed from post-erosional volcanics of the Koʻolau Volcano. Additionally, the surrounding areas of Red Hill Fuel Annex, Waiawa Watershed, Hālawa Housing Community, Mānana Housing Community, and Red Hill Housing Community are located on the erosional slopes/aprons/fans of the Koʻolau Volcano.

4.2.2 Topography

Section 2.2.2 provides a description of the topography of the island of Oʻahu. Figure 4-4 provides topographic map coverage for JBPHH Main Base and Surrounding Areas. The majority of land adjacent to JBPHH Main Base waterfront is flat and low-lying. Nearly all of Ford Island and Pearl City Peninsula have ground elevations of less than 20 feet (6 meters) above MSL. Topography rises away from the harbor, across Interstate H-1 (Figure 4-4). The eastern portion of the JBPHH Main Base area has a maximum elevation of 80 feet (24 meters) above MSL at the rim of Makalapa Crater. The Red Hill Fuel Annex, Waiawa Watershed, Hālawa Housing Community, Mānana Housing Community, and Red Hill Housing Community, which are located on the erosional slopes/aprons/fans of the Koʻolau Volcano, have higher elevations than the rest of JBPHH Main Base. Topography is not a major factor or development constraint within JBPHH Main Base.

4.2.3 Climate

Section 2.2.3 provides a description of the climate of the Hawaiian Islands and the island of Oʻahu. JBPHH Main Base and Surrounding Areas are located in the leeward lowlands of Oʻahu. In these areas, daytime temperatures are slightly higher and nighttime temperatures are slightly lower than in windward lowland locations. Dry weather prevails except for occasional light trade wind showers which drift over from the mountains to windward and for periods of major storms. In some leeward areas, an afternoon sea breeze is common, especially in summer (Western Region Climate Center, 2021). The monthly average temperature at the study area ranges from 74 degrees Fahrenheit (°F) (23 degrees Celsius [°C]) in the winter to 82°F (28°C) in the summer. The highest maximum monthly average is 89°F (31°C) for the month of August and the lowest minimum monthly average is 67°F (20°C) for the month of January (NOAA, 2021a) (Table 4-1).

Table 4-1 10-Year Monthly Average Air Temperature Ranges near JBPHH Main Base and Surrounding Areas (2011-2020)

Month	*Daniel K. Inouye International Airport Air Temperature (Fahrenheit [Celsius])*		
	Monthly Average	*Monthly Maximum Average*	*Monthly Minimum Average*
January	74.15 (23.42)	80.91 (27.17)	67.38 (19.66)
February	74.41 (23.56)	80.93 (27.13)	67.97 (19.98)
March	74.75 (23.75)	81.13 (27.29)	68.36 (20.20)
April	76.89 (24.94)	83.21 (28.45)	70.60 (21.44)
May	78.23 (25.68)	84.60 (29.22)	71.86 (22.14)
June	80.07 (26.71)	86.40 (30.22)	73.76 (23.20)
July	81.74 (27.63)	88.04 (31.13)	75.44 (24.13)
August	82.24 (27.91)	88.60 (31.44)	75.88 (24.38)
September	81.73 (27.63)	88.17 (31.21)	75.28 (24.04)
October	80.46 (26.92)	86.83 (30.46)	74.10 (23.39)
November	78.31 (25.73)	84.35 (29.08)	72.28 (22.38)
December	75.96 (24.42)	82.16 (27.87)	69.76 (20.98)

Source: NOAA, 2021a.

Figure 4-4 JBPHH Main Base and Surrounding Areas Topography

Monthly average rainfall indicates peak rainfall between November and March, and lowest rainfall between April and September. The average annual rainfall for JBPHH Main Base and Surrounding Areas ranges between 16 and 30 inches (29 to 74 cm). Table 4-2 provides average precipitation by month in the study area from 2011 to 2020.

Table 4-2 10-Year Monthly Average Precipitation near JBPHH Main Base and Surrounding Areas (2011-2020)

Month	*Daniel K. Inouye International Airport (inch [centimeter])*	*Moanalua (inch [centimeter])*
January	1.10 (2.80)	2.25 (5.71)
February	2.04 (5.19)	2.66 (6.75)
March	2.21 (5.60)	3.08 (7.82)
April	1.26 (3.19)	2.47 (6.28)
May	1.21 (3.06)	2.00 (5.08)
June	0.91 (2.31)	1.89 (4.81)
July	0.65 (1.65)	1.50 (3.81)
August	1.32 (3.36)	1.80 (4.57)
September	1.40 (3.56)	2.73 (6.93)
October	1.89 (4.79)	2.63 (6.69)
November	1.30 (3.30)	2.67 (6.77)
December	1.30 (3.30)	3.34 (8.49)
Annual Total	16.57 (42.10)	29.03 (73.73)

Source: NOAA, 2021a.

The relative humidity of JBPHH Main Base and Surrounding Areas varies between 60 and 70 percent and seldom falls below 40 percent anywhere at elevations below the trade wind inversion (Western Region Climate Center, 2021). While not high, these humidity levels do cause bodily discomfort and promote corrosion of unprotected metal. Pan evaporation rates are in the range of 40 to 90 inches (100 to 230 cm) per year. The extreme difference between rainfall and pan evaporation rates is indicative of a very dry, coastal climate (NAVFAC PAC, 2011).

4.2.4 Geology

Section 2.2.4 provides a description of the geology of the Hawaiian Archipelago and the island of Oʻahu. Figure 4-5 provides a map of the generalized geology of the study area. The following paragraphs summarize the geology of JBPHH Main Base and Surrounding Areas.

JBPHH Main Base

The Pearl Harbor basin is a drowned river system with several tributaries that form the three main lochs (West Loch, Middle Loch, and East Loch). These join to form the Pearl Harbor Entrance Channel. The geologic processes that formed Pearl Harbor include sea level fluctuations, stream erosion, alluvial deposits, and volcanism. During periods of sea-level transgression (rise) and regression (fall), marine and terrestrial sediments were deposited over lavas of the Koʻolau and Waiʻanae Volcanoes (Stearns, 1985).

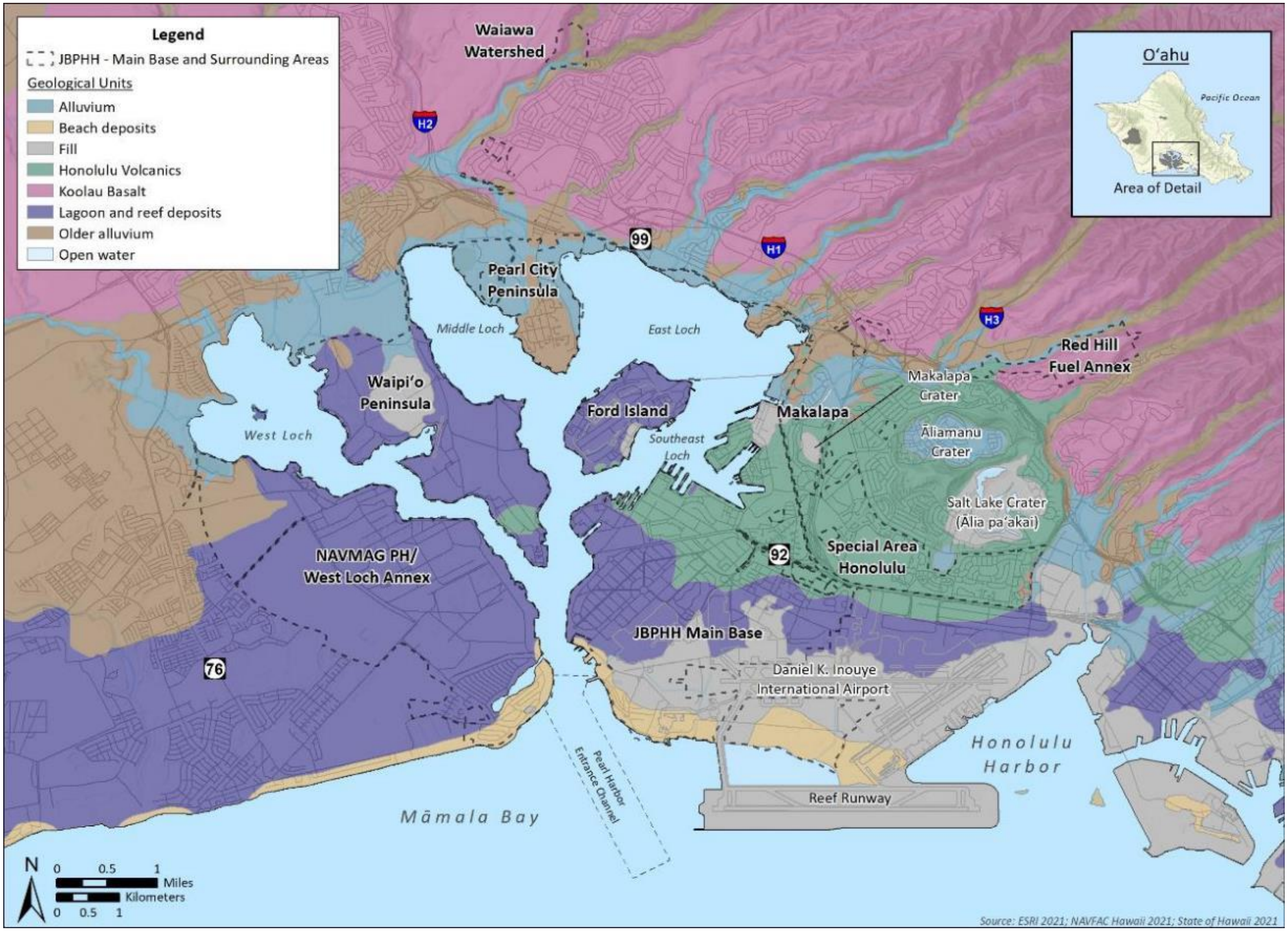


Figure 4-5 JBPHH Main Base and Surrounding Areas Geology

The Pearl Harbor inlet or re-entrant was created by the banking of the younger Koʻolau lavas against the older Waiʻanae lavas. Waikele (also known as Waikakalaua) and Waiawa streams flowing off the Koʻolau Range cut these lavas. The streams were deflected southward, following the path of the lava flows. In addition, two other streams, formed from a high rain-belt with large drainage area, entered the inlet cutting deep canyons into the hard basalt. At that time, the sea level was at a lower level or stand and these four streams flowed farther out to sea than Pearl Harbor. During the Kaʻena stand of the sea, the Pearl Harbor re-entrant was a broad unsheltered bay. At that time, a continuous reef was not built in the bay due to the large quantity of gravel and mud, delivered by the streams and tributaries, which suffocated existing coral reef growth (Stearns, 1985).

Slowly, the sea retreated as the ice caps at the Earth's poles grew during the next glaciation, and as a result, the sea fell approximately 350 feet (107 meters) or more, lower than the present shoreline. The rivers and tributaries re-established themselves and cut steep-sided deep valleys across the flat (the former broad embayment). During this time, Salt Lake Crater erupted and deposited several feet of well-bedded ash (tuff) over the area. Slowly, the sea level rose again as the glacial epoch ended and the valleys were again flooded with water levels reaching a height of 25 feet (8 meters) above the present sea level. Oyster beds flourished in the drowned interstream divides and thin coral reefs grew in stretches of clear water. Again, the sea receded with the next glaciation (growth of the polar ice caps) and a new cycle of stream erosion began. The old valleys were cut again by the streams. Some of the reefs and associated deposits on the ancient interstream divides were washed into the sea. Caprock sediments overlie the Koʻolau basalts in some areas near the shoreline north of the harbor (Stearns, 1985). Bishop Point, Fort Kamehameha Wastewater Treatment Plant (WWTP), and the Shipyard are located within the Honolulu Coastal Plain. These areas are underlain by marine and terrestrial deposits as well as fill materials.

Ford Island, Pearl City Peninsula, and Waipiʻo Peninsula

Pearl City Peninsula, as well as Ford Island and Waipiʻo Peninsula, represents an old interstream divide that was extended by reefs and sediments (Stearns, 1985). Where Pearl City Peninsula, Waipiʻo Peninsula, and Ford Island are located, is composed mostly of limestone reef material known as the ʻEwa Plain. Waipiʻo Peninsula is an old interstream divide within the coastal plain. Waipiʻo Peninsula, where Beckoning Point and NISMO are located, and Ford Island represent old interstream divides that were extended by reefs and sediments during the formation of Pearl Harbor and are considered part of the ʻEwa Coastal Plain.

Naval Magazine Pearl Harbor/West Loch Annex

This ancient reef that comprises the ʻEwa Plain grew when sea level was up to 100 feet (30.8 meters) higher than present. The consolidated limestone increases in thickness from 120 feet (37 meters) at the northwest corner of NAVMAG PH/West Loch Annex to 200 feet (61 meters) near Iroquois Point, a change of only 80 feet (24 meters) in over 2 miles (greater than 3.2 km). The fossil reef is highly permeable and serves as an aquifer and filter. Below the fossil reef there exists caprock, which consists of a complicated sequence of terrestrial and marine sediments. The caprock extends to the top of the basement rock (i.e., Koʻolau basalt). The caprock basalt contact plunges from a depth of nearly 500 feet (152 meters) below sea level at the Iroquois Point boundary. The ground surface at NAVMAG PH/West Loch Annex is the top of a fossil reef association (ʻEwa Coastal Plain) that has been consolidated into limestone.

Red Hill Fuel Annex

The geological units of Red Hill Fuel Annex consist primarily of basaltic volcanic bedrock and volcanic alluvium derived from the Koʻolau Volcanic Series.

Makalapa Crater

Makalapa Crater, along with Salt Lake (Ālia paʻakai) and Āliamanu Craters, was formed approximately 0.5 million years ago by hydromagmatic explosions that occurred after the Koʻolau Range had been inactive for more than a million years and had become deeply eroded (see Figure 4-5). These craters were formed from secondary eruptions and are part of the Honolulu Volcanic Series (Stearns, 1985).

Housing and Special Area Honolulu

Tuff deposits of the Honolulu Volcanic Series underlie the Catlin Park, Doris Miller, Hale Moku, Halsey Terrace, Hōkūlani, Little Makalapa, Makalapa, Maloelap, Marine Barracks, Moanalua Terrace, Radford Terrace Housing Communities, and Special Area Honolulu.

Ford Island Housing Community is located on Ford Island and the Pearl City Peninsula Housing Community is located on Pearl City Peninsula. These areas represent old interstream divides created during the formation of Pearl Harbor and are part of the ʻEwa Coastal Plain. The Hospital Point Housing Community is located within the Honolulu Coastal Plain. The McGrew Point Housing Community is located within the ʻEwa Coastal Plain.

The Hālawa, Mānana, and Red Hill Housing Communities are located on alluvium derived from the Koʻolau Volcano and, at depth, are underlain by basic igneous rocks from the Koʻolau Volcanic Series.

Waiawa Watershed

The Waiawa Watershed consists of an escarpment of solid bedrock about 100 feet (30 meters) high on the east bank of the Waiawa Stream and an alluvial terrace on the opposite bank. The maximum thickness of the alluvial terrace is about 500 feet (152 meters). The geological units of Waiawa Watershed consist primarily of basaltic volcanic bedrock from the Koʻolau Volcano and volcanic alluvium derived from eroded basalt that was transported by stream and sheet flow to the area.

4.2.5 Soils

The majority of the soils at JBPHH Main Base and Surrounding Areas reflect the geology of the region; however, several areas within the study area are underlain by Fill Land (Fd) (USDA, 1972). Figure 4-6 shows the locations of soil types and Table 4-3 provides a summary of soil types within the study area. Descriptions of the soil composition of JBPHH Main Base and Surrounding Areas are provided below.

JBPHH Main Base

JBPHH Main Base is largely underlain by clays of the Makalapa and Māmala Series, Fd, and Coral Outcrop (CR), with smaller areas of Keaʻau and Waipahu clays, Jaucus sand 0-15 percent slope (JaC), Rockland (rRK), and Mucky Silt Loam. Makalapa Clay, 2 to 6 percent slopes (MdB) areas have high potential for shrinking and swelling which may damage foundations, roads, and structures.

Ford Island

Ford Island is underlain entirely by CR soils.

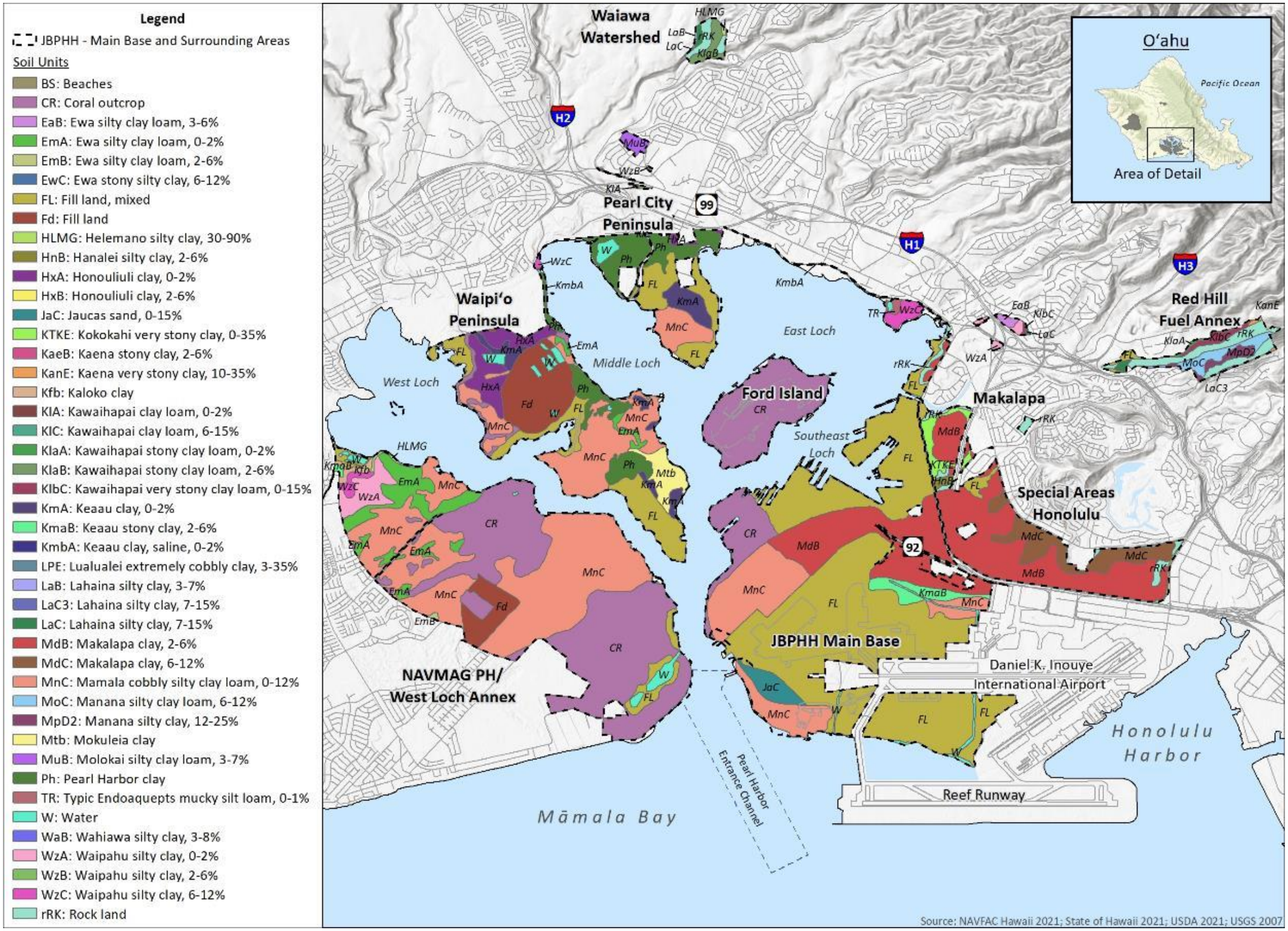


Figure 4-6 JBPHH Main Base and Surrounding Areas Soils

Table 4-3 Soils of JBPHH Main Base and Surrounding Areas

Soil Type	*Location*	*Description*	*Characteristics*
Coral Outcrop (CR)	Small areas of CR are exposed on the ocean shore, on the coastal plains, and at the foot of the uplands. These soils can be found at Bishop Point, Ford Island (including housing areas), and Hospital Point Housing Community.	Composed of coral or cemented calcareous sand. In a typical profile, CR makes up about 80 to 90 percent of the acreage with the remaining 10 or 20 percent consisting of a thin layer of friable, red soil material in cracks, crevices, and depressions within the CR.	Soil characteristics were not reported for this soil type.
ʻEwa Series: This series consists of well-drained soils in basins and on alluvial fans. These soils developed in alluvium derived from basic igneous rock.			
ʻEwa silty clay loam, 3 to 6 percent slopes (EaB)	These soils can be found on alluvial fans and terraces, including portions of the Hālawa Housing Community.	The surface layer is neutral, dark reddish-brown silty clay loam (approximately 18 inches [46 cm] thick). The subsoil is neutral, dark reddish-brown and dark-red silty clay loam that has subangular, blocky structure (approximately 42 inches [107 cm] thick). The substratum is coral limestone, sand, or gravelly alluvium.	Permeability is moderate, runoff is slow, and the erosion hazard is slight. The available water capacity is 1.3 inches/feet (11 cm/meter) in the surface layer and 1.4 inches/feet (12 cm/meter) in the subsoil.
ʻEwa silty clay loam, moderately shallow, 0 to 2 percent slopes (EmA)	This soil type occurs on alluvial fans and terraces including portions of NAVMAG PH/West Loch Annex.	The surface layer is dark reddish-brown silty clay loam about 18 inches (45.7 cm) thick. The subsoil is dark reddish-brown and dark-red silty clay loam that has a subangular blocky structure. The substratum is coral limestone, which can be found at 20 to 50 inches (50.8 to 127 cm) depth.	Permeability is moderate, runoff is very slow, and the erosion hazard is no more than slight. The available water capacity is 1.3 inches/feet (11 cm/meter) in the surface layer and 1.4 inches/feet (12 cm/meter) in the subsoil.
ʻEwa silty clay loam, moderately shallow, 2 to 6 percent slopes (EmB)	This soil type occurs on alluvial fans and terraces including portions of NAVMAG PH/West Loch Annex.	This soil is similar to EmA except for the slope.	Physical properties are the same as EmA.

Soil Type	*Location*	*Description*	*Characteristics*
Fill Land (Fd): This land type consists of areas filled with material from dredging, excavation from adjacent uplands, garbage, and bagasse and slurry from sugar mills. A few areas are filled with material from dredging and excavation. Generally, these materials are dumped and spread over marshes, low-lying areas along coastal flats, coral sand, coral limestone, or areas of shallow bedrock.			
Fill land, mixed (FL)	FL occurs mostly near Pearl Harbor and in Honolulu adjacent to the ocean. These soils occur at Pearl City Peninsula (including the housing community), Red Hill Fuel Annex, Naval Station, Public Works Center, Shipyard, and Marine Barracks Housing Community.	Areas filled with material dredged from the ocean or hauled from nearby areas, garbage, and general material from other sources.	Soil characteristics were not reported.
Haleiʻwa Series: Consists of well-drained soils on fans and in drainage ways along coastal plains. They developed in alluvium derived from basic igneous material.			
Haleiʻwa silty clay, 2 to 6 percent slopes (HeB)	This soil type occurs as large areas on alluvial fans or as long narrow areas in drainage ways.	In a representative profile, the surface layer is dark brown silty clay about 17 inches (43.2 cm) thick. The subsoil and substratum, to a depth of more than 5 feet (1.5 meters), are dark brown and dark yellowish-brown silty clay that has subangular blocky structure. The soil is neutral to slightly acid.	Permeability is moderate. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.9 inches/feet (15.8 cm/meter).
Hanalei Series: This series consists of somewhat poorly drained to poorly drained soils on bottom lands. These soils develop in alluvium derived from basic igneous rock.			
Hanalei silty clay, 2 to 6 percent slopes (HnB)	This soil is found on stream bottoms and flood plains. These soils occur at Makalapa Crater.	The surface layer is about 10 inches (25 cm) thick, dark gray and very dark gray silty clay that has dark brown and reddish mottles. The subsurface layer is very dark gray and dark gray silty clay loam that has angular blocky structure. The substratum is stratified alluvium. The soil is strongly acid to very strongly acid in the surface layer and neutral in the subsoil.	Permeability is moderate. Runoff is slow, and the erosion hazard is slight. The available moisture capacity is about 2.1 inches/feet (17.5 cm/meter). Flooding is a hazard.

Soil Type	*Location*	*Description*	*Characteristics*
Helemano Series: This series consists of well-drained soils on alluvial fans and colluvial slopes on the sides of gulches. They developed in alluvium and colluvium derived from basic igneous rock.			
Helemano silty clay, 30 to 90 percent slopes (HLMG)	These soils can be found on the sides of V-shaped gulches including portions of Waiawa Watershed and Camp Stover Housing Community.	The surface layer is neutral, dark reddish-brown silty clay (approximately 10 inches [25 cm] thick). The subsoil (approximately 50 inches [127 cm] thick) is neutral to slightly acid, dark reddish-brown and dark-red silty clay that has subangular blocky structure. The substratum is soft, highly weathered basic igneous rock.	Permeability is moderately rapid. Runoff is medium to very rapid and the erosion hazard is severe to very severe. Available water capacity was not reported.
Honouliuli Series: This series consists of well-drained soils on coastal plains in the ʻEwa area. These soils developed in alluvium derived from basic igneous material.			
Honouliuli clay, 0 to 2 percent (HxA)	These soils occur on lowlands on coastal plains including portions of Pearl City Peninsula.	Neutral to moderately alkaline, dark reddish-brown, very sticky, very plastic in the surface layer (about 15 inches [38 cm] thick). The subsoil and substratum are similar to the surface layer but have subangular blocky structure.	Permeability is moderately slow. Runoff is slow and the erosion hazard is no more than slight. The shrink-swell potential is high. The available water capacity is about 1.8 inches/feet (15 cm/meter).
Honouliuli clay, 2 to 6 percent slopes (HxB)	These soils occur on lowlands on coastal plains.	Neutral to moderately alkaline, dark reddish-brown, very sticky, very plastic in the surface layer (about 15 inches [38 cm] thick). The subsoil and substratum are similar to the surface layer but have subangular blocky structure.	Permeability is moderately slow. Runoff is slow and the erosion hazard is slight. The shrink-swell potential is high. The available water capacity is about 1.8 inches/feet (15 cm/m).
Jaucas Series: This series consists of extensively drained, calcareous soils that occur as narrow strips on coastal plains, adjacent to the ocean.			
Jaucas sand, 0 to 15 percent slopes (JaC)	These soils occur on coastal plains including portions of Fort Kamehameha WWTP.	Neutral to moderately alkaline single grain, pale brown to very pale brown, sand (greater than 60 inches [152 cm] thick). The surface layer can be dark brown as a result of accumulation of organic matter and alluvium.	Permeability is rapid, and runoff is very slow to slow. The water erosion hazard is slight but the wind erosion hazard is severe where vegetation has been removed. The available water capacity is about 0.5 to 1 inch/feet (4 to 8 cm/meter).

Soil Type	*Location*	*Description*	*Characteristics*
Kaʻena Series: This series consists of very deep, poorly drained soils on alluvial fans and talus slopes. These soils developed in alluvium and colluvium from basic igneous rocks.			
Kaʻena very stony clay, 10 to 35 percent slopes (KanE)	This soil occurs on talus slopes and alluvial fans including portions of Red Hill Fuel Annex.	There are many stones in this soil. The surface layer is very dark gray clay about 10 inches (25 cm) thick. The next layer, 36 inches (91 cm) to more than 48 inches (122 cm) thick, is dark gray and dark grayish brown clay that has prismatic structure. It is underlain by highly weathered gravel.	Permeability is slow. Runoff is low to medium and the erosion hazard is slight to moderate. Workability is difficult because the soil is stony, steep, very sticky, and very plastic. The shrink-swell potential is very high. The available water capacity is about 1.7 inches/feet (14.16 cm/meter).
Kaloko Series: This series consists of poorly drained soils on coastal plains. These soils developed in alluvium derived from basic igneous rock; the alluvium has been deposited over marly lagoon deposits.			
Kaloko clay, noncalcareous variant (Kfb)	This soil occurs in slight depressions on the coastal plains including small portions of NAVMAG PH/West Loch Annex.	The surface layer is very dark gray clay. The subsoil is gray or grayish brown prismatic clay. The substratum is massive clay and silty clay. This soil is slightly acid to neutral throughout. It is more acid and grayer than is typical for the Kaloko series. It is underlain by noncalcareous material.	Permeability is slow. Runoff is ponded to very slow, and the erosion hazard is none to slight. The available water capacity is 1.6 inches/feet (13.3 cm/meter) of soil.
Kawaihāpai Series: This series consists of well-drained soils in drainageways and on alluvial fans on coastal plains. These soils formed in alluvium derived from basic igneous rock in humid uplands.			
Kawaihāpai stony clay loam, 0 to 2 percent slopes (KlaA)	These soils occur on smooth slopes including portions of Red Hill Fuel Annex.	Neutral, dark brown clay loam in the surface layer (about 22 inches [56 cm] thick) with enough stones to hinder but not prevent cultivation. The next layer is neutral, dark brown stratified sandy loam (about 32 inches [81 cm] thick). The substratum is neutral, stony, and gravelly.	Permeability is moderate. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.8 inches/feet (15 cm/meters) in the surface layer and 1.6 inches/feet (13 cm/meter) in the subsoil. Workability is slightly difficult due to stoniness.
Kawaihāpai stony clay loam, 2 to 6 percent slopes (KlaB)	These soils occur on smooth slopes including portions of Red Hill Fuel Annex and Waiawa Watershed.	Similar in profile to KlaA.	Similar in characteristics as KlaA.
Kawaihāpai very stony clay loam, 0 to 15 percent slopes (KlaC)	These soils occur in narrow drainageways including portions of Red Hill Fuel Annex and Waiawa Watershed.	Similar in profile to KlaA except that there are enough stones to prevent cultivation.	Similar in characteristics as KlaA except that runoff is medium and erosion hazard is moderate.

Soil Type	*Location*	*Description*	*Characteristics*
Kawaihāpai silty clay loam, 2 to 7 percent slopes (KlcB)	These soils occur on smooth slopes including portions of Red Hill Fuel Annex.	These soils differ from the typical Kawaihāpai soils in the following respects: it occurs at higher elevations; the soil is strongly acidic in the surface layer and medium acid in the subsoil.	Similar in characteristics as KlaC.
Keaʻau Series: This series consists of poorly drained soils on coastal plains. These soils developed in alluvium deposited over reef limestone or consolidated coral sand.			
Keaʻau clay, 0 to 2 percent slopes (KmA)	These soils occur on lowlands on coastal plains including portions of Pearl City Peninsula (containing the housing community), Beckoning Point, and Halsey Terrace Housing Community.	This soil is mildly alkaline, very dark grayish brown clay about 15 inches (38 cm) thick in the surface layer. The subsoil (about 19 inches [48 cm] thick) is moderately alkaline, very dark grayish brown and dark brown, mottled clay that has subangular and angular blocky structure. The substratum is moderately alkaline, white to very pale brown reef limestone, or consolidated coral sand. The water table is at a depth of 1.5 to 3 feet (0.5 to 1 meter).	Permeability is slow, runoff is slow, and the erosion hazard is no more than slight. The shrink-swell potential is high. The available water capacity is 1.5 inches/feet (13 cm/meter).
Keaʻau clay, saline, 0 to 2 percent slopes (KmbA)	This soil occurs on lowlands on the coastal plains.	This soil has a profile like that of KmA except that there are sufficient stones to hinder machine cultivation.	Permeability is slow, runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.5 inches/feet (12.5 cm/meter). The shrink-swell potential is high.
Keaʻau stony clay, 0 to 2 percent slopes (KmaB)	This soil occurs on lowlands on the coastal plains including small portions of NAVMAG PH/West Loch Annex.	This soil has a profile similar to KmA except that there are sufficient stones in this soil type to hinder machine cultivation.	This soil is similar to KmA except that the erosion hazard is slight.

Soil Type	*Location*	*Description*	*Characteristics*
Kokokahi Series: This series consists of moderately well-drained soils on talus slopes and alluvial fans. These soils developed in colluvium and alluvium derived from basic igneous rock.			
Kokokahi very stony clay, 0 to 35 percent slopes (KTKE)	These soils occur on talus slopes and alluvial fans including portions of Makalapa Crater (including the housing community).	All layers contain many stones and boulders. The surface layer is slightly acid to neutral, very dark gray clay (approximately 14 inches [36 cm] thick). The next layer (about 12 inches [31 cm] thick) is slightly acid to moderately alkaline, dark grayish brown clay that has a subangular blocky structure. The substratum is slightly acid to moderately alkaline, grayish brown, and light grayish brown clay (14 to 20 inches [36 to 51 cm] thick).	These soils are very sticky and very plastic, and they crack widely upon drying. Permeability is slow to moderately slow. Runoff is medium to rapid and the erosion hazard is moderate to severe. The shrink-swell potential is high. The available water capacity is 1.6 inches/feet (13 cm/meter).
Lāhainā Series: This series consists of well-drained soils on uplands. These soils developed in material weathered from basic igneous rock.			
Lāhainā silty clay, 7 to 15 percent slopes (LaC)	These soils occur on smooth uplands including portions of Red Hill Fuel Annex and Red Hill Housing Community.	Medium acid dark reddish-brown, silty clay in the surface layer (approximately 15 inches [38 cm] thick). The subsoil is slightly acid to medium, dusky-red and dark reddish-brown subangular blocky silty clay and silty clay loam (approximately 45 inches [114 cm] thick). The substratum is slightly acid to medium acid, soft, weathered basic igneous rock.	Permeability is moderate. Runoff is medium and erosion hazard is medium. Available water capacity is 1.3 inches/feet (11 cm/meter) in the surface layer and 1.4 inches/feet (12 cm/meter) in the subsoil.
Lāhainā silty clay, 7 to 15 percent slopes, severely eroded (LaC3)	These soils occur on smooth uplands including portions of the Red Hill Housing Community.	Similar in profile to LaC except the surface layer and, in places, part of the subsoil has been removed by erosion.	Similar in characteristics to LaC except that runoff is medium and the erosion hazard is severe.

Soil Type	*Location*	*Description*	*Characteristics*
Makalapa Series: This series consists of well-drained soils on uplands near Salt Lake Crater.			
Makalapa Clay, 2 to 6 percent slopes (MdB)	These soils occur on gently sloping areas near Salt Lake Crater including portions of Makalapa Crater (including the housing community), FFD, MSC/NEX/Commissary, Naval Station, Navy-Marine Golf Course, ʻOhana Nui, Public Works Center, Richardson Recreation Center, Salt Lake Storage Area as well as Catlin Park, Doris Miller Park, Hale Moku, Halsey Terrace, Hōkūlani, Little Makalapa, Makalapa, Maloelap, Marine Barracks, and Moanalua Terrace Housing Communities.	This soil is mildly alkaline, dark grayish brown clay about 8 inches (20 cm) thick. The next layer (18 to 36 inches [46 to 91 cm] thick) is mildly to moderately alkaline, very dark grayish brown, weathered volcanic tuff.	The clays are very sticky and very plastic and they crack upon drying. Permeability is slow, runoff is slow, and the erosion hazard is slight. The shrink-swell potential is high. Available water capacity is 1.4 inches/feet (12 cm/meter).
Makalapa Clay, 6 to 12 percent slopes (MdC)	These soils occur on alluvial fans including portions of the Halsey Terrace, Maloelap, Moanalua Terrace, and Radford Terrace Housing Communities.	Similar in profile to MdC except that it occurs on alluvial fans.	Similar in characteristics as MdB.
Makalapa Clay, 12 to 20 percent slopes (MdD)	These soils occur on smooth uplands including portions of Moanalua Terrace.	Similar in profile to MdB.	Similar in characteristics as MdB except that runoff is medium and the erosion hazard is moderate.
Māmala Series: This series consists of shallow, well-drained soils along the coastal plains. These soils formed in alluvium deposited over coral limestone and consolidated calcareous sand.			
Māmala stony silty clay loam, 0 to 12 percent slopes (MnC)	These soils occur on coastal plains including portions of Pearl City Peninsula, Beckoning Point, and Fort Kamehameha WWTP.	Neutral to mildly alkaline, dark reddish-brown stony silty clay loam in the surface layer (approximately 8 inches [20 cm] thick). The subsoil is neutral to mildly alkaline, dark reddish-brown silty clay loam (approximately 11 inches [28 cm] thick). The soil is underlain by coral limestone and consolidated calcareous sand at depths of 8 to 20 inches (20 to 51 cm). Stones, mostly coral rock fragments, are common in the surface layer and in profile.	Permeability is moderate. Runoff is very slow to medium and the erosion hazard is slight to moderate. The available water capacity is 2.2 inches/feet (18 cm/meter) in the surface layer and 1.9 inches/feet (16 cm/meter) in the subsoil.

Soil Type	*Location*	*Description*	*Characteristics*
Mānana Series: This series consists of well-drained soils on uplands. These soils developed in material weathered from basic igneous rock.			
Mānana silty clay loam, 12 to 25 percent slopes, eroded (MpD2)	These soils occur on smooth slopes including portions of Red Hill Fuel Annex.	The surface layer is strongly acidic, dark reddish-brown silty clay loam (8 inches [20 cm] thick). The subsoil (about 42 inches [107 cm] thick) is strongly to extremely acidic, dusky-red, dark reddish-gray, and dark reddish-brown silty clay that has subangular blocky structure. A nonporous, pan-like sheet (0.125 to 0.25 inch [0.32 to 0.64 cm] thick) occurs in the subsoil at less than 15 inches (38 cm). The substratum is strongly to extremely acidic, soft, weathered basic igneous rock.	Permeability is moderately rapid above the pan and moderate below. Runoff is rapid, and the erosion hazard is severe. The available water capacity is 1.2 inches/feet (10 cm/meter) in the surface layer and 1.3 inches/feet (11 cm/meter) in the subsoil.
Mānana silty clay loam, 6 to 12 percent slopes (MoC)	These soils occur on smooth slopes including portions of Red Hill Fuel Annex.	Similar to MpD2 except that the depth of the pan ranges from 15 to 50 inches (38 to 127 cm).	Similar in characteristics as MpD2 except that runoff is medium and the erosion hazard is moderate.
Molokaʻi Series: This series consists of well-drained soils on uplands. These soils formed in material weathered from basic igneous rock.			
Molokaʻi silty clay loam, 3 to 7 percent slopes (MuB)	These soils occur on smooth slopes including portions of the Mānana Housing Community.	Slightly acidic to neutral, dark reddish-brown silty clay loam in the surface layer (approximately 15 inches [38 cm] thick). The subsoil is slightly acidic to neutral, dark reddish-brown silty clay loam that has prismatic structure (approximately 57 inches [145 cm] thick). The material at depths of 35 to 64 inches (89 to 163 cm) is moderately compact in place. The substratum is slightly acidic to neutral, soft, weathered rock.	Permeability is moderate. Runoff is slow and the erosion hazard is slight. Available water capacity is 1.3 inches/feet (11 cm/meter).
Molokaʻi silty clay loam, 3 to 7 percent slopes, severely eroded (MuC)	These soils occur on knolls and sharp slope breaks including portions of the Mānana Housing Community.	A profile like MuB except that the surface layer and, in places, part of the subsoil have been removed by wind and water erosion.	Similar in characteristics as MuB except that runoff is moderate and erosion hazard is severe.

Soil Type	*Location*	*Description*	*Characteristics*
Mokulēʻia Series: Consists of well-drained soils along the coastal plains. These soils formed in recent alluvium deposited over coral sand. They are shallow and nearly level.			
Mokulēʻia clay (Mtb)	This soil occurs as small areas on the coastal plains.	It is nearly level. In a representative profile, the surface layer is very dark grayish brown clay about 16 inches (40.6 cm) thick. The next layer, about 34 to 48 inches (86.4 to 121.9 cm) thick, is dark brown and light-gray, single grain sand and loamy sand. The material is moderately alkaline.	Permeability is slow in the surface layer and rapid in the subsoil. Runoff is very slow, and the erosion hazard is no more than slight. The available water capacity is 1.8 inches/feet (15 cm/meter) in the surface layer and about 1.0 inches/feet (8.3 cm/meter) in the subsoil. Workability is difficult due to the sticky, plastic clay.
Pearl Harbor Series: This series consists of very poorly drained soils on nearly level coastal plains. These soils developed in alluvium overlying organic material.			
Pearl Harbor clay (Ph)	These soils occur on coastal plains including portions of Pearl City Peninsula and NISMO.	Neutral, very dark gray, mottled clay in the surface layer (about 12 inches [31 cm] thick). The subsoil (about 19 inches [48 cm] thick) is mildly to moderately alkaline, very dark gray and very dark grayish brown, mottled clay that has angular and subangular blocky structure. The substratum is muck or peat.	Permeability is very slow. Runoff is very slow to ponded, and erosion hazard is no more than slight. Available water capacity is about 1.4 inches/feet (12 cm/meter).
Rockland (rRK)	This soil type includes exposed rock covering 25 to 90 percent of the surface and can be found at Makalapa Crater and Red Hill Fuel Annex.	The rock outcrops and very shallow soils are the main characteristics. The rock outcrops are mainly basalt and andesite.	In many areas, the soil material associated with the rock outcrops is very sticky and very plastic. It also has high shrink-swell potential. Buildings on the steep slopes are susceptible to sliding when the soil is saturated. Foundations and retaining walls are susceptible to cracking.
Tropaquepts (TR)	These soils are poorly drained and are periodically flooded by irrigation in order to grow crops that thrive in water. These soils have been flooded for varying lengths of time, and soil development differs in degree from place to place. They occur at portions of the McGrew Point Housing Community.	The surface layer (approximately 10 inches [25 cm] thick) consists of dark gray, soft, mucky silt loam. This layer overlies firm to compact silty clay loam (approximately 5 to 10 inches [13 to 25 cm] thick), that is mottled with gray, yellow, and brown. The mottled layer overlies friable alluvium.	No characteristics reported.

Soil Type	*Location*	*Description*	*Characteristics*
Waipahu Series: This series consists of well-drained soils on terraces. These soils developed in old alluvium derived from basic igneous rock.			
Waipahu silty clay, 0 to 2 percent slopes (WzA)	These soils occur on dissected terraces adjacent to the ocean including portions of the Hālawa Housing Community.	The surface layer is slightly acidic, grayish brown silty clay (approximately 12 inches [31 cm] thick). The subsoil is slightly acidic, dark brown silty clay that has prismatic structure (approximately 58 inches [147 cm] thick) and is very sticky and very plastic in the lower part. The substratum is clayey alluvium.	Permeability is moderately slow. Runoff is slow or very slow and the erosion hazard is none to slight. Available water capacity is about 1.4 inches/feet (12 cm/meter) in the surface layer and 1.6 inches/feet 13 cm/meter) in the subsoil.
Waipahu silty clay, 2 to 6 percent slopes (WzB)	This soil occurs on dissected terraces adjacent to the ocean including portions of the Mānana Housing Community.	In a representative profile, the surface layer is grayish brown silty clay about 12 inches (30.5 cm) thick. The subsoil, about 58 inches (147.3 cm) thick, is dark brown silty clay that has prismatic structure. It is very sticky and very plastic in the lower part. The substratum is clayey alluvium. The soil is slightly acidic in the surface layer and subsoil.	Permeability is moderately slow. Runoff is slow and the erosion hazard is slight. Available water capacity is about 1.4 inches/feet (12 cm/meter) in the surface layer and 1.6 inches/feet 13 cm/meter) in the subsoil.
Waipahu silty clay, 6 to 12 percent slopes (WzC)	These soils occur on dissected terraces adjacent to the ocean including areas at NISMO and McGrew Point Housing Community.	Similar in profile to WzA.	Similar in profile to WzA except that runoff is medium and the erosion hazard is moderate.

Notes: cm = centimeter; FFD = Federal Fire Department; MSC = Military Sealift Command; NAVMAG PH = Naval Magazine Pearl Harbor; NEX = Navy Exchange; NISMO = Naval Inactive Ship Maintenance Office; WWTP = Wastewater Treatment Plant.
Source: USDA, 1972.

Pearl City Peninsula

Pearl City Peninsula is underlain by soils of the Honouliuli Series, Keaʻau Series, Māmala Series, and the Pearl Harbor Series as well as Fd. Portions of the peninsula underlain by the Honouliuli clay, 0 to 2 percent (HxA) and Keaʻau clay, 0 to 2 percent slopes (KmA), have a high shrink-swell potential. In addition, ponded water may occur in areas underlain by Pearl Harbor clay (Ph) (USDA, 1972).

Waipiʻo Peninsula

The Waipiʻo Peninsula is underlain mainly by soils of the Māmala and Honouliuli series as well as Fd, with smaller areas of Ph, Mokulēʻia and Keaʻau clays, and CR. As previously described, HxA, Mokulēʻia clay (Mtb), and Keaʻau clay, 0 to 2 percent slopes (KmA) soils have a high shrink-swell potential.

Naval Magazine Pearl Harbor/West Loch Annex7

Portions of NAVMAG PH/West Loch Annex are underlain by soils of the Helemano Series (e.g., HLMG) have a severe to very severe erosion hazard and soils of the Honouliuli Series and Keaʻau Series have a high shrink-swell potential (USDA, 1972). Although there are heavy sediment loads deposited into West Loch of Pearl Harbor estuary after rains, the sediments originate in the upper portion of the watershed where civilian activities predominate, and the DON does not control inputs to stormwater. In the vicinity of Pearl Harbor, where military controlled lands prevail, the topography is level to gently sloping.

Makalapa Crater

Makalapa Crater is underlain by rRK and soils of the Hanalei Series, Kokokahi Series (KTKE), and Makalapa Series. Portions of the crater underlain by Kokokahi very stony clay, 0 to 35 percent (KTKE) and MdB high shrink-swell potential. In addition, the KTKE soil type and the soils associated with rRK are characterized by a moderate to severe erosion hazard (USDA, 1972).

Housing Communities and Special Area Honolulu

Catlin Park, Doris Miller Park, Hale Moku, Halsey Terrace, Hōkūlani, Hospital Point, Little Makalapa, Makalapa, Maloelap, Mānana, Marine Barracks, Moanalua Terrace, and Radford Terrace are underlain or partially underlain by clay soils of the Keaʻau, Makalapa, or Molokaʻi Series which are all characterized by high shrink-swell potential. Pearl City Peninsula Housing Community is underlain by Ph, which is characterized by ponded water. In addition, the KTKE soil type (Makalapa Housing Community), Lāhainā silty clay, 7 to 15 percent slopes, severely eroded (LaC3) (Red Hill Housing Community), and the soils associated with rRK are characterized by moderate to severe erosion hazard (USDA, 1972). The Special Area Honolulu is characterized by MdB and Makalapa clay, 6-12 percent slopes (MdC), both which have very high shrink-swell potential.

Red Hill Fuel Annex

Most of Red Hill Fuel Annex consists of steep slopes along a narrow ridge. Several large areas of erosion were observed on the ridge at Red Hill by NAVFAC PAC biologists in the fall of 2006 (NAVFAC PAC, 2006a). A significant portion of the ridge is eroded, primarily due to vegetation loss from human activities, including vehicle maneuvering, parking, etc. Topsoil has been lost through wind erosion and new vegetation has not been re-established, but the remaining vegetation does prevent soil loss and watershed protection to some degree. Biologists have recommended that the eroded areas be revegetated with native groundcover species such as ʻūlei (*Osteomeles anthyllidifolia)*, aʻaliʻi (*Dodonaea viscosa)*, and native coastal sandalwood or ʻiliahi aloʻe (*Santalum ellipticum)* (NAVFAC PAC, 2006a).

The Red Hill Fuel Annex is underlain by rRK as well as fill materials and soils of the Lāhainā Series, Mānana Series, Kawaihāpai Series, and Kaʻena Series. Soils of the Mānana silty clay loam, 12 to 25 percent slopes (MpD2), are characterized by severe erosion hazard and soils of the Kaʻena very stony clay, 10 to 35 percent slopes (KanE), have high shrink-swell potential (USDA, 1972).

Waiawa Watershed

Waiawa Watershed is underlain by soils of the Kawaihāpai Series and HLMG. Helemano silty clay, 30 to 90 percent slopes, is characterized by severe to very severe erosion hazard (USDA, 1972).

4.2.6 Hydrology

Section 2.2.5 provides a description of the hydrology of the Hawaiian Islands and the island of Oʻahu. The discussion of the study area hydrology is divided into two subsections: surface water resources and groundwater resources (hydrogeology).

4.2.6.1 Surface Water Resources

Pearl Harbor Watershed

The Pearl Harbor watershed is subdivided into distinct subwatersheds that empty into Pearl Harbor and are shown in Figure 4-7. The Pearl Harbor Watershed is characterized by a very steep precipitation gradient from the harbor to the crest of the Koʻolau Range. Although the Pearl Harbor area is relatively dry with a mean annual rainfall of 25.5 inches (64.8 cm), the crest of the Koʻolau Range and other mountainous regions within the watershed are considerably wetter with a mean annual rainfall that can exceed 275 inches (699 cm). Rainfall is seasonal within the Pearl Harbor watershed, varying from 4 inches (10.2 cm) per month during the winter (December to February) to 1 inch (2.54 cm) per month during the summer (June to July) (Earth Tech Inc., 2005). On the coastal plain, perennial freshwater flow may originate from basal groundwater springs. The volume of fresh water from springs entering Pearl Harbor was estimated in the 1970s at 50 million gallons per day (mgd) (189 million liters per day [mld]) during dry periods and greater than 100 mgd (379 mld) during rainy periods (Cox and Gordon, 1970; B-K Dynamics, 1972). Combined, the springs are now estimated to flow at 80 mgd (363 mld) as of a 1983 estimate (Englund et al., 2000) and were similarly documented by Nichols et al. in 1996 (Oceanit et al., 2007).

ʻAiea, Hālawa, Kalauao, Waimalu, and Waimano Streams drain steep, relatively narrow valleys of the Koʻolau Range and, therefore, transport substantial coarse sediment loads during storm events. Waikele and Honouliuli streams drain the Schofield Plateau and typically transport large amounts of fine-grained sediment. The Waikele Watershed is largest and comprises 40 percent of the overall Pearl Harbor Watershed and discharges the heaviest sediment load of any of the Pearl Harbor Basin streams (Grovhoug, 1992). All streams drain forested and agricultural lands and pass through highly urbanized areas before entering Pearl Harbor.

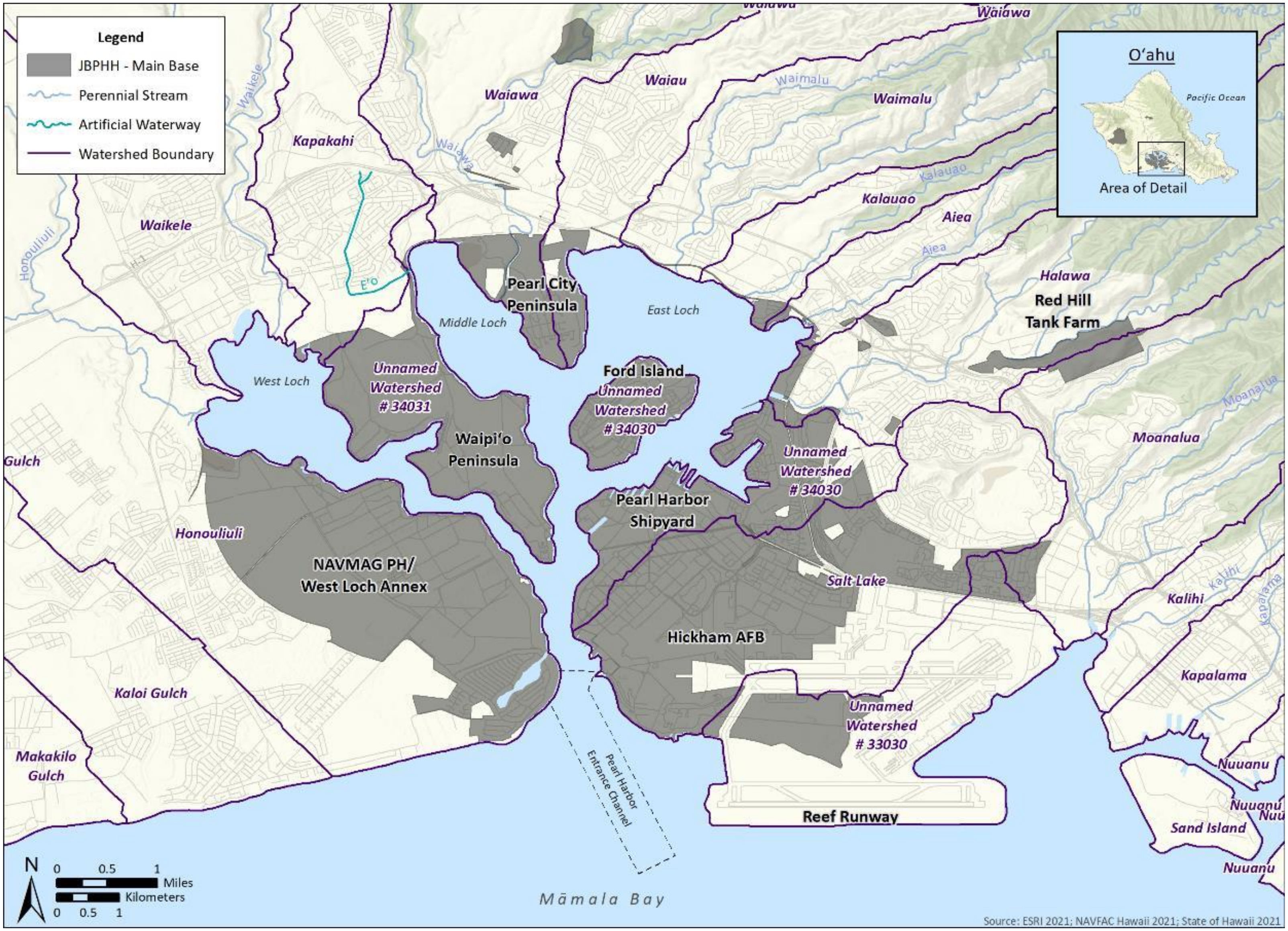


Figure 4-7 JBPHH Main Base and Surrounding Areas Watersheds and Streams

Streams

Stream flow constitutes approximately 8 mgd (30 mld) of fresh water into the harbor during dry periods and 56 mgd (212 mld) during wet periods. Approximately 40 percent of the stream runoff entering the harbor enters into Middle Loch, another 40 percent enters into West Loch, and 20 percent enters into East Loch (Grovhoug, 1992). Six perennial (year-round) streams: Waikele, Waiawa, Waiau, Waimalu, Kalauao, Hālawa; and two intermittent (periodic) streams: Honouliuli and ʻAiea, flow into Pearl Harbor (Gonzalez et al., 2021). Additionally, and notably different from the others, is Eʻo waterway, an artificially constructed stream outlet formed by dredging and draining the former Loko Eʻo fishpond. Eʻo waterway consists of a marine and tidally influenced canal from Middle Loch well inland before giving way to freshwater influence from Waipahu neighborhood surface runoff (Gonzalez, et al., 2021).

These perennial and intermittent streams drain through agricultural and urban lands before passing through highly urbanized lands near the harbor. Stream water is fresh up until a short distance upstream from the mouth of the streams where they enter into the saline waters of the estuary and mixing occurs. High flood peaks and low base flow above the areas of influence from springs characterize Pearl Harbor streams. While base flows generally have low turbidity and high water quality, significant rain events can increase stream flow levels and rates typically carrying larger loads of sediments and potential pollutants from the watershed into Pearl Harbor estuary (NAVFAC PAC, 2020a).

Springs

Five large springs heavily influence the stream flows into Pearl Harbor: Waikele, Waiawa, Waimanu, Waiau, and Kalauao. These springs are located along the shoreline and are considered the largest and most significant spring complex in the Hawaiian Islands. The largest spring is the Waimanu-Waiau Spring, which drains into East Loch; it has a median flow of 32 mgd (121 mld). The springs issue from points along the edge of the upper confining member of the aquifer and represent overflow of the artesian basin rather than artesian springs. Spring discharges have increased since sugarcane cultivation and its associated irrigation water pumping have ceased. Stream flow into the harbor contributes 31 mgd (117 mld) during dry periods and 87 mgd (329 mld) during wet periods and heavily influences the harbor water chemistry and associated marine biological conditions of the harbor (Earth Tech Inc., 2005).

Pearl Harbor Estuary

Pearl Harbor is the SOH's largest estuary, a coastal area where fresh water from rivers and streams mix with salt water from the ocean. Borders of Pearl Harbor have a variety of wetlands, including grassy marshes and woody (often red mangrove [*Rhizophora mangle]*) swamp habitat, where siltation is a significant ongoing process. The HDOH classifies the waters of the harbor as an inland estuary, Class 2. The objective of Class 2 water is to protect their use for recreational purposes, propagation of fish and other aquatic life, and agricultural and industrial water supplies, shipping, navigation, and propagation of shellfish. Discharges into Class 2 waters must receive the highest degree of treatment or control compatible with the criteria established for this class (HDOH, 2004).

Like all estuaries, Pearl Harbor is a natural sediment trap, and is the ultimate "recipient" of the contaminant load from many sources within the watershed. It is estimated that approximately 96,300 tons (180,000 cubic yards or 137,500 cubic meters) of sediment per year is delivered to Pearl Harbor from basin streams (Grovhoug, 1992). Pearl Harbor has been identified by HDOH as one of 18 "Water Quality-Limited Segments" around the state. After heavy rains, the nearshore waters of the harbor often turn red or brown from the sediment-laden runoff. This sediment discharge is due primarily to poor erosion and sediment control in upland areas—along stream banks, unstable slopes, and cleared land (e.g., agricultural land, urban construction sites). Heavy metals and other chemical contaminants (e.g., pesticides, herbicides, etc.) frequently adsorb to sediment particles and are transported to the harbor waters. These contaminants do adversely impact the marine ecosystem. Although the DON is required by law to meet SOH and federal water quality standards in Pearl Harbor, it has little control over activities in the watershed that impact water quality.

Point source discharges are defined by HDOH as discharges that enter a body of water from a specific, identifiable point such as a pipe, ditch, tunnel, channel, or similar discrete conveyance (HDOH, 2004).

HDOH issued a National Pollutant Discharge Elimination System (NPDES) permit for the DON's WWTP, which took effect June 1, 2020 and expires May 31, 2025. The DON's WWTP accepts domestic and industrial wastewater and has a capacity of 13 mgd (49 mld). The WWTP has a deep ocean outfall that reduces pollutant discharge into Pearl Harbor by taking advanced secondary treated effluent into deeper waters where it will be disbursed with help of ocean currents (NAVFAC HI, 2020). Another source of continual point source discharge into Pearl Harbor is for the cooling effluent from Hawaiian Electric Company's Waiau Power Plant. In addition to these continual sources, there are dozens of other NPDES permits, both individual and general permits, which have been issued for occasional or intermittent discharges into Pearl Harbor.

The EPA placed Pearl Harbor on the National Priorities List in 1992. In 1998, HDOH issued an advisory warning that humans should not consume fish and shellfish caught in Pearl Harbor, posted warning signs in various locations around the harbor, and published multilingual brochures warning of possible health effects associated with eating fish and shellfish from the harbor. The advisory warning remains in effect (HDOH, 2020). The DON, in cooperation with EPA, HDOH, USFWS, NMFS, and members of the public, have conducted a Remedial Investigation (RI) of the harbor (DON, 2007). Toxicity tests have identified areas of concern in Southeast Loch, Middle Loch, West Loch, and the Pearl Harbor Entrance Channel. Although the RI has identified areas of the harbor for cleanup, Pearl Harbor continues to receive runoff and pollutants from 22 percent of the land area of Oʻahu including former and existing agricultural lands, urban areas, and commercial and light industrial areas (HDOH, 2020).

Flooding and Tsunami Zones

Flood Insurance Rate Maps for JBPHH Main Base and Surrounding Areas (Federal Emergency Management Agency [FEMA], 2011) indicate that the majority of the study area is located in Zone D ("areas of undetermined, but possible, flood hazards") (Figure 4-8). Portions of the study area are located in Zone A, Zone AE, Zone AH, Zone AO, Zone VE, and Zone X. Zone A is in the 100-year base flood zone with no depth of base elevations determined; Zone AE is in the 100-year base flood zone with elevations determined; Zone AH is in the 100-year flood zone with shallow flooding, usually in the form of a pond, with an average depth of 1 to 3 feet (0.3 to 0.9 meter); Zone AO includes river and stream flood hazard areas and in the 100-year floods zone with an average depth of 1 to 3 feet (0.3 to 0.9 meter); Zone VE includes coastal areas within the 100-year flood zone which have an additional hazard associated with storm waves. Zone X is outside the 500-year flood zone (FEMA, 2015). Small portions of the study area are located in the 500-year flood hazard zone (FEMA, 2015). The majority of shore and nearshore areas at JBPHH Main Base and Surrounding Areas are located in tsunami evacuation zones (CCH, 2015a,b,c).

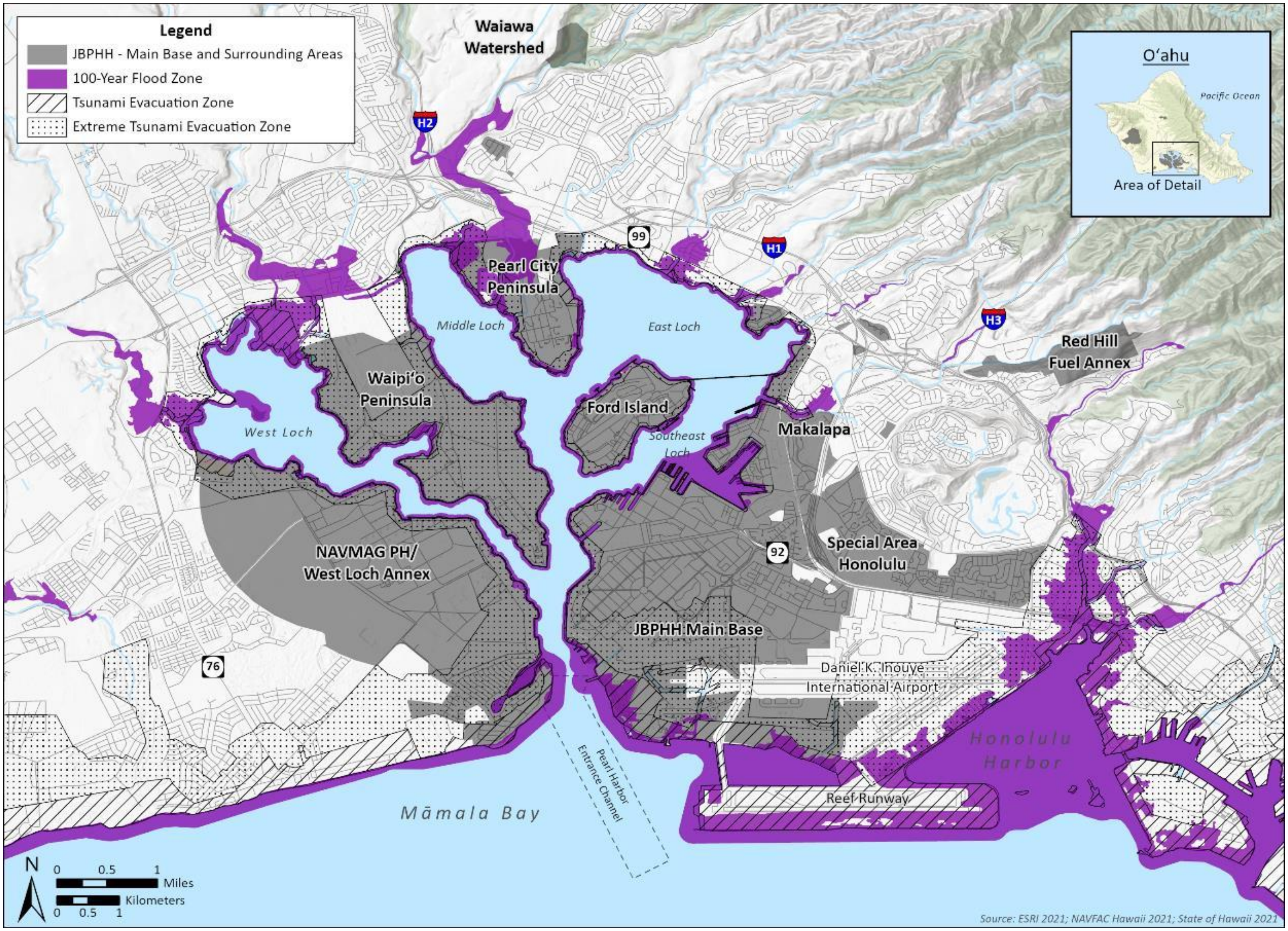


Figure 4-8 JBPHH Main Base and Surrounding Areas Flood and Tsunami Zones

Groundwater flow toward Pearl Harbor may act as a transport pathway for chemicals present in upland soils to reach the harbor. Chemicals present in upland soils may enter the groundwater by leaching through highly permeable overlying soils except in areas overlain by sedimentary caprock. Once in the groundwater, chemicals may be transported to streams that discharge to the harbor or the harbor directly.

Table 4-4 presents a summary of the aquifer characteristics for JBPHH Main Base and Surrounding Areas. As indicated in Table 4-4, there are four aquifers that are currently used for drinking water within the study area (Mink and Lau, 1990); these are further described below.

- Basal, unconfined, flank aquifer of the Waimalu Aquifer System of the Pearl Harbor Aquifer Sector (30201111[11111]); it underlies Red Hill Fuel Annex, Public Works Center Compound, and the Hālawa Housing Community. There are DON potable water supply wells located at Red Hill Fuel Annex and adjacent to the Hālawa Housing Community.
- Basal, unconfined, flank aquifer of the Waiawa Aquifer System of the Pearl Harbor Aquifer Sector (30202111 [11111]); it underlies Little Makalapa, Makalapa, and Mānana Housing Communities.
- Basal, confined, flank aquifer of the Moanalua Aquifer System of the Honolulu Aquifer Sector (30104121 [11113]); it underlies ‘Ohana Nui and the Hoku Lani Housing Community.
- Basal, unconfined, flank aquifer of the Moanalua Aquifer System of the Honolulu Aquifer Sector (30104111 [11111]); it underlies a portion of Red Hill Fuel Annex, Waiawa Watershed, FFD, MSC/NEX/Commissary, Navy-Marine Golf Course, Public Works Center Compound, and Salt Lake Storage Area, Catlin Park, Doris Miller, Halsey Terrace, Maloelap, Moanalua Terrace, Radford Terrace Housing Communities.

Table 4-4 Summary of JBPHH Main Base and Surrounding Areas Aquifer Characteristics

Aquifer Code	*Aquifer Sector*	*Aquifer System*	*Aquifer Type*	*Development Stage/Utility/Salinity*	*Uniqueness*/Vulnerability to Contamination*
30201116 (12211)	Pearl Harbor	Waimalu	Basal unconfined sedimentary	Currently used, ecologically important, with low salinity (250-1,000 milligrams per liter [mg/L] mg/L chlorides [Cl^-])	Irreplaceable, high vulnerability to contamination
Land areas underlain by this aquifer: Red Hill Housing Community, Makalapa Crater					
30201121 (12212)	Pearl Harbor	Waimalu	Basal, confined, horizontally extensive lavas (flank)	Currently used, ecologically important, with low salinity	Irreplaceable, moderate vulnerability to contamination
Land areas underlain by this aquifer: Red Hill Housing Community, Makalapa Crater					
30201111 (11111)	Pearl Harbor	Waimalu	Basal, unconfined, flank	Currently used for drinking water and is fresh, fuel storage tanks above aquifer	Irreplaceable with a high vulnerability to contamination
Land areas underlain by this aquifer: Red Hill Fuel Annex, Public Works Center Compound, Hālawa Housing Community					

Aquifer Code	***Aquifer Sector***	***Aquifer System***	***Aquifer Type***	***Development Stage/Utility/Salinity***	***Uniqueness*/Vulnerability to Contamination***
30202111 (11111)	Pearl Harbor	Waiawa	Basal, unconfined, flank	Currently used for drinking water and is fresh	Irreplaceable with a high vulnerability to contamination
Land areas underlain by this aquifer: Little Makalapa, Makalapa, Mānana					
30202116 (12211)	Pearl Harbor	Waiawa	Basal, unconfined, sedimentary	Currently used, ecologically important, with low salinity	Irreplaceable, high vulnerability to contamination
Land areas underlain by this aquifer: Beckoning Point, Bishop Point, Ford Island, Fort Kamehameha WWTP, Ford Island Housing Community, Shipyard, Hale Moku Housing Community, Hospital Point, Marine Barracks, McGrew Point, Pearl City Peninsula					
30202121 (12212)	Pearl Harbor	Waiawa	Basal, confined, flank	Currently used, ecologically important, with low salinity	Irreplaceable, moderate vulnerability to contamination
Land areas underlain by this aquifer: Pearl City Peninsula, Beckoning Point, Bishop Point, Ford Island, Fort Kamehameha WWTP NISMO, Naval Station, Richardson Recreation Center, Shipyard, Ford Island, Hale Moku Housing Community, Hospital Point, Marine Barracks, McGrew Point, Pearl City Peninsula					
30203116 (12211)	Pearl Harbor	Waipahu	Basal, unconfined, sedimentary	Currently used, ecologically important, with low salinity	Irreplaceable, high vulnerability to contamination
Land areas underlain by this aquifer: Pearl City Peninsula, NISMO, Naval Station, Richardson Recreation Center					
30203121 (12212)	Pearl Harbor	Waipahu	Basal, confined, flank	Currently used, ecologically important, with low salinity	Irreplaceable, moderate vulnerability to contamination
Land areas underlain by this aquifer: Pearl City Peninsula					
30104116 (23321)	Honolulu	Moanalua	Basal, unconfined, sedimentary	Potential use, not considered suitable for drinking water or ecologically important, moderate salinity (1,000 to 5,000 mg/l Cl^-)	Replaceable with a high vulnerability to contamination
Land areas underlain by this aquifer: ʻOhana Nui, Hoku Lani					
30104121 (11113)	Honolulu	Moanalua	Basal, confined, flank	Currently used for drinking water and is fresh (less than 250 mg/l Cl^-)	Irreplaceable with a low vulnerability to contamination
Land areas underlain by this aquifer: ʻOhana Nui, Hoku Lani					
30104111 (11111)	Honolulu	Moanalua	Basal, unconfined, flank	Currently used for drinking water and is fresh (less than 250 mg/l Cl^-)	Irreplaceable with a high vulnerability to contamination
Land areas underlain by this aquifer: Red Hill Fuel Annex, Waiawa Watershed, FFD, MSC/NEX/Commissary, Navy-Marine Golf Course, Public Works Center Compound, and Salt Lake Storage Area, Catlin Park, Doris Miller, Halsey Terrace, Maloelap, Moanalua Terrace, Radford Terrace Housing Communities					

Notes: Cl^- = chlorides; FFD = Federal Fire Department; mg/l = milligram per liter; MSC = Military Sealift Command; NEX = Navy Exchange; NISMO = Naval Inactive Ship Maintenance Office; WWTP = Wastewater Treatment Plant.

Source: Mink and Lau, 1990.

4.3 General Biotic Environment

The discussion of the general biotic environment is divided into three subsections (4.3.1 through 4.3.3): wetlands, ecosystems, and terrestrial biology.

4.3.1 Wetlands

The discussion of wetlands within the study area includes a summary of the USACE-defined jurisdictional and reconnaissance level wetlands within the vicinity of Pearl Harbor, a summary of the USFWS-defined wetlands within Pearl Harbor, and a description of wetlands within the study area.

4.3.1.1 USACE-defined Wetlands

As discussed in Section 1.6.8, USACE defines wetlands as having all three of the following characteristics: (1) vegetation that is at least periodically present and supports hydrophytes or water-loving plants; (2) substrate of predominately undrained, hydric soil; (3) and substrate that is saturated with water or covered by shallow water at some point during the growing season of each year. A USACE-defined jurisdictional wetland is subject to regulation under Section 404 of the CWA.

USACE performed a wetland inventory of Pearl Harbor in 1999 (USACE, 1999). NAVFAC PAC performed an update to the 1999 wetlands inventory in 2006 (NAVFAC PAC, 2007a). The DON has the responsibility for respecting and caring for all wetlands and aquatic habitats that occur on the DON property and the wetland surveys contribute to the inventory and jurisdictional determination of wetlands and aquatic habitats. In essence, nearly all natural aquatic environments in and around Pearl Harbor meet the CWA definition of "special aquatic sites" and therefore are jurisdictional (NAVFAC PAC, 2007a). There are six categories of special aquatic sites: sanctuaries and refuges, wetlands, mudflats, vegetated shallows, coral reefs, and streams including riffle and pool complexes. All of these are subject to provisions of the CWA (NAVFAC PAC, 2007a).

The 2006 wetlands surveys compared the condition of wetlands with those made by USACE in 1999 (Table 4-5). The 1999 survey identified 126.9 acres (51.4 hectares) of jurisdictional wetlands within Pearl Harbor, the majority (91 percent) of which were colonized by mangroves, an invasive plant species (Table 4-6). In the subsequent years, the legal definition of wetlands has been further refined, and the conditions of some of the wetlands may have changed. Therefore, this table is provided as a guide and for historical context and may not represent existing conditions at the wetland sites. As wetland delineations are performed within the study area, the more detailed information will be incorporated into this document as appropriate.

Table 4-5 Summary of Changes in Pearl Harbor Wetlands (1999-2006)

Site	*Description*	*Changes From 1999 to 2006*	*USACE 1999 ID Number*
Puuloa Rifle Range and Iroquois Point Lagoon to Honouliuli Unit, PHNWR			
Golf course ponds	Eight ponds surveyed, none discussed	More ponds exist; no ponds surveyed in 2006	.1197-.1204
Puuloa Rifle Range	No wetlands	No changes	Not applicable
Puuloa Rifle Range and Iroquois Point Lagoon to Honouliuli Unit, PHNWR (continued)			
Kapilina Beach Homes Lagoons	Man-made marine ponds with fill (rock or eroding shore)	Mangroves removed; minimal or no wetlands present	.2231-.2338
Loko 'Oki'okiolepe	Mangal within pond	Mangrove expanding	.2206
Loko Pamoku	Mangal within pond	Mangrove expanding	.2207

Site	*Description*	*Changes From 1999 to 2006*	*USACE 1999 ID Number*
Unnamed mangal	Shoreline mangal	Mangrove expanding	.2208 through .2212
Unnamed pond	Mangal within pond	Mangrove expanding	.2213
Unnamed mangal	Shoreline mangal	Not seen in 1999	.2214
PHNWR Honouliuli Unit	Refuge wetlands	No change	.3158, .3164, .3165
West Loch Shoreline			
South end of ID .3163	Depression with a small palustrine wetland	Distinctive from ID .3163, a palustrine feature	.3159
Ponds surrounded by Batis flat		No change	.3163
Four ponds south of Honouliuli Stream mouth	Overgrown with mangrove	No change	.3160 through .3162, .3178
Mangrove at mouth of Honouliuli Stream and south along shore	A stream channel through mangal	No change	.3166, .3177, and .3179
Kaʻaukuʻu Fishpond	Heavily overgrown with mangrove with some open water remaining (non-DON land)	Less open water present	.3181
West Loch Shoreline Park	Mangrove, some areas of pickleweed(non-DON land)	Some expansion of mangrove, but CCH removing mangrove along the park shore	none
Honouliuli Estuary	Channel lined with mangrove	No change	.3175 through .3177
Honouliuli Stream	Palustrine wetland overgrown with California grass	No change	.3172, .3174, and .3177
Golf course water supply reservoir and driving range	Wetland (non-DON lands)	Not a wetland	.3182
West Loch Golf Course ponds and water traps	Wetlands (non-DON lands)	Ponds, most do have non-jurisdictional wetland margins	.3168, .3169, .3171, .3173, .3183
West Loch Shoreline (continued)			
Former Kahua Meat Company Pond	Pond utilized for treating wash-down effluent (non-DON lands)	Filled in	.3167
Laulaunui Islet and fishpond	All low areas overgrown with mangrove	No change	.3186 through .3196
Private kalo loʻi	Spring-fed pond (non-DON lands)	Stocked with ornamentals	.3185
West Loch north shore mangrove	Extensive mangal around old fishpond	No change	.3219, .3220
Pūpūʻolē wetland	Depressional wetlands (non-DON lands)	Nearly choked with California grass	.3217, .3218

Site	*Description*	*Changes From 1999 to 2006*	*USACE 1999 ID Number*
West Loch north shore mangrove	Extensive mangal at mouth of Waikele Stream	Further expansion of mangrove into West Loch; coalescence of numerous small clusters off stream mouth	.3223 through .3230, .3239 through .3240
Waipiʻo Peninsula			
West Loch north shore mangrove	Pouhala Marsh (non-DON lands)	Ongoing project to clean up marsh and playa areas and eliminate mangrove	.4241
West Loch north shore mangrove	Kapakahi Stream estuary (non-DON lands)	Mangroves removed	.4243 through .4244
West Loch northeast shore mangrove	Mostly a thin belt of mangrove off the old CCH ash landfill	No change	.4245 through .4246, .4517 (or .4284)
Former Oʻahu Sugar Company settling ponds	Settling ponds that developed into extensive wetlands	Use curtailed prior to 1999 and now completely dried up.	None
Scattered shoreline areas west of Walker Bay	Small mangrove clusters	Unchanged	.4062 through .4066
Walker Bay, north shore	Mangal with pickleweed flats behind	Unchanged	.4068 through .4072
Inland of north side of Walker Bay	Playas in man-made catchment basins	More than one feature is present	.4067
Walker Bay, south shore	Narrow band of mangrove at shore	Unchanged	.4073 through .4076
Wetland west of degaussing station	Interior wetland	Not investigated	.4057
Waipiʻo Peninsula (continued)			
West shore of Middle Loch	Narrow mangrove belt becoming mangal at north end	Unchanged	.4052 through .4056, .4288
Makalena Golf Course pond	Open water feature with margin of emergent vegetation (non-DON lands)	Unchanged	.4060
Kahu Drainage Channel	Mangroves lining modified drainage channels (non-DON lands)	Mangroves removed from smaller channels to maintain flood hydrology	.4058 through .4059, .4061, .4076 through .4078
Middle Loch and Pearl City Peninsula			
Kōlea Cove	Mitigation wetland (non-DON lands)	Much overgrown with loss of biological wetland functions	.6285
Middle Loch, northwest shore wetlands	Shoreline mangal (non-DON lands)	Significant portions of mangrove have been removed	.6077, .6079, .6082 through .6083
Waiawa Springs	Numerous ponds/diked enclosures used for watercress production (non-DON lands)	Many have been abandoned or are overgrown; .6125 reduced by fill	.6104 through .6120, .6122 through .6125
Bikeway drainage ditch	Depression overgrown with Batis (non-DON Navy lands)	Unchanged	.6121

Site	*Description*	*Changes From 1999 to 2006*	*USACE 1999 ID Number*
Waiawa Unit, PHNWR	Man-made wildlife ponds	Unchanged, although fronting mangrove has been removed by USFWS	.6080 through .6081
Waiawa wetlands	Remnant low land areas on flood plain	More overgrown with elephant grass	.6098 through .6101
Former WWTP site	Batis wetlands and playa	Unchanged	.6084 through .6086
Waiawa Stream estuary	Mangal	Unchanged	.6087 through .6088
Drainage ditch	Narrow mangrove-lined channel	Unchanged	.6093 through .6098, .6287
Middle Loch east shore	Narrow shoreline mangrove lands	Unchanged	.6090 through .6092
Northwest shore of East Loch	Shoreline mangal (non-DON lands)	Portions appear to have been filled	.6102 through .6103 and .7270
North Shore of East Loch: Waiau to Kalauao Stream			
Northwest shore of East Loch	Shoreline mangal (non-DON lands)	Portion appears to have been filled since 1999	.6103
North shore of East Loch	Shoreline mangal (non-DON lands)	Mangroves removed in front of Hawaiian Electric Company's Waiau Plant	.7270
Abandoned pondfields	Four diked ponds presumably used for watercress or taro production (non-DON lands)	Abandoned before 1999	.6251 through .6254
Pondfields north of H-1	Spring-fed, diked ponds used for watercress or taro production (non-DON lands)	Still in use	.6255
Pondfields south of H-1	Spring-fed, diked ponds used for watercress or taro production (non-DON lands)	Most still in agricultural use	.7256 through .7267
Waiau cooling water pond	Spring-fed, diked ponds (non-DON lands)	Emergent vegetation lacking	.7268
East of Pearl City Stream	Palustrine wet area(s) (non-DON lands)	Only .7258 seen in 1999	.7258, .7269
Shoreline mangrove east from Waiau to Blaisdell Park	Isolated mangrove copses and mangal (non-DON lands)	Most or all of the mangrove has been removed	.7129-.7130, .7131, .7132-.7133, .7271-.7261
Waiau wetland north of Kamehameha Highway	Spring-fed wetland with pondfields (non-DON lands)	Small agricultural plots	.7128
Blaisdell Park	Mangrove and pickleweed flat (non-DON lands)	Mangrove growth consolidated into mangal	.7140, .7144 .7145
Kalauao Spring	Sumida Watercress Farm (non-DON lands)	Commercial use continues	.7049
Harbor Center	Drainage ditches (non-DON lands)	No change	.7152, .7275

Site	*Description*	*Changes From 1999 to 2006*	*USACE 1999 ID Number*
Mangroves, Waimalu Stream to Kalauao Stream	Isolated mangrove copses and some mangal areas (non-DON lands)	Some consolidation, other growths are too small to regard as wetlands	.7035-.7038, .7040, .7041, .7043, .7047-.7048, .7053-.7056, .7057-.7059, .7283
North Shore of East Loch: Waiau to Kalauao Stream (continued)			
Pearl Kai wetland	Mitigation pond (non-DON lands)	Generally overgrown	.7042
Eastern Shore: McGrew Point to Bishop Point and Ford Island			
Loko Paʻaiau	Former fishpond, renovated in 2014	No change	.8001
McGrew Point	Scattered mangrove growth along the shore	Potentially one area (.8007) consolidating toward mangal	.8007 to .8022, .8045 to .8046
ʻAiea Bay	Extensive mangal at head of embayment	All mangrove removed in 2007	.9024 to .9034
Hālawa Stream	Mangals along the estuary	Portion removed by bridge reconstruction	.10050 through .10051
Makalapa Crater	California grass and pickleweed patches; not wetlands	Not known, but unlikely changed into wetlands	.11200 and .11201

Notes: CCH = City and County of Honolulu; DON = Department of the Navy; PHNWR = Pearl Harbor National Wildlife Refuge; USACE = United States Army Corps of Engineers; USFWS = United States Fish and Wildlife Service; WWTP = Wastewater Treatment Plant;* = Not all of the features listed in this table are visible in maps of Appendix J; () = The map number the feature would have appeared in had it been included in the map.

Source: USACE, 1999; NAVFAC PAC, 2007a.

Table 4-6 Jurisdictional Wetlands of Pearl Harbor

Location	*Mangrove acres (hectares)*	*Other Coastal acres (hectares)*	*Stream acres (hectares)*	*Other Fresh Water acres (hectares)*	*Total acres (hectares)*
Pearl City Peninsula	53.05 (21.47)	3.85 (1.56)	0.10 (0.04)	6.24 (2.53)	63.24 (25.60)
Waipiʻo Peninsula	36.61 (14.82)	0.86 (0.35)	0.00 (0.00)	0.00 (0.00)	37.47 (15.21)
West Loch	14.74 (5.97)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	14.74 (5.97)
McGrew Point	5.27 (2.13)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	5.27 (2.13)
Iroquois Point Lagoon	2.86 (1.16)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	2.86 (1.16)
Naval Station	0.13 (0.05)	0.00 (0.00)	0.25 (0.10)	0.00 (0.00)	0.38 (0.15)
All other areas of Pearl Harbor	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Totals	112.66 (45.60)	4.71 (1.91)	0.35 (0.14)	6.24 (2.53)	123.96 (50.18)
Percentage	91.10%	3.71%	0.28%	4.92%	

Source: USACE, 1999.

4.3.1.2 USFWS-defined Wetlands

As mentioned in Section 1.6.8, *Clean Water Act*, the USFWS National Wetland Inventory (NWI) program produces mapping that depict the location, size, and type of wetlands within a defined geographic region. These maps are useful for planning and identifying the likely presence of wetland in a given area. In addition, NWI mapping designates wetland type according to the USFWS classification of wetland and deep waters habitats of the U.S. (Cowardin, 1979). The 1999 NWI for Pearl Harbor identified a total of 5,207.2 acres (2,107.4 hectares) of wetlands within Pearl Harbor. These are summarized in Table 4-7.

Table 4-7 NWI Wetland Classification (1999)

Wetland Type	*Area in acres (hectares)*
Estuarine Permanently Flooded (includes the waters of Pearl Harbor)	4,758 (1,926)
Intertidal (extending upstream and landward to where ocean-derived salts measure less than 0.5 per thousand during the period of average annual low flow)	368 (149)
Palustrine (non-tidal wetlands dominated by trees, shrubs, persistent emergent vegetation, and all wetlands that occur in tidal areas with salinity below 0.5 per thousand)	73 (30)
Riverine (wetlands and deepwater habitats contained within a channel, which periodically or continuously contains moving water)	8 (3)
Total	5,207 (2,107)

Source: USACE, 1999.

Pearl Harbor

The wetlands of Pearl Harbor provide important wildlife habitat, are biologically rich and diverse areas, and are an important natural resource. Wetland areas adjacent to Pearl Harbor, which include mudflats, shallow ponds, small streams, mangal, pickleweed (*Batis maritima*) beds, cattails beds (*Typha spp.)*, and watercress beds, provide a variety of habitat types for fishes, crustaceans, aquatic plants, and waterbirds, including federally-listed endangered waterbirds. In addition, four historic fishponds (Loko Laulaunui, Loko Paʻaiau, Loko ʻOkiʻ Okiolepe, and Loko Pamoku) are part of the Pearl Harbor wetlands.

Pearl Harbor National Wildlife Refuge

The PHNWR is managed by USFWS and consists of three units: the Honouliuli Unit located along the west shore of West Loch (Appendix J, Figure 2-1) ; the Waiawa Unit located near the east shore of Middle Loch (Appendix J, Figure 4-2); and the Kalaeloa Unit, located on the flat coastal ʻEwa Plain approximately 7 miles southwest of Pearl Harbor (Section 7.3.3.1). The Honouliuli and Waiawa Units are managed under a use agreement with the DON (Appendix J-9). The PHNWR was created in 1976 to partially mitigate loss of natural habitat resulting from the construction of the Reef Runway at Honolulu International Airport. The PHNWR provides habitat for numerous bird species, including four endemic federally-listed endangered waterbirds (Section 4.3.3.2). The primary mission of the PHNWR is the management of Hawaiʻi's four endangered waterbirds: the Hawaiian coot (*Fulica alai*), Hawaiian gallinule (*Gallinula chloropus sandvicensis*), Hawaiian stilt (*Himantopus mexicanus knudseni*), and Hawaiian duck (*Anas wyvilliana*) in the Honouliuli and Waiawa Units and the endangered plants round-leaf chaffed flower (*Achyranthes splendens* var. *rotundata*) and ʻakoko (*Euphorbia skottsbergii var. skottsbergii*) in the Kalaeloa Unit (Section 7.3.3.1). Secondarily, and consistent with this management, benefits are also realized for a variety of migratory waterbirds (NAVFAC PAC, 2006b).

Wetlands within the PHNWR are primarily managed by manipulating the water level and controlling vegetation. Water levels are varied to control or foster certain plant species throughout most of the year, particularly during waterbird nesting seasons. Water levels are maintained at a relatively high level through the fall and winter. This is to provide a relatively constant water level suitable for migratory waterfowl. However, portions of the shallow water and mudflat areas are maintained for migratory shorebirds. This habitat provides feeding, loafing and protection. These migrants generally return to their breeding grounds around April (NAVFAC PAC, 2006b). Hawaiian coots and Hawaiian gallinules will nest year-round with an emphasis from April to September. Water levels are normally lowered to accommodate Hawaiian stilt nesting in late winter. Hawaiian stilts nest on open flats rather than in open water. During the Hawaiian stilt nesting season (March through August), water levels are pulsed or fluctuated to maintain nesting, foraging, and chick rearing habitat for Hawaiian stilts. Water level management is also a means for producing a variety of invertebrates and plants utilized by Hawai‘i’s four endangered waterbirds for food, nesting, thermal cover, and protection from predators (NAVFAC PAC, 2006b).

Upon completion of Hawaiian stilt nesting and fledging in August, one of the two water impoundments is de-watered and mechanical vegetation control is achieved using small tractors and mowers. By late September or early October, the goal is to have habitat work completed and to begin re-flooding the impoundment. The mechanical vegetation removal allows creation of vegetation interspersion, variety in vegetative structure, thinning of vegetation, and control of plants less desirable to waterbirds (NAVFAC PAC, 2006b).

A predator control program (by USFWS) is in operation yearlong and is monitored weekly. Fencing, live traps, D0C250, GoodNature and diphacinone bait stations are used in the program. The targeted species are feral cats (*Felis catus*), mongoose (*Herpestes javanicus*), rats (*Rattus* spp.), and other feral animals; all of which will kill birds and destroy eggs (NAVFAC PAC, 2006b).

There are ongoing law enforcement concerns at the PHNWR including: graffiti to the overlook and interpretive signs; trespassing along shoreline for crabbing and fishing as well as cutting the fences to enter the wetlands; and feeding of feral cats (*Felis catus*) immediately adjacent to the PHNWR.

Honouliuli Unit of the Pearl Harbor National Wildlife Refuge

The Honouliuli Unit of PHNWR is approximately 36.6 acres (14.8 hectares) and consists of two water impoundments. One impoundment is 4.8 acres (1.9 hectares) and the other is 13.8 acres (5.6 hectares). The remainder of the unit is composed of shoreline and upland habitat. The salinity of the water in the impoundment is typically 2.9 to 3.9 parts per thousand (ppt) (USFWS, 2011a).

In the early 2^{0t}h century, the west shore of West Loch (known as Honouliuli) included numerous fishponds and a 31-acre (12.5-hectare) salt evaporation pond. The salt pond was set aside as a wildlife sanctuary by the DON in 1971, and in 1972 was modified to be managed as part of the PHNWR system under a use agreement between the DON and the USFWS.

The Honouliuli Unit has two ponds with nesting islands and flats and is surrounded on three sides by a mammalian exclusion fence. Water from this unit comes from a well. The Honouliuli Unit also hosts the Hawai‘i Nature Center’s third grade wetlands education program that teaches students all over O‘ahu about the value of wetlands. Every year, thousands of third grade students learn about the recovery of Hawai‘i’s four endangered waterbirds and the value of this refuge to their recovery. This program was halted in 2020 in response to State and Federal emergency health and safety orders and is scheduled to resume in the fall of 2021.

The Betty Nagamine Bliss Memorial Overlook at the Honouliuli Unit connects to the Leeward Bike Path and provides views of West Loch and the Refuge. Interpretive panels tell the story of how Betty Nagamine Bliss spoke for the birds and convinced the government to establish the refuge; information about the endangered native waterbirds is also featured. Unfortunately, the overlook was destroyed by arson and USFWS intends to rebuild. The USFWS would like to improve communication and collaboration with DON in the efforts to prevent and respond to trespass and refuse dumping on the property; discourage feral cat feeding in the vicinity; and discourage vandalism to unit fences and overlook when rebuilt (L. Beauregard, personal communication, 2021).

The project is aimed at restoring the shoreline to a more natural condition and improving the suitability for fish and other native coastal species. The USFWS would like the DON's support in the effort to restore the natural habitat, including the mangrove removal.

Kalaeloa Unit of the Pearl Harbor National Wildlife Refuge

Located 7 miles southwest of Pearl Harbor on the ʻEwa Plain, the 37.4 acre Kalaeloa Unit was established in 2001 to protect and enhance the habitat for the endangered coastal dryland plants round-leaf chaffed flower and ʻakoko. The Kalaeloa Unit's anchialine pools provide habitat for two species of native shrimp and one species of damselfly: the Hawaiian red shrimp (*Halocaridina rubra*), Anchialine pool shrimp (*Metabetaeus lohena*), and orange-black Hawaiian damselfly (*Megalagrion xanthomelas*). The Service coordinates environmental education in the Kalaeloa Unit and work has been ongoing to restore the area to its native state. The Kalaeloa Unit of PHNWR is located on Base Realignment and Closure (BRAC) land and therefore not discussed further in Chapter 8.

Waiawa Unit of the Pearl Harbor National Wildlife Refuge

The Waiawa Unit of the PHNWR consists of Parcel 1a (13.8 acres [5.6 hectares]), Parcel 1b (13.4 acres [5.4 hectares], and Parcel 2 (11.3 acres [4.6 hectares]), totaling 38.5 acres (15.6 hectares) (Appendix J-9). The Waiawa unit contains two water impoundments. One impoundment is 6.8 acres (2.8 hectares) and the other is 13.8 acres (5.6 hectares). The remainder of the unit comprises both shoreline and upland habitat. The salinity in the impoundments is often approximately 6.7 ppt and can be allowed to become hypersaline (USFWS, 2011a).

Man-made nesting islands for Hawaiian stilts are located within the two ponds. Water is pumped into the unit from an artisan well that was installed in 2004, immediately north of the unit, and empties into adjacent Pearl Harbor. Water levels can be regulated in either of the two ponds via a manually operated gate. The refuge is surrounded on three sides by an 8-foot (2.4-meter) high chain link fence to discourage human and predator intrusion. A trapping program for mongoose, feral dogs (*Canis lupus familiaris*), and cats is an ongoing part of refuge management. Specific management programs at the refuge include the maintenance of man-made ponds and wetlands, predator control, waterbird reproductive success monitoring, and the reduction of human disturbances. The Waiawa Unit does not presently support public use activity, although a number of volunteer organizations and individuals assist with water quality monitoring, vegetation control, bird identification, and other tasks.

JBPHH Main Base

Only one wetland has been described for the highly developed and/or industrialized areas of JBPHH Main Base. A project to remove approximately 5 acres (2 hectares) of dense, tangled red mangrove from the shoreline was completed by USFWS in 2006. The project was aimed at restoring the shoreline to a more natural condition and improving the suitability for fish and other native coastal species (NAVFAC PAC, 2006b). There is a small mangrove wetland located slightly inland of Middle Loch at Beckoning Point. If and where wetland delineations are completed, new wetland boundaries and information will be utilized where appropriate.

Outer Pearl Harbor Entrance Channel – Fort Kamehameha

Although not investigated as part of the 1999 or 2006 wetland surveys, the presence of a mangal wetland was noted in the 2006 wetland survey on a reef flat off Fort Kamehameha at the mouth of Pearl Harbor. This wetland is the approximately 4-acre (1.6-hectare) Āhua Reef Wetland on the east side of the harbor mouth. JBPHH has management requirements for the Āhua Reef Wetland stemming from a 2009 Biological Opinion (Appendix J-1) on endangered waterbird air strike hazard interaction at what was previously Hickam AFB. One of the requirements was to restore the wetland habitat with native plants and open water areas for birds. JBPHH is required to report on management actions to the USFWS. Āhua Reef Wetland is currently used by the Hawaiian stilt, a federally-listed endangered waterbird, for foraging. A variety of other water and shorebirds also use this wetland. Since the Biological Opinion was issued, mangrove and pickleweed removal actions have occurred, as well as the planting of native species. The area is currently an active restoration site.

Pearl City Peninsula

Pearl City Peninsula historically included at least four fishponds bordering the outlet of Waiawa Stream at the northwest edge of the peninsula. The site of the PHNWR Waiawa Unit was formerly a brackish pond and marsh. Waiawa Stream drainage provides habitat for Hawaiian stilt and other birds. The areas around the Waiawa Stream drainage and most of the western shoreline have since been colonized by mangrove forest thereby eliminating the natural habitat for native birds.

USACE has defined several wetland areas at Pearl City Peninsula including the Waiawa Unit of PHNWR (discussed under Pearl Harbor). In addition to the Waiawa Unit, USACE defined five other wetlands within the DON property at Pearl City Peninsula: Freshwater Wetland, Mangrove Forest, Drainage Ditch, Waiawa Stream, and Pickleweed Field at the abandoned sewage treatment plant. Further information can be obtained from Wetlands of Pearl Harbor, Pearl Harbor, Oʻahu, Hawaiʻi (USACE, 1999; NAVFAC PAC, 2007a).

Naval Magazine Pearl Harbor/West Loch Annex and Waipiʻo Peninsula

Intertidal mudflats and mangrove areas occur along the shoreline of NAVMAG PH/West Loch Annex on both the Waipiʻo Peninsula and West Loch side. These areas are considered wetlands and include ʻOkiʻokiolepe Fishpond, PHNWR Honouliuli Unit, Walker Bay, Laulaunui Island (extant fishpond), and Loko Pamoku. There were two interior wetlands (located away from the coastal areas) on Waipiʻo Peninsula that have provided habitat for waterbirds. They include two former Oʻahu Sugar Company irrigation ponds. Since the cessation of sugarcane cultivation on Waipiʻo Peninsula in 1995, the ponds have essentially dried up and no longer provide habitat for waterbirds (NAVFAC PAC, 2001).

Makalapa Crater

In the past, wetland areas were defined in the interior of Makalapa Crater. Several wetland plants were recorded near a former pond; however, the absence of soil and hydrology indicators prevents this area as being defined as a USACE-defined wetland (USACE, 1999; NAVFAC, 2007a).

Red Hill Fuel Annex

There are no USACE-defined or USFWS-defined wetlands at Red Hill Fuel Annex. No streams cross the site and there are no other surface water resources at the site. The South Hālawa Stream passes along the north side of and adjacent to the Red Hill Fuel Annex.

Waiawa Watershed Red Hill Fuel Annex

There are riparian wetlands along both the Waiawa and Waimano Streams that flow through the Waiawa Watershed. These are classified by the USFWS NWI as “palustrine, forested, broad-leafed evergreen, temporary,” indicating that the streams are intermittent and receive surface flow only during brief periods during the year. Stream bank overflow occurs about six times a year but flooding at the level of the terrace is rare. The stream course is deep and wide enough to contain flood flows.

Family Housing Areas

Two DON family housing communities contain USACE-defined wetlands: McGrew Point and Pearl City Peninsula. There are no wetlands in the interior of McGrew Point; however, there is a significant wetland along the shoreline (Loko Paʻaiau [fishpond]) as well as some low-lying areas along the coast that are considered smaller wetlands. These wetlands have been colonized by pickleweed and mangrove. The wetland areas at the Pearl City Peninsula family housing are discussed under the Waiawa Unit of PHNWR and Pearl City Peninsula. Further information can be obtained from Wetlands of Pearl Harbor, Pearl Harbor, Oʻahu, Hawaiʻi (USACE, 1999; NAVFAC PAC, 2007a).

4.3.2 Ecosystems

The terrestrial ecosystems of JBPHH Main Base and Surrounding Areas are classified as non-native, and are all lands transformed by human activity (Juvik et al., 1998). The coastal area of the Pearl Harbor region has been disturbed for well over 100 years and it is difficult to ascertain its similarity to the native vegetation communities originally present (Ziegler, 2002). The more inland portions of JBPHH are also highly altered by humans, through agriculture, burning, and ranching, so it is hard to tell how closely the region resembles its original state (Ziegler, 2002). The vegetation communities present in the study area are discussed further in Section 4.3.3.1.

4.3.3 Terrestrial Biology

4.3.3.1 Flora

The discussion of terrestrial vegetation within JBPHH Main Base and Surrounding Areas focuses on the following nine areas: Joint Base Pearl Harbor-Hickam and Family Housing Areas, Pearl Harbor Shoreline, Ford Island, Pearl City Peninsula, Waipiʻo Peninsula, NAVMAG PH/West Loch Annex, Red Hill Fuel Annex, Makalapa Crater, and the Waiawa Watershed. Botanical surveys of Pearl Harbor and Makalapa Crater were completed for the 2001 INRMP (Char, 1999, 2000a,b,c), a botanical survey for the Pearl Harbor Coastal Zone was completed in 2006 (NAVFAC PAC, 2006c), and a more recent base-wide botanical survey was completed in 2015 (AECOM, 2016). A list of all naturally occurring (non-landscaped) terrestrial flora species at JBPHH Main Base and Surrounding Areas is provided in Appendix J-2.

Threatened and Endangered Flora Species and Species of Concern

No federally- or SOH-listed plant species occur at JBPHH Main Base and Surrounding Areas (AECOM, 2016), with the exception of one federally- and SOH-listed endangered shrub species, *Abutilon menziesii*, planted at the Honouliuli Unit of PHNWR (USFWS, 2010).

Vegetation Communities of JBPHH Main Base, Family Housing Areas, and Special Area Honolulu

The majority of JBPHH Main Base is largely developed and has relatively little unmanaged vegetation (Figure 4-9). Most of the vegetation within JBPHH Main Base is managed grass and planted trees including monkeypod (*Samanea saman*), date palm (*Phoenix dactylifera*), fan palm (*Livistona chinensis*), royal palm (*Roystonea regia*), banyan (*Ficus microcarpa*), silk oak (*Grevillea robusta*), milo (*Thespesia populnea*), rainbow shower tree (*Cassia x nealiae*), and coconut palm (*Cocos nucifera*). The managed landscaped areas occur mostly in housing areas and around buildings, main roads, and recreational areas. Extensive areas of ruderal vegetation are periodically maintained. Unmanaged vegetation is mostly found in the western portion (e.g., Waipiʻo and West Loch) of JBPHH Main Base and includes sparse kiawe (*Prosopis pallida* and *P. juliflora*) scrub with a dense understory of buffelgrass (*Cenchrus ciliaris*), pickleweed flats, and red mangrove. Four native flora species (wiliwili [*Erythrina sandwicensis*], maʻo [*Gossypium tomentosum*], kokiʻo keʻokeʻo [*Hibiscus arnottianus*], and ʻākia [*Wikstroemia uva-ursi*]) were observed during the 2015 survey (AECOM, 2016). Most vegetation on the base consists of plantings and maintained areas. As of 2015, 38 percent of the species present were considered ornamentals, while 54 percent were non-native, naturalized species (AECOM, 2016).

Vegetation Communities of Pearl Harbor Shoreline

The Pearl Harbor Shoreline refers to all areas immediately along the harbor shore. These areas are dominated by non-native plant species. The 1999-2000, 2006, and 2016 botanical surveys found no threatened or endangered species, nor any species of concern (Char, 2000c; NAVFAC PAC, 2006c; AECOM, 2016). The non-native mangrove community is the dominant vegetation type. Mangroves occur in relatively sheltered, shallow water along the undeveloped portions of Pearl Harbor (Char, 2000c). Other vegetation communities are found adjacent to and inland of the dense mangrove thickets. Pickleweed marsh is found in low-lying areas behind the mangrove. Along the margins of mangrove thickets, small numbers of other species occur, such as kiawe and milo. Kiawe forest (approximately 50 percent kiawe tree cover) occurs inland of the mangrove community in some areas, mixed with ʻopiuma (*Pithcellobium dulce*), monkeypod, milo, and coconut palms. In addition, shrubs of koa haole (*Leucaena leucocephala*), Christmas berry (*Schinus terebinthifolius*), and Indian fleabane (*Pluchea indica*) are common to abundant (Char, 2000c).

Vegetation Communities of Ford Island

Ford Island is mostly flat with highly developed areas including piers and seawalls around its edge and an inactive airport and runway at the center. The entire island falls into the disturbed and/or landscaped vegetation category; 59 percent of recorded species consist of non-native taxa and the only endemic species is the kokiʻo keʻokeʻo planted in landscaping arrangements around the island. The inactive airport and runway at the center of Ford Island provides a substratum of old pavement and limestone that is composed of a disturbed grassland area. This grassland contains weedy, non-native species such as rose natal grass (*Melinus repens*), coat buttons (*Tridax procumbens*), bracted fanpetals (*Sida ciliaris*), trailing indigo (*Indigofera hendecaphylla*), swollen fingergrass (*Chloris barbata*), white moneywort (*Alysicarpus vaginalis*), beggarticks (*Bidens pilosa*), scarletfruit passionflower (*Passiflora foetida*), pillpod sandmat (*Euphorbia hirta*), and native kaunaʻoa (*Cuscuta sandwichiana*).

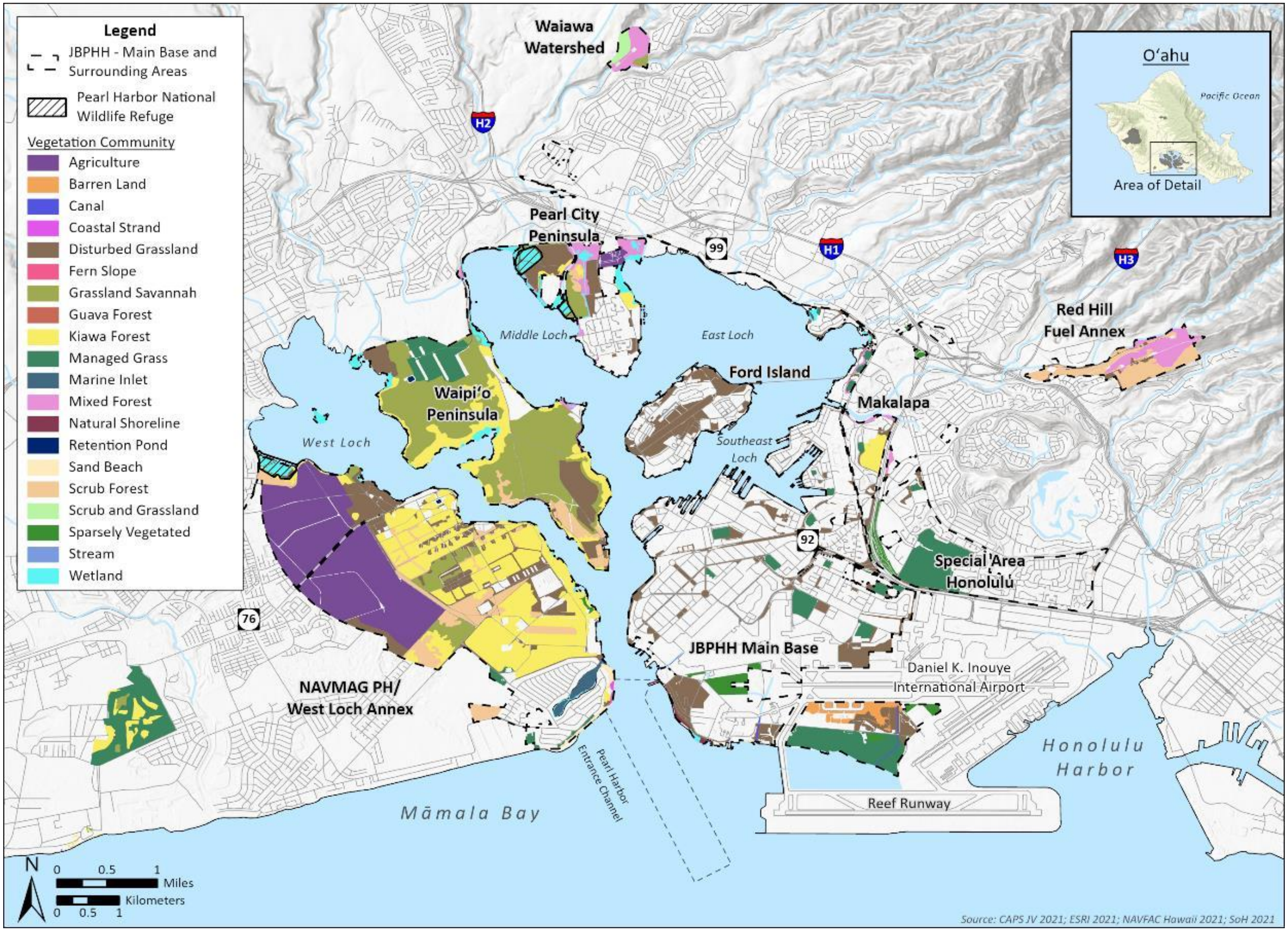


Figure 4-9 JBPHH Main Base and Surrounding Areas Vegetation Communities

Vegetation Communities of Pearl City Peninsula

The Pearl City Peninsula is divided into a developed southeastern portion and an undeveloped western portion around the Waiawa Stream and Waiawa Unit of PHNWR (see Figures 4-7 and 4-9). As of the 2016 surveys, no ESA-listed plant species or species of concern were reported (AECOM, 2016). No native vegetation communities are present; only scattered individuals of these species remain throughout the area (AECOM, 2016). Koa haole is found inland of the mangroves on the western portion of the Pearl City Peninsula (Char, 2000c). Ground cover is generally Guinea grass and scattered patches of pitted beardgrass (*Bothriochloa pertusa*), Australian saltbush (*Atriplex semibaccata*), and swollen fingergrass (Char, 2000c). All remaining natural areas within Pearl City Peninsula are highly disturbed and dominated by ruderal species (AECOM, 2016). The northeastern corner of the peninsula, east of Lehua Avenue, contained milo-dominated vegetation with a hau (*Talipariti tiliaceum*) and naupaka (*Scaveloa sericea*) understory (NAVFAC PAC, 2006c). In the northwestern corner of the peninsula, a 27.5-acre (11.1-hectare) parcel of the Waiawa Unit is designated part of the PHNWR. Native species occurring in this portion of PHNWR include ʻākulikuli (*Sesuvium portulacastrum*), ʻuhaloa (*Waltheria indica*), seaside heliotrope or kīpūkai (*Heliotropium curassavicum)*, pāʻū o hiʻiaka (*Jacquemontia ovalifolia*), kaluhā (*Bolboschoenus maritimus)*, and milo.

Vegetation Communities of Waipiʻo Peninsula

Waipiʻo Peninsula is an interfluvial area that has been highly disturbed since the early 1900s and no native vegetation communities remain there (AECOM, 2016). While areas have been filled, the peninsula itself is not man-made (AECOS and Wil Chee-Planning, Inc., 2007). In the past, this area had been leased for farming and is crisscrossed by drainage ditches; along some of these ditches, Indian fleabane and ʻākulikuli kai (*Batis maritima*) occur (AECOS and Wil Chee-Planning, Inc., 2007). Most of the eastern shore of Waipiʻo Peninsula is covered with invasive red mangrove (AECOS and Wil Chee-Planning, Inc., 2007). Parts of the peninsula were dedicated to drying and sorting dredged material and comprise patches of very disturbed land, either absent of vegetation or only supporting ephemeral, weedy growth (AECOM, 2016). Ground cover is generally Guinea grass and scattered patches of pitted beardgrass, Australian saltbush, and swollen fingergrass (Char 2000c).

Vegetation Communities of Naval Magazine Pearl Harbor/West Loch Annex

The NAVMAG PH/West Loch Annex primarily consists of disturbed, non-native kiawe forest (see Figure 4-9). Several buildings, both active and abandoned, are scattered throughout the site. Much of the site consists of kiawe forest, with an understory of buffelgrass and/or Guinea grass. The open field areas are also dominated by the same two grass species. The diversity in tree species can be attributed largely to landscaping in developed portions of the site or former residential areas. Part of the DON-owned land outside the western perimeter fence is leased for agricultural use. Mangroves are located along the entire shoreline of the West Loch Annex, usually scattered or in a narrow strip due to the steep limestone cliffs occurring very close to the shore. Mangrove forests also occur beside the ancient fishponds. The 36.6-acre (14.8-hectare) northwest corner of West Loch Annex comprises the Honouliuli Unit of the PHNWR. While this area was created to protect waterbirds, it does contain one federally- and SOH-listed endangered shrub species, the endemic *Abutilon menziesii*. Seventy individuals were planted at Honouliuli and as of 2007, appeared to be stable and healthy (USFWS, 2010). Other native species occurring here include ʻahuʻawa (*Cyperus javanicus*), ʻaeʻae (*Bacopa monnieri*), seaside heliotrope, pāʻū o hiʻiaka, kaluhā, milo, and the endemic species ʻanunu (*Sicyos pachycarpus*).

Vegetation Communities of Red Hill Fuel Annex

Red Hill Fuel Annex includes a ridgeline with some steep, inaccessible slopes on either side. While these slopes may include species not captured by surveys, they are unlikely to be disturbed by DON activities due to their remote location. A large portion of the south facing slope (Moanalua Valley side) as well as the area downslope of the North Reservoir is dominated by koa haole with an understory of Guinea grass and Chinese violet (*Asystasia gangetica*). The northern (Hālawa Valley facing) slope is dominated by scrubby growth of mixed native forest. On the south slope, this forest is dominated by Christmas berry, while the north slope is dominated by strawberry guava (*Psidium cattleianum*). Also frequently observed in this community were Java plum (*Syzygium cuminii*), silk oak, satinleaf (*Chrysophyllum oliviforme*), Mickey Mouse plant (*Ochna thomasiana*), mock orange (*Murraya paniculata*), and the natives ʻūlei and ʻaʻaliʻi. Native species are largely limited in distribution to the upper elevations of the Red Hill site. These begin to appear mainly above the North Reservoir and increase in number with increasing elevation. Endemics lama (*Diospyros sandwicensis*), koa (*Acacia koa*), ʻōhiʻa (*Metrosideros polymorpha*), ʻiliahi aloʻe, and ʻākia, and natives pūkiawe (*Styphelia tameiameiae*), ʻūlei, alaheʻe (*Psydrax odorata*), and ʻaʻaliʻi are common in this area and form a remnant native forest community not found at lower elevations on Oʻahu. In disturbed areas, the grasses rat tail (*Sporobolus indicus*), molasses grass (*Melinis minutiflora*), Bermuda grass (*Cynodon dactylon*), and Guinea grass are common. The invasive vine known as cat's claw climber (*Macfadyena uncata*) covers many koa haole and earpod trees (*Enterolobium cyclocarpum*) in the vicinity of 400 feet (120 meter) elevation just south of the ridge.

Vegetation Communities of Makalapa Crater

Makalapa Crater consists of a smaller parcel containing housing and administrative operations with extensive landscaping and disturbed natural growth including kiawe, koa haole, and buffelgrass. Only three native species occur on the site: kaunaʻoa or native dodder (*Cuscuta sandwichiana*), ʻilima (*Sida fallax*), and pōpolo (*Solanum americanum*) (AECOM, 2016). A few low-lying spots support pickleweed and California grass (*Urochloa mutica*). Kiawe-koa haole scrub forest covers the north and east portions of the crater, where kiawe trees form a closed-canopy forest (AECOM, 2016). Wild date palm, monkeypod, ʻopiuma, sebesten plum (*Cordia dichotoma*), and yellow poinciana (*Peltophorum pterocarpum*) are scattered in the kiawe forest. The understory vegetation consists of scattered shrubs of koa haole and dense tufts of Guinea grass (Char, 1999). Weedy annual plants such as hairy spurge (*Euphorbia hirta*), coat buttons, *Boerhavia coccinea*, swollen fingergrass, sowthistle (*Sonchus oleraceus*), and false mallow (*Malvastrum coromandelianum*) were observed in the overgrown trails and dirt roads that cross the open kiawe forest (Char, 1999).

Vegetation Communities of Waiawa Watershed

The Waiawa Watershed includes a small valley of 75 acres (30 hectares) with Waimano Stream bordering the southern edge of the site and Waiawa Stream crossing the middle of the property along the valley bottom (see Figure 4-7). The valley floor contains a road passing through a mixed/non-native forest with an understory of Guinea grass. An ephemeral stream bed runs along the road and a narrow band of riparian forest occurs along the stream. Java plum dominates this community; other common species include the autograph tree (*Clusia rosea*), macaranga (*Macaranga tanarius*), and monkeypod. Along Waimano Stream, hau is the dominant species, occurring along with tree and shrub species such as sweet pittosporum (*Pittosporum undulatum*), mock orange, fern tree (*Filicium decipiens*), scattered ʻopiuma, and common kiawe.

4.3.3.2 Fauna

The following is a discussion of terrestrial fauna with the potential to occur at JBPHH Main Base and Surrounding Areas. The discussion focuses on threatened and endangered species and other wildlife such as amphibians and reptiles, birds, terrestrial mammals, and invertebrates within the study area. A list of terrestrial fauna species known to occur or with potential to occur within the study area is included in Appendix J-3.

Threatened and Endangered Species

Several threatened and endangered fauna species occur or have potential to occur at JBPHH Main Base and Surrounding Areas and are listed in Table 4-8. These species and their occurrence at the study area are described below.

Table 4-8 Federally- and SOH-listed Terrestrial Species with Potential to Occur at JBPHH Main Base and Surrounding Areas

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence**
Bird Species				
Anas wyvilliana	Hawaiian Duck	Koloa maoli	FE, SE, MBTA	Potential
Asio flammeus sandwichensis	Hawaiian Short-eared Owl	Pueo	SE	Confirmed
Branta sandvicensis	Hawaiian Goose	Nēnē	FE, SE, MBTA	Potential
Fulica alai	Hawaiian Coot	ʻAlae keʻokeʻo	FE, SE, MBTA	Confirmed
Gallinula chloropus sandvicensis	Hawaiian Gallinule	ʻAlae ʻula	FE, SE	Confirmed
Gygis alba	White Tern	Manu-o-kū	SE, MBTA	Confirmed
Himantopus mexicanus knudseni	Hawaiian Stilt	Aeʻo	FE, SE	Confirmed
Oceanodroma castro	Band-rumped Storm Petrel	ʻAkēʻakē	FE, SE	Potential
Pterodroma sandwichensis	Hawaiian Petrel	ʻUaʻu	FE, SE, MBTA	Potential
Puffinus newelli	Newell's Shearwater	ʻAʻo	FT, ST, MBTA	Potential
Terrestrial Mammal Species				
Lasiurus cinereus semotus	Hawaiian Hoary Bat	ʻŌpeʻapeʻa	FE, SE	Confirmed

Notes: FE = federally-listed endangered; FT = federally-listed threatened; MBTA = Migratory Bird Treaty Act; SE = SOH-listed endangered; SOH = State of Hawaiʻi; ST = SOH-listed threatened. *Definitions provided in Appendix I. ** = Definitions of Study Area Occurrence terms are provided in Appendix J-4.

Sources: B. Wolfe, personal communication, 2019; eBird, 2021; Hamer Environmental, 2016; NAVFAC PAC, 2006b; Pyle and Pyle, 2017; RCUH, 2020a,b; USFWS, 2020; VanderWerf and Downs, 2018; Young et al., 2019.

Endangered Species Act-listed Waterbird Species


Photo 4-2: Hawaiian duck

Hawaiian duck (Photo 4-2) is a federally-listed endangered, endemic waterbird that historically was found along the shoreline, estuarine, and freshwater habitats of Pearl Harbor. They were generally observed in the Honouliuli and Waiawa Units of the PHNWR, at the mouth of streams that flow into the harbor, and at West Loch Oxidation Pond (NAVFAC PAC, 2006b; Pyle and Pyle, 2017; Research Corporation of the University of Hawaiʻi [RCUH], 2020a). By the mid-1900s, the Hawaiian duck population had been decimated on Oʻahu from habitat loss, hunting, and introduced mammalian predation. The Christmas bird count of 1966 resulted in a single Hawaiian duck observation on the island of Oʻahu (Pyle and Pyle, 2017). Between 1968 and 1982, reintroduction programs on Oʻahu released Hawaiian ducks and had some success. Currently, the greatest threat to the Hawaiian duck is the genetic introgression from feral mallards (Pyle and Pyle, 2017). Biologists believe that the Hawaiian duck has largely been replaced by the Hawaiian duck-mallard hybrid on Oʻahu (USGS, 2007). In 2005, a Hawaiian duck was documented on Oʻahu, through genetic testing, as result of an airstrike incident with a commercial airliner at Daniel K. Inouye International Airport (USAF, 2019). Hawaiian ducks were present on Oʻahu and in the mid-2010s, a small population of Hawaiian-like ducks inhabited Kapiolani Park and were observed feeding with pigeons in Waikīkī (Pyle and Pyle, 2017). During the 2014-2015 point count surveys, a single Hawaiian duck (potentially hybrid) was observed at Hickam Airfield (Hamer Environmental, 2016). Hawaiian duck/Hawaiian duck-mallard hybrids are regularly observed where suitable habitat is present, including West Loch Oxidation Pond, during waterbird monitoring surveys and at Manu Wai Canal and Māmala Bay Golf Course (RCUH, 2017; N. Dunn, personal communication, 2021a).

The Hawaiian duck is generally mottled brown and has a green to blue speculum with white borders. They can begin breeding at 1-year old and nest year-round, but the main breeding season is between January and May. Two to 10 eggs are laid in a well concealed nest lined with down and feathers. The incubation period is 30 days. Because their nests are established on the ground, they are highly vulnerable to mongoose, feral pig (*Sus scrofa*), feral cat, and dog attacks. American bullfrogs (*Lithobates catesbeianus*) and largemouth bass (*Micropterus salmoides*) sometimes eat the chicks. In addition to hybridization with mallards, threats to this species includes loss or modification of wetlands, predation (e.g., pigs, cats, dogs, rats, black-crowned night herons [*Nycticorax nycticorax*], cattle egrets [*Bubulcus ibis*], barn owls [*Tyto alba*], and non-native fish), avian diseases including botulism (*Clostridium botulinum*) and environmental contaminants including oil and fuel spills.

Photo 4-3: Hawaiian gallinule

Hawaiian gallinule (Photo 4-3) is a federally-listed endangered, endemic, small, black waterbird that can be found along the shoreline, estuarine, and freshwater habitats of Pearl Harbor (NAVFAC PAC, 2006b). This species is commonly observed at the Honouliuli and Waiawa Units of the PHNWR, along the shorelines of Pearl Harbor, and in streams that flow into the harbor (eBird, 2021). Breeding occurs year-round, but peaks from March through August. Nesting phenology is apparently tied to water levels and the presence of appropriately dense emergent vegetation. Platform nests are constructed in dense vegetation over water. Hawaiian gallinule lay approximately five to six eggs in a nest; the eggs have an incubation period of 19-22 days. This species uses a variety of freshwater habitats. They are opportunistic feeders and their diet varies with habitat but may include algae, grass seeds, plant material, insects, and snails. Hawaiian gallinule is very secretive and, thus, are hard to monitor. Similar to other native Hawaiian waterbirds, the Hawaiian gallinule is threatened by habitat loss, introduced predators, altered hydrology (including SLR), non-native invasive plants, avian diseases, and vehicle strikes.


Photo 4-4: Hawaiian coot

Hawaiian coot (Photo 4-4) is a federally-listed endangered, endemic waterbird that can be found along shoreline, estuarine, and freshwater habitats of Pearl Harbor including the Honouliuli and Waiawa Units of PHNWR and the West Loch Oxidation Pond (NAVFAC PAC 2006b; RCUH, 2020b; eBird, 2021). This species is somewhat gregarious and uses freshwater and brackish wetlands, including agricultural (e.g., taro fields) wetlands and aquaculture ponds. Hawaiian coots are generalists and feed on land, from the surface of the water or will dive; they will also graze on grass adjacent to wetlands. Food items include seeds, leaves, snails, crustaceans, insects, tadpoles, and small fish. Nesting habitats include freshwater and brackish ponds, irrigation ditches, and taro fields. Floating nests are constructed of aquatic vegetation and found in open water or anchored to emergent vegetation. This species normally breeds from March to September but may breed during all months of the year. The incubation period is approximately 25 days (DLNR, 2015a). Similar to other native Hawaiian waterbirds, the Hawaiian coot is threatened by habitat loss, introduced predators, altered hydrology (including SLR), non-native invasive plants, avian diseases, and vehicle strikes.


Photo 4-5: Hawaiian stilt

Hawaiian stilt (Photo 4-5) is a federally-listed endangered, endemic wading bird that can be found along shoreline, estuarine, and freshwater habitats of Pearl Harbor (eBird, 2021). In Pearl Harbor, the primary Hawaiian stilt habitat includes the Honouliuli and Waiawa Units of the PHNWR, as well as other shallow mudflats along the intertidal areas of Pearl City Peninsula and NAVMAG PH/West Loch Annex and Āhua Reef wetland (NAVFAC PAC, 2006b; RCUH, 2020a; eBird, 2021). Hawaiian stilt has also been observed at Hickam Airfield (Hamer Environmental, 2016). This species is known to forage and nests at the Āhua Reef Wetland (RCUH, 2020a; N. Dunn, personal communication, 2021b). During the

2014-2015 point count surveys, 29 individuals were observed at Waipiʻo Peninsula and two at Pearl City Peninsula (Hamer Environmental, 2016).

This species is black above and white below and has long, pink legs. The breeding season normally runs from mid-February through late August, with peak nesting varying among years. Hawaiian stilt typically lay three to four eggs over a 4- to 5-day period and have an incubation period of approximately 23 to 26 days. Threats to Hawaiian stilt include habitat loss, introduced predators, altered hydrology (including SLR), non-native invasive plants, avian diseases, and vehicle strikes.

Hawaiian Goose

Hawaiian goose or nēnē (*Branta sandvicensis*) is federally-listed endangered and endemic to Hawaiʻi. This species inhabits a variety of habitats including coastal vegetation, non-native grasslands (e.g., golf courses, pastures, rural areas), sparsely vegetated low- and high-elevation lava flows, mid-elevation native and non-native shrublands, and open native and non-native alpine shrubland-woodland (DLNR, 2015a). Currently, Hawaiian goose is not known to occur on Oʻahu year-round and are only occasionally observed on the island. In 2014, a pair successfully nested at James Campbell National Wildlife Refuge and the adults and/or fledged young were occasionally observed in the Pearl Harbor area through 2016 (Pyle and Pyle, 2017). Several citizen observations were reported from the Pearl Harbor area in 2018 (eBird, 2021). Recently, Navy-Marine Golf Course staff have reported occasional observations of Hawaiian geese.

Adult Hawaiian geese are dark brown with a black face and cream-colored cheeks, they have a buff neck with black streaks. This species is more terrestrial than other geese and have longer legs and less webbing between their toes (DLNR, 2015a). They have an extended breeding season and may nest almost year-round with the exception of May, June, and July (DLNR, 2015a). Threats to Hawaiian goose include predation by introduced predators, human-caused disturbance and mortality (e.g., vehicle collisions, disturbance by hikers, aircraft strikes), loss of habitat, exposure to disease (e.g., toxoplasmosis), behavioral problems relating to captive breeding, and inbreeding depression (DLNR, 2015a).

White Tern

White tern or manu-o-kū (*Gygis alba)* (Photo 4-6) is a SOH-listed threatened and MBTA-protected seabird that is commonly observed along the southern shores of Oʻahu (eBird, 2021). White terns nest in large, mature trees in urban and suburban areas of Honolulu. Nesting pairs have been observed at JBPHH Main Base but not in the density observed in Honolulu (VanderWerf and Downs, 2018). Additional text can be found in Section 4.5.1*, Protected Species and Ecosystem Monitoring and Management*.


Photo 4-6: White tern

The white tern is a small, entirely white seabird with dark eyes and a thick, sharply pointed black bill with an electric blue base. In Hawaiʻi, their diet consists mostly of juvenile goatfish and flying fish. Breeding adults remain close to nest sites and forage in inshore areas such as shoals and banks, with occasional forays into offshore waters. They do not construct nests but instead lay a single egg in a suitable depression including tree branches, building, rock ledges, or on the ground. Pairs will replace an egg after initial nest failure and some successfully raise two or three broods per year. Both the male and female incubate eggs, brood, and feed the chick. Fledglings are dependent on adults up to 2 months. The species does not seem to be affected by human presence and prefer to nest in heavily trafficked and well-lit urban areas. Scientists hypothesize the success of the white tern in urban Honolulu may be due to pest control of non-native mammals that would otherwise predate nests (VanderWerf and Downs, 2018). The primary threat to the white tern in the study area is tree trimming during the nesting season which lasts from January to June.

Hawaiian Short-eared Owl

Photo 4-7: Hawaiian short-eared owl

Hawaiian short-eared owl (Photo 4-7) is SOH-listed as endangered on Oʻahu and was recorded at Waipiʻo Peninsula, PHNWR, and West Loch (NAVFAC PAC, 2006b; Hamer Environmental, 2016; RCUH, 2020b). Two citizen observations were reported from West Loch Drive in 2016 and at Daniel K. Inouye International Airport in 2018 (eBird, 2021). Field biologists have also observed Hawaiian short-eared owl in the West Loch area (N. Dunn, personal communication, 2021a).

The Hawaiian short-eared owl is an endemic subspecies of one of the world's most widely distributed medium-sized owls. Hawaiian short-eared owls occur on all the Main Hawaiian Islands, but is most common on Kauaʻi, Maui, and Hawaiʻi. Unlike most owls, Hawaiian short-eared owl is active during the day and is commonly seen hovering or soaring over open areas. This species primarily consumes small mammals. Females build nests on the ground constructed of simple scrapes in the ground lined with grasses and feather down. Little is known about the breeding biology of the Hawaiian short-eared owl, but nests have been found throughout the year. Chicks hatch asynchronously and are fed by the female with food delivered by the male. Young may fledge from the nest on foot before they are able to fly and depend on their parents for approximately 2 months. Hawaiian short-eared owl populations were widespread at the end of the 1^{9t}h century but are thought to be declining (Division of Forestry and Wildlife [DOFAW] 2005). They are threatened by loss and degradation of habitat, predation by introduced mammals (e.g., rats and cats), and disease.

Endangered Species Act-listed Seabirds

The following three ESA-listed seabirds have the potential to occur in the study area: band-rumped storm petrel (federally endangered), Newell's shearwater (federally threatened), and Hawaiian petrel (federally endangered). The Newell's shearwater and Hawaiian petrel are Hawaii's only two endemic seabirds, and both were believed to be extirpated from Oʻahu until recent survey detections in 2016–2017. However, neither species was detected in the vicinity of Pearl Harbor (Young et al., 2019). In Hawaiʻi, band-rumped storm petrels are known to nest primarily in remote cliff locations on Kauaʻi and Lehua Islet and in high-elevation lava fields on the island of Hawaiʻi (Federal Register, 2016). In 1990, there was an observation of band-rumped storm petrel flying near Honolulu (now Daniel K. Inouye) International Airport (Pyle and Pyle, 2017) and this species may fly over the study area.

Photo 4-8: Newell's shearwater

While band-rumped storm petrel, Hawaiian petrel, and Newell's shearwater do not nest at JBPHH Main Base or Surrounding Areas, they may fly over the study area when moving between suitable nesting habitat in the Waiʻanae and Koʻolau Mountains and the ocean. These species are particularly vulnerable to fallout – when fledglings or occasional migrating adult birds are disoriented by artificial light and become grounded. Due to the occasional flyovers and groundings, they have the potential to occur in the study area.

Endangered Species Act-listed Terrestrial Mammal

Photo 4-9: Hawaiian hoary bat

The Hawaiian hoary bat is Hawaii's only native terrestrial mammal and is listed as endangered under the ESA. Very little is known about Hawaiian hoary bat ecology and life history (DLNR, 2015a). It has been recorded on all the Main Hawaiian Islands and in a diversity of habitats including developed areas and agricultural lands (DLNR, 2015b; USGS, 2015). During a 2-year acoustic monitoring study that included Honouliuli and Waiawa PHNWR units, only four bat calls were recorded at the Honouliuli Unit between 2017 and 2018 (B. Wolfe, personal communication, 2019). If Hawaiian hoary bat were routinely foraging or roosting nearby, scientists would expect to have recorded many more calls (B. Wolfe, personal communication, 2019). However, areas of dense vegetation with moderate tree cover are present throughout the survey area and may serve as suitable roosting (woody vegetation greater than 15 feet [4.6 meters] [NAVFAC PAC, 2020a]) and foraging habitat. Additionally, Hawaiian hoary bat has been observed foraging on insects congregating near artificial lights in urban areas (Pacific Rim Conservation, 2013). Threats to Hawaiian hoary bat include habitat loss; pesticides; predation; roost disturbance; and morality from collisions with barbed wire, towers, and wind turbines (Mitchell et al., 2005).

Other Wildlife

Amphibian and Reptile Species

There are no native, endemic, or protected terrestrial amphibian or reptile species present within JBPHH. Limited amphibian and reptile surveys were conducted at Pearl City Peninsula, NAVMAG PH/West Loch Annex, and Waiawa Watershed in 2006 (NAVFAC PAC, 2006d). House gecko (*Hemidactylus frenatus*), mourning gecko (*Lepidodactylus lugubris*), and Indo-Pacific gecko (*Hemidactylus garnotii*) were observed during the surveys. These species are introduced, non-native, and abundant throughout Oʻahu. Although not observed during the surveys, invasive, non-native cane toad (*Rhinella marina*), American bullfrog, and Jackson's chameleon (*Trioceros jacksonii*) are ubiquitous on the island of Oʻahu and likely to occur within the study area.

Avifauna

Numerous MBTA-covered species are known to occur within the study area, especially at the Honouliuli and Waiawa Units of PHNWR. Table 4-9 details the MBTA-protected species that have been recorded within or adjacent to the study area and their occurrence. Federally- and SOH-listed species that are also protected under MBTA (e.g., Hawaiian duck, Hawaiian coot, and white tern) were discussed in the Threatened and Endangered Species section above and are not listed again in Table 4-9.

Table 4-9 Migratory Bird Treaty Act-Protected Species with Potential to Occur at JBPHH Main Base and Surrounding Areas

Scientific Name	***Common Name***	***Hawaiian Name***	***Study Area Occurrence***
Alaudidae			
Alauda arvensis	Eurasian Skylark	-	**Non-native resident, non-breeding visitor, vagrant** Eurasian skylark has established populations at Waipiʻo Peninsula and the Pearl Harbor area (Pyle and Pyle, 2017).
Anatidae			
Anas acuta	Northern Pintail	Koloa Mapu	**Non-breeding visitor, regular winterer** **August – May** The northern pintail is the most common migratory wintering duck in the Hawaiian Islands (Pyle and Pyle, 2017) and has been observed at PHNWR and the West Loch Oxidation Pond (NAVFAC PAC, 2006b; N. Dunn, personal communication, 2021a). During the winter, the birds use a variety of shallow inland freshwater and intertidal habitats, typically shallow wetlands with little emergent cover.
Anas americana	American Wigeon	-	**Non-breeding visitor, regular winterer** **October – April** American wigeon was observed at PHNWR in 2006 (NAVFAC PAC, 2006b) and has been known to occur at the Waipahu mudflats in the Pouhala March Wildlife Sanctuary just north of installation boundary on Waipiʻo Peninsula (Pyle and Pyle, 2017). They may occur in ponds, flooded fields, mudflats, estuaries, bays, and marshes.
Anas clypeata	Northern Shoveler	Koloa Mōhā	**Non-breeding visitor, regular winterer** **September – May** Northern shoveler is commonly seen throughout Oʻahu during the winter season and has been observed at PHNWR and the West Loch Oxidation Pond (NAVFAC PAC, 2006b; N. Dunn, personal communication, 2021a). This species utilizes a variety of wetland habitats, including freshwater and saline marshes, and agricultural ponds.
Anas crecca	American Green-winged Teal	-	**Non-breeding visitor, regular winterer** **September – April** American green-winged teal has been reported at Waipio Peninsula (Pyle and Pyle, 2017) and at PHNWR (NAVFAC PAC, 2006b). This species is known to inhabit lakes, ponds, marshes, pools, and shallow streams.
Anas cyanoptera	Cinnamon Teal	-	**Non-breeding visitor, vagrant** Cinnamon teal has been observed at PHNWR (NAVFAC PAC, 2006b). This species is known to inhabit wetlands and marshes.

Scientific Name	*Common Name*	*Hawaiian Name*	*Study Area Occurrence*
Anas discors	Blue-winged Teal	-	**Non-breeding visitor, occasional winterer** **September – May** Blue-winged teal has been observed at PHNWR in 1999 (Pyle and Pyle, 2017) 2006 (NAVFAC PAC, 2006b). This species is known to inhabit shorelines, marshes, ponds, streams, and pools.
Anas penelope	Eurasian Wigeon	-	**Non-breeding visitor, occasional winterer** **October – March** Eurasian wigeon was observed at PHNWR in 2005 (Pyle and Pyle, 2017) and 2006 (NAVFAC PAC, 2006b) and inhabits marshes, ponds, bays, and fields.
Anas platyrhynchos	Mallard	-	**Non-breeding visitor, occasional winterer; non-native resident, long established** Mallard is widespread throughout Oʻahu. This species favors ponds, streams, marshes, and pools (Pyle and Pyle, 2017). Occasional wild migrant Mallards probably arrive to the Main Hawaiian Islands in the fall, but they are not easily distinguished from those of the naturalized populations (Pyle and Pyle, 2017).
Anas querquedula	Garganey	-	**Non-breeding visitor, occasional winterer** **September – April** Garganey has been observed at PHNWR (NAVFAC PAC, 2006b). This species is known to inhabit freshwater wetlands and shallow ponds.
Anas spp.	Hawaiian Duck-Mallard Hybrid	-	**Breeding resident** Suspected Hawaiian Duck-Mallard hybrid species was observed at Hickam Airfield (Hamer Environmental, 2016) but may occur throughout the study area. Feral mallards dispersing to wetland areas interbreed freely with the closely related Hawaiian duck (*Anas wyvilliana*), also known as Koloa. This has resulted in Hawaiian duck-mallard hybrids and severely threatens the integrity of the Hawaiian duck species. Like mallards and Hawaiian duck, hybrids are found in private ponds in parks, suburban areas, spreading into refuges and wetlands (Pyle and Pyle, 2017).
Anser albifrons	Greater White-fronted Goose	-	**Non-breeding visitor, occasional winterer** **October – May** Greater white-fronted goose was observed at PHNWR in 2006 (NAVFAC PAC, 2006b). The species can be found in wetlands and croplands.
Aythya affinis	Lesser Scaup	-	**Non-breeding visitor, regular winterer** **October – April** Lesser scaup is a regular but uncommon visitor to the Hawaiian Islands (Pyle and Pyle, 2017). This species is known to winter in fresh or brackish water.

Scientific Name	*Common Name*	*Hawaiian Name*	*Study Area Occurrence*
Aythya collaris	Ring-necked Duck	-	**Non-breeding visitor, regular winterer** **September – May** Ring-necked duck is commonly observed wintering in the Hawaiian Islands and has been observed at PHNWR and the West Loch Oxidation Pond (NAVFAC PAC, 2006b; N. Dunn, personal communication, 2021a). They are known to inhabit ponds, streams, and estuaries. They generally do not inhabit saltwater bays.
Branta hutchinsii	Cackling Goose	-	Non-breeding visitor, regular winterer October – May Cackling Geese are known to winter in a variety of wetland habitats including ponds on refuges, ranches, and golf courses, and in marshes and parks throughout the Hawaiian Islands (Pyle and Pyle, 2017).
Bucephala albeola	Bufflehead	-	**Non-breeding visitor, occasional winterer** **November – April** Bufflehead has been observed at PHNWR in 2006 (NAVFAC PAC, 2006d). This species is known to winter in shallow saltwater or in lakes or rivers.
Apodidae			
Aerodramus bartschi	Mariana Swiftlet	-	**Naturalized (non-native) resident, recently established** In 1962 and 1965, swiftlets from Guam were released into lower Waimea Valley (Pyle and Pyle, 2017). The species has been recorded nesting in caves and lava tubes in the Koʻolau Range. Mariana swiftlet was observed during the 2014-2015 point count surveys at Red Hill Fuel Annex (Hamer Environmental, 2016).
Ardeidae			
Bubulcus ibis	Cattle Egret	-	**Naturalized, recently established; non-breeding visitor, unknown status** Cattle egrets were observed at Makalapa Crater, Pearl City Peninsula, Waiawa Watershed, NAVMAG PH/West Loch Annex, Waipiʻo Peninsula/Laulaunui Island, PHNWR, Hickam Airfield, and Red Hill (NAVFAC PAC, 2006b; Hamer Environmental, 2016). They can be found in almost any habitat on Oʻahu. They are opportunistic feeders that eat insects as well as other birds.
Nycticorax nycticorax	Black-crowned Night-heron	Aukuʻu	**Native resident, indigenous** **Breeds from May – June** Black-crowned night-heron has been observed at Pearl City Peninsula, NAVMAG PH/West Loch Annex, Waipiʻo Peninsula, and PHNWR (NAVFAC PAC, 2006; Hamer Environmental, 2016). Black-crowned night-heron is commonly observed foraging along edges of ponds, canals, ditches, shorelines, marshy wetlands, and streams. (Pyle and Pyle, 2017)

Scientific Name	***Common Name***	***Hawaiian Name***	***Study Area Occurrence***
Cardinalidae			
Cardinalis cardinalis	Northern Cardinal	-	**Naturalized (non-native) resident, long established.** Northern cardinal was first released on Oʻahu in 1929 and was well established by the 1940s (Pyle and Pyle, 2017). This species is found commonly throughout the island in developed areas and disturbed forests and occur throughout the study area (Hamer Environmental, 2016).
Charadriidae			
Arenaria interpres	Ruddy Turnstone	ʻAkekeke	**Non-breeding visitor, regular winterer** **July – May** Ruddy turnstone has been observed at Ford Island, Hickam Airfield, Pearl City Peninsula, NAVMAG PH/West Loch Annex, and PHNWR (NAVFAC PAC, 2006b; Hamer Environmental, 2016). The species is also regularly observed by Field biologists (N. Dunn, personal communication, 2021a). While in Hawaiʻi, they are almost exclusively coastal, foraging mostly along stony or rocky shorelines with abundant seaweed and commonly on sandy shorelines and in mudflats and river deltas.
Calidris acuminata	Sharp-tailed Sandpiper	-	**Non-breeding visitor, regular migrant** **September – May** Sharp-tailed sandpiper has been observed at PHNWR (NAVFAC PAC, 2006b). This species is known to forage in on flooded grasslands and mudflats.
Calidris alba	Sanderling	Hunakai	**Non-breeding visitor, regular winterer** **July – May** Sanderling has been observed at PHNWR 2006 (NAVFAC PAC, 2006b). They are well known for their habit of foraging at the edge of the surf zone and running up and down the beach to avoid waves while probing the sand for invertebrates. They winter in Hawaiʻi (as well as other locations) and prefer to forage on sandy beaches, tidal flats, and mudflats.
Calidris alpina	Dunlin	-	**Non-breeding visitor, regular winterer** **September – May** Dunlin has been observed at PHNWR (NAVFAC PAC, 2006b). This species winters along mudflats, estuaries, marshes, flooded fields, sandy beaches, and shores of lakes and ponds.
Calidris canutus	Red Knot	-	**Non-breeding visitor, vagrant** Red knot has been observed at PHNWR (NAVFAC PAC, 2006b). This species is known to forage in mudflats, lagoons, estuaries, bays, mangrove swamps, and sandy beaches.

Scientific Name	*Common Name*	*Hawaiian Name*	*Study Area Occurrence*
Calidris ferruginea	Curlew Sandpiper	-	**Non-breeding visitor, vagrant** Two first-spring curlew sandpipers were observed in the Honouliuli Unit of PHNWR in 2005 (Pyle and Pyle, 2017). Subsequent, sporadic records of adults in various places throughout Oʻahu likely refer to a single individual, one of the first-year birds in winter 2004-2005; it was most often recorded in the Pearl Harbor area. Observations of this species were recorded October through May. (Pyle and Pyle, 2017). This species is known to forage in mudflats, beaches, and along coastlines.
Calidris himantopus	Stilt Sandpiper	-	**Non-breeding visitor, vagrant** Stilt sandpiper was recorded during surveys in 2006 at PHNWR (NAVFAC PAC, 2006b); however, only one substantiated record exists on Oʻahu at the Kiʻi Unit of the James Campbell National Wildlife Refuge in 2002 (Pyle and Pyle, 2017). Regardless, the species is very rare on Oʻahu. This species forages in mudflats, flooded fields, shallow ponds and pools, and marshes.
Calidris melanotos	Pectoral Sandpiper	-	**Non-breeding visitor, regular migrant** **July – April** Pectoral sandpiper has been observed at PHNWR (NAVFAC PAC, 2006b). They are found most commonly on mudflats with short grass or weedy vegetation.
Calidris minutilla	Least Sandpiper	-	**Non-breeding visitor, occasional winterer** **August – April** Least sandpiper has been observed at PHNWR (NAVFAC PAC, 2006b). This species is known to forage in mudflats, flooded fields, and less frequently to sandy beaches.
Charadrius semipalmatus	Semipalmated Plover	-	**Non-breeding visitor, occasional winterer** **September – April** Semipalmated plover has been observed at PHNWR (NAVFAC PAC, 2006b). This species forages for food on beaches, tidal flats, and fields.
Gallinago	Common Snipe	-	**Non-breeding visitor, vagrant** Common snipe has been at PHNWR (NAVFAC PAC, 2006b). Common snipes are primarily birds of open freshwater marshes, bogs, wet meadows, and mudflats.
Limnodromus scolopaceus	Long-billed Dowitcher	-	**Non-breeding visitor, regular winterer** **September – May** Long-billed dowitcher has been observed at PHNWR (NAVFAC PAC, 2006b) and Waipiʻo Peninsula (Pyle and Pyle, 2017). They are known to forage in coastal areas including estuaries, ponds, and seem to prefer freshwater to saltwater habitats.

Scientific Name	***Common Name***	***Hawaiian Name***	***Study Area Occurrence***
Limosa	Black-tailed Godwit	-	**Non-breeding visitor, vagrant** Black-tailed godwit has been observed at PHNWR (NAVFAC PAC, 2006b) and two unsubstantiated reports occurred at Pouhala March Wildlife Sanctuary just north of the installation boundary on Waipiʻo Peninsula and Fort Kamehameha flats (Pyle and Pyle, 2017). This species is known to forage in mudflats and marshes.
Limosa lapponica	Bar-tailed Godwit	-	**Non-breeding visitor, occasional migrant** **August – June** Approximately 24 individuals have been recorded at the Main Hawaiian Islands since the early 1900s. Although uncommon, they have been observed wintering in Waipiʻo Peninsula and the Pearl Harbor area. (Pyle and Pyle, 2017). Bar-tailed godwit was observed at PHNWR in 2006 (NAVFAC PAC, 2006b). This species is known to forage in mudflats or marshes.
Numenius tahitiensis	Bristle-thighed Curlew	Kioea	**Non-breeding visitor, regular winterer** **July – May** This species primarily winters in the Northwestern Hawaiian Islands but occur in small numbers in the Main Hawaiian Islands. This species prefers beaches, coral reefs, mudflats, and grassy fields and may occur within the study area where suitable foraging habitat is present.
Phalaropus tricolor	Wilson's Phalarope	-	**Non-breeding visitor, vagrant** Pyle and Pyle (2017) report one confirmed siting of Wilson's phalarope at Waipiʻo Peninsula in 1979. The surveys of PHNWR in 2006 also recorded the species (NAVFAC PAC, 2006b). This species is known to forage in shallow ponds, flooded fields, and mudflats.
Philomachus pugnax	Ruff	-	**Non-breeding visitor, occasional migrant** **July – May** Since the 1970s ruff has been regularly observed at Waipiʻo Peninsula (Pyle and Pyle, 2017) and was observed at PHNWR in 2006 (NAVFAC PAC, 2006b). This species is known to forage in mudflats, marches, and wet grass.
Pluvialis fulva	Pacific Golden Plover	Kōlea	**Non-breeding visitor, regular winterer** **September – May** Pacific golden plover has been observed at Ford Island, Hickam Airfield, Red Hill, Waiawa Watershed, Makalapa Crater, NAVMAG PH/West Loch Annex, Waipiʻo Peninsula, and PHNWR (NAVFAC PAC, 2006b; Hamer Environmental, 2016). During the winter months, they occupy upland and coastal habitats in the Hawaiian Islands. They leave Hawaiʻi in April to migrate to Alaska to breed and return to Hawaiʻi in August. Hunting was a significant threat to the species until 1941 when it was prohibited.

Scientific Name	*Common Name*	*Hawaiian Name*	*Study Area Occurrence*
Pluvialis squatarola	Black-bellied Plover	-	**Non-breeding visitor, regular winterer** **July – May** Black-bellied plover has been observed at PHNWR (NAVFAC PAC, 2006b) and is commonly observed by Field biologists (N. Dunn, personal communication, 2021a). This species winters on coastal beaches and estuaries and may use flooded pasture and agricultural land.
Tringa flavipes	Lesser Yellowlegs	-	**Non-breeding visitor, regular migrant** **August – June** Lesser yellowlegs is a regular visitor to the Hawaiian Islands and has been observed at PHNWR (NAVFAC PAC, 2006b). This species winters in a variety of shallow fresh and saltwater habitats.
Tringa incana	Wandering Tattler	ʻūlili	**Non-breeding visitor, regular winterer** **August – May** Wandering tattler has been observed at PHNWR (NAVFAC PAC, 2006b), Hickam Airfield (Hamer Environmental, 2016), and by Field biologists (N. Dunn, personal communication, 2021a). This species forages in intertidal habitats such as coral reefs and less frequently in soft mud or sand. Wandering tattler may also forage along mountain streams, in wetlands, fishponds, and human-modified areas.
Tringa melanoleuca	Greater Yellowlegs	-	**Non-breeding visitor, vagrant** **September – April** Greater yellowlegs has been recorded on Waipiʻo Peninsula (Pyle and Pyle, 2017) and at PHNWR (NAVFAC PAC, 2006b). This species winters in a wide variety of shallow fresh and saltwater habitats.
Tringa stagnatilis	Marsh Sandpiper	-	**Non-breeding visitor, vagrant** Marsh sandpiper has been observed at PHNWR (NAVFAC PAC, 2006b). This species forages in shallow water or on wet mud.
Falconidae			
Falco peregrinus	Peregrine Falcon	-	**Non-breeding visitor, regular winterer** **October – May** Pyle and Pyle (2017) report that peregrine falcon is now annual winter visitor, with records every winter since 1980. Virtually all reports are of single individuals, and it is strongly suspected the individuals move between islands during the winter (Pyle and Pyle, 2017). This species was observed at PHNWR in 2006 (NAVFAC PAC, 2006b) Little is known about the preferred roosting and foraging habitats of the peregrine falcon in Hawaiʻi.

Scientific Name	***Common Name***	***Hawaiian Name***	***Study Area Occurrence***
Fregatidae			
Fregata minor palmerstoni	Great Frigatebird	ʻIwa	**Breeding visitor, indigenous** Great frigatebird is commonly observed along the coasts of Oʻahu and has been observed at PHNWR (NAVFAC PAC, 2006b). This species breeds throughout the Northwestern Hawaiian Islands.
Fringillidae			
Haemorhous mexicanus	House Finch	-	**Naturalized (non-native) resident, long established** Little is known about the introduction of house finch to the Hawaiian Islands but by 1880-1900 the species was well established (Pyle and Pyle, 2017). House finch can be found throughout developed and natural areas on Oʻahu and within the study area (Hamer Environmental, 2016).
Laridae			
Hydroprogne caspia	Caspian Tern	-	**Non-breeding visitor, vagrant** Pyle and Pyle (2017) report only 17 observations of Caspian tern throughout the Main Hawaiian Islands and the species was observed during surveys at PHNWR in 2006 (NAVFAC PAC, 2006b). This species forages in coastal waters and beaches.
Larus atricilla	Laughing Gull	-	**Non-breeding visitor, regular winterer** **October – May** Laughing gull has been observed at PHNWR (NAVFAC PAC, 2006b). This species is known to forage in salt marshes, beaches, fields, and dumps. Laughing gull will forage in developed areas if food is readily available.
Larus californicus	California Gull	-	**Non-breeding visitor, vagrant** Only five substantiated records of California gull have been listed by Pyle and Pyle (2017) in Hawaiʻi. However, the study at PHNWR in 2006 recorded the species (NAVFAC PAC, 2006b).
Larus delawarensis	Ring-billed Gull	-	**Non-breeding visitor, regular winterer** **August – May** Ring-billed gull has been observed at PHNWR (NAVFAC PAC, 2006b) and those that winter in the Main Hawaiian Islands exhibit site fidelity to a single wintering area (Pyle and Pyle, 2017). Ring-billed gulls forage in flight or pick up objects while swimming, walking, or wading along the coastline. This species will also steal food from other birds and frequently scavenge.

Scientific Name	***Common Name***	***Hawaiian Name***	***Study Area Occurrence***
Larus philadelphia	Bonaparte's Gull	-	**Non-breeding, vagrant** **September – May** Bonaparte's gull is rare in the Hawaiian Islands (Pyle and Pyle, 2017) but was observed at PHNWR in 2006 (NAVFAC PAC, 2006b). This species winters near people and in rivers, sewage ponds, estuaries, and open ocean.
Larus pipixcan	Franklin's Gull	-	**Non-breeding visitor, occasional migrant** **March – May** Pyle and Pyle (2017) report four substantiated records of Franklin's gull at Waipiʻo Peninsula and the species was observed during surveys at PHNWR in 2006 (NAVFAC PAC, 2006b). They are known to forage along coasts and in bays and estuaries.
Sterna antillarum	Least Tern	-	**Non-breeding visitor, occasional; rare breeding visitor** Least tern has been observed at PHNWR (NAVFAC PAC, 2006b) and Waipiʻo Peninsula (Pyle and Pyle, 2017). Records indicate potential breeding at Waipiʻo Peninsula in 1976, 1980, 2002, and 2009 (Pyle and Pyle, 2017). The species is known to nest on coastal dunes and on sand or shell beaches, in areas that are swept clear of vegetation (USFWS, 2001)
Sterna fuscata	Sooty Tern	ʻEwaʻewa	**Breeding visitor, indigenous** Approximately 60,000 to 90,000 pairs of sooty tern breed on Mānana islet and 10,000 to 20,000 pairs breed on Moku Manu islet (Pyle and Pyle, 2017). The species has potential to fly over the study area and may forage in and around Pearl Harbor but is more commonly observed offshore.
Mimidae			
Minus polyglottos	Northern Mockingbird	-	**Naturalized (non-native) resident, long established** Northing mockingbird was released on Oʻahu in the 1920s. Although a population of northing mockingbird has been established, for reasons unknown, the species has not been as successful as other introduced species and has seen a population decline on Oʻahu since the 1970s (Pyle and Pyle, 2017). This species has been recorded on Waipiʻo Peninsula (Hamer Environmental, 2016).

Scientific Name	***Common Name***	***Hawaiian Name***	***Study Area Occurrence***
Pandionidae			
Pandion haliaetus	Osprey	-	**Non-breeding visitor, occasional winterer** Most reports of osprey in the Main Hawaiian Islands are of single birds and it is likely that the birds regularly fly between islands. There are relatively few summer records suggesting regular migrations and probably frequent turnover. Examination of dates and locations suggest that one to four individuals winter in the Main Hawaiian Islands almost annually and that adult birds potentially return to the same localities for five or more consecutive winters. (Pyle and Pyle, 2017). NAVFAC PAC biologists observed an osprey flying over Pearl Harbor (Waipiʻo Peninsula and PHNWR) in 2005 (NAVFAC PAC, 2006b) and an osprey was struck by a plane at Honolulu (now Daniel K. Inouye) International Airport in 2008 (P. Howard, personal communication, 2021). Osprey feed almost exclusively on fish. This species winter along large bodies of water containing fish.
Phaethontidae			
Ardenna pacifica	Wedge-tailed Shearwater	ʻUaʻu kani	**Breeding visitor, indigenous** Wedge-tailed shearwater is common on Oʻahu. The largest colonies occur on Mānana Island, the two islets of Mokulua, Mokuʻauia, and Moku Manu islets. Smaller colonies are present on Oʻahu primarily on the north and northeastern coastlines (Pyle and Pyle, 2017). Chicks fledging during late fall often become stranded on Oʻahu beaches (August–December). Wedge-tailed shearwaters are observed commonly from shore and from boats offshore.
Phaethon lepturus	White-Tailed Tropicbird	Koaʻe, Koaʻe kea	**Breeding visitor, indigenous** White-tailed tropicbird is known to nest in scattered locations on the eastern side of the Koʻolau Range, in Mānoa and Nānākuli valleys, and on Mokoliʻi Islet. Approximately 15 white-tailed tropicbirds were found stranded on Oʻahu between 1990 and 2002 (Pyle and Pyle, 2017).
Scolopacidae			
Actitis macularius	Spotted Sandpiper	-	**Non-breeding visitor, occasional** Spotted sandpiper has been observed at Loko Iʻa Pāʻaiau Fish Pond (personal communication, N. Dunn, 2022). The spotted sandpiper is a vagrant to the Hawaiian Islands (David, 1991; Pyle and Pyle, 2009).

Scientific Name	***Common Name***	***Hawaiian Name***	***Study Area Occurrence***
Threskiornithidae			
Plegadis chihi	White-faced Ibis	-	**Non-breeding visitor, occasional** White-faced ibis is occasionally observed on Oʻahu (Pyle and Pyle, 2017) and was recorded at PHNWR in 2006 (NAVFAC PAC, 2006b). This species inhabits marshes, irrigated land, and shallow water.
Tytonidae			
Tyto alba	Barn Owl	-	**Naturalized (non-native) resident, recently established** Barn owl was intentionally introduced to Hawaiʻi as pest control in 1958 and quickly expanded their range throughout the Main Hawaiian Islands. They prefer to nest in the hallows of trees but will nest in man-made structures as well. Barn owls are known to inhabit West Loch and Makalapa Crater (N. Dunn, personal communication, 2021a).

Notes: NAVFAC PAC = Naval Facilities Engineering System Command, Pacific; NAVMAG PH = Naval Magazine Pearl Harbor; PHNWR = Pearl Harbor National Wildlife Refuge; - = no data

Source: eBird, 2021; NAVFAC PAC, 2006b; Pyle and Pyle, 2017.

Between 2014 and 2015, point count surveys were conducted throughout the study area (Hamer Environmental, 2016). The most common birds observed at JBPHH Main Base and Surrounding Areas were introduced species such as common waxbill (*Estrilda astrild*), warbling white-eye (*Zosterops japonicus*), chestnut munia (*Lonchura atricapilla*), common myna (*Acridotheres tristis*), and red-vented bulbul (*Pycnonotus cafer*). A full list of bird species observed during the 2014–2015 point count surveys (Hamer Environmental, 2016) and previous INRMP bird surveys can be found in Appendix J-3.

Freshwater Species and Invertebrates

Between 2017 and 2020, inventory surveys were conducted to determine the biodiversity of fish within five Pearl Harbor streams (Waikele, Eʻo, Waiawa, Kalauao, and Hālawa) (Gonzalez et al., 2021). Pearl Harbor provides the only connection for the five endemic freshwater Goby species to migrate across the western Koʻolau's and the eastern Waiʻanae Mountain watersheds to complete their life cycle. Although they are not federally listed as threatened species, the Hawaiian endemic freshwater gobies, or ʻoʻopu, are the only endemic freshwater fish for the Hawaiian Islands. They are important to Hawaiian culture and currently face population declines due to poor water quality, loss of available habitat, and predation by the overwhelming number of invasive freshwater fish in Hawaiian streams (Schmidt, 2014 in Gonzalez et al., 2021). This group comprises four gobies (*Stenogobius hawaiiensis*, *Awaous stamineus*, *Sicyopterus stimpsoni*, and *Lentipes concolor*) and one eleotrid species (*Eleotris sandwicensis*). Each of the five endemic freshwater goby species were detected in all the streams surveyed (Gonzalez et al., 2021).

NAVFAC PAC performed a survey of a portion of Waiawa Stream on the DON property for aquatic species in 2007 (NAVFAC PAC, 2007b). The primary purpose of the survey was to determine whether native Hawaiian damselflies (*Megalagrion* sp.) were present in the area. No adult or immature damselflies were observed or caught in the portion of the stream that flows on the DON land. Additionally, surveys conducted by USFWS determined the absence and likely extirpation of native Hawaiian damselflies in Pearl Harbor stream mouths, wetlands, spring complexes and estuaries (USFWS, 2011b). The only member of the Odonta (order of insects composed of dragonflies and damselflies) found in this portion of the stream was the dragonfly *Pantala flavescens*. This species is indigenous to Hawaiʻi and is commonly found around ponds, slow moving streams, and temporary pools. The only other aquatic indigenous species was *Awaous guamensis* or ʻoʻopu nākea. This fish represents Hawaiʻi's largest native goby. It is not considered to be endemic to Hawaiʻi as it occurs naturally in other locations in the Pacific. In addition to the two indigenous species, five other alien species were recorded: Chinese catfish (*Clarias fuscus*), topminnows (*Poeciliidae* spp.), cane toad tadpole, bullfrog tadpole, and Tahitian prawn (*Macrobrachium lar*) (NAVFAC PAC, 2007b).

Terrestrial Mammals

With the exception of the Hawaiian hoary bat discussed above in the Threatened and Endangered Species section, all terrestrial mammals on Oʻahu are non-native species. Limited mammal surveys have been completed for JBPHH Main Base and Surrounding Areas and all observations have been on non-native species. Small Indian mongoose and feral cats have been observed at Makalapa Crater, Pearl City Peninsula, NAVMAG PH/West Loch Annex, Red Hill Fuel Annex, and Waiawa Watershed (mongoose only) (Bruner, 1999a; NAVFAC PAC, 2006d; DON, 2021c). Black rat (*Rattus rattus*) was observed at Makalapa Crater, Red Hill Fuel Annex, and Wahiawa Watershed (NAVFAC PAC, 2006d). Additionally, feral pigs, black rat, and other rodents are common throughout Oʻahu and very likely occur throughout the study area.

Invasive and Nuisance Terrestrial Species

Coconut Rhinoceros Beetle. In December 2013, a coconut rhinoceros beetle (*Oryctes rhinoceros*) was found in a pest survey trap at JBPHH Main Base and subsequently two breeding sites were discovered in compost piles on golf courses at JBPHH (USDA, 2020). Eradication efforts were immediately undertaken at these locations. Current detections of coconut rhinoceros beetle extend north to Waialua and west to Nānākuli. Isolated observations of coconut rhinoceros beetle at Marine Corps Base Hawaii, Waimanalo, and Waiʻanae have occurred in recent years (Coconut Rhinoceros Beetle Response, 2021). Eradication efforts have focused on Iroquois Point and Pearl City Peninsula, as coconut rhinoceros beetles have been historically active at these locations and had a similar number of monthly coconut rhinoceros beetle encounters before 2020. Canines are used to track and locate coconut rhinoceros beetle breeding sites. Additionally, the use of pesticide injections into host trees has greatly reduced the number of trapped beetles at Iroquois point. Injections were completed at Pearl City Peninsula in autumn of 2021. Coconut rhinoceros beetle effort is still working towards eradication at this time. Despite local eradication efforts, this species continues to expand across the island. The coconut rhinoceros beetle-G biotype is resistant to some conventional biocontrols. Control on Oʻahu is important to prevent spread of coconut rhinoceros beetle-G to other areas of the Pacific (Marshall et al., 2016)**.**

Adults damage palm trees, including the native loulou-hiwa palm (*Pritchardia martii*), and have potential to significantly reduce coconut production and palm stands throughout Oʻahu, where it has been detected in close proximity to native forest areas. This species has also been recorded feeding on commercial crops such as pandan, bananas, sugarcane, papayas, sisal, pineapples, taro, and date palms (USDA, 2020).

Naio Thrips. Myoporum thrips, also known as naio thrips (*Klambothrips myopori*), were detected on Oʻahu on November 23, 2018 (Oʻahu Invasive Species Committee [OISC], 2021). Naio thrips attack the native Hawaiian naio plant (*Myoporum sandwicense* var. *stellatum* and *M. sandwicense*). A rapid response was initiated with OISC in coordination with SOH Department of Agriculture, DOFAW, and other parties including Natural Resource staff at JBPHH. Three infected plants on Navy-leased land at Ford Island were treated with insecticidal soap, all leaves were removed, and nearby naio plant populations were treated with insecticide by NAVFAC Pest Control staff (RCUH, 2021).

Initial eradication efforts failed to stop the spread of naio thrips and the strategy for addressing this species have moved from eradication to management (OISC, 2021). Six locations on JPBHH hosted naio plants: Ford Island, Āhua Reef, Ft. Kamehameha Beach, Takano Nakamura, Loko Iʻa Pāʻaiau Fishpond, and an area known as the ʻTank Farm.ʼ As of FY19 Quarter 4, all naio plants had been completely removed from Takano Nakamura and Ford Island and have not been observed since. In November 2019, the Army Natural Resource Program Oʻahu assisted in the large-scale removal of naio plants from the remaining locations (RCUH, 2021).

During removal of naio at Āhua Reef, staff noticed one variety of naio (eight individuals) that did not host naio thrips. These eight shrubs were left and have been monitored quarterly. These plants continue to remain free of naio thrips. JBPHH Biology staff regularly conduct surveys to look for newly sprouted naio and remove any that are infested.

The previous State goal was to prevent the spread of naio thrips to wild naio populations, which has since failed. It is currently suggested to let naio grow with the intent that the plants will grow a tolerance to thrips. Therefore, going forward, naio plants will no longer be removed from JBPHH.

Feral Cats. Despite efforts to control the feral cat colonies, they are common at JBPHH Main Base and Surrounding Areas including PHNWR. The DON's current policy (Appendix J-5, Preventing Feral Cat and Dog Populations on Navy Property) includes creation of an educational plan on the negative effects of feral cats on native wildlife (Table 8-7, Rows 1 and 27, and Table 8-8, Row 17) and includes control of feral cats that prey on waterbirds and transfer diseases to Hawaiian monk seals. A contractor is in place and available for mongoose and feral cat trapping at West Loch Oxidation Pond to protect the ESA-listed bird species that occur there (DON, 2021c).

4.4 General Marine Biotic Environment

The discussion of the general biotic environment is divided into nine subsections (4.4.1 through 4.4.9): marine physical environment, JBPHH Main Base-administered submerged lands, marine habitats, marine flora, marine invertebrates, marine fisheries, EFH, marine protected species, and marine non-native and nuisance species.

Degradation of Hawaiʻi's nearshore marine resources was noted as early as 1902 (Jordan and Everman, 1902); fisheries were said to be declining rapidly due to overfishing. Over the last 40 years, the Hawaiian ecoregion has suffered a significant decline in the distribution, diversity, and abundance of coral reef organisms (NOAA, 2018). Overfishing and destructive fishing methods impact not only fish, but all the associated marine resources, particularly coral. Depleted stocks of herbivorous fish make coral more vulnerable to bleaching events, overgrowth by algae, and disease in general. In more recent times, the aquarium trade has further stressed Hawaiʻi's reefs by removing colorful (non-food) fishes as well as invertebrates living on and in coral heads, such as feather duster worms (*S. spectabilis*), hermit crabs, and coral shrimp. These extractive practices are having and have had a strong negative impact upon corals, corals reefs, and the associated ecosystem in Florida, the Virgin Islands, and Guam as well as in Hawaiʻi. Riegl et al. (2008) state: "…marine resources in Hawaii have steadily declined over the last century…." This decline has also been due to a wide range of other factors, including but not limited to poor land use practices, oil, pesticide and heavy metal pollution, increased sedimentation, sewage discharge, shoreline filling, increased small boat traffic and anchoring, and tourist and recreational diving.

4.4.1 Marine Physical Environment

The discussion of the general marine physical environment is divided into three subsections (4.4.1.1 through 4.4.1.3): bathymetry and currents, turbidity and water quality, and waves and storms.

4.4.1.1 Bathymetry and Currents

The bathymetry of the majority of Pearl Harbor, including the navigation channels, basins, and berthing areas was mapped by hydrographic survey in 2016 (NAVFAC PAC, 2016). The results of that survey effort are presented in Figure 4-10. The hydrographic survey data, combined with NOAA data, identifies the following trends of water depth inside the harbor and in adjacent Māmala Bay areas (NOAA, 2021b). The approximate average depth of East Loch is -35 feet (-11 meters at Mean Lower Low Water), with a range of -2 to -55 feet (-0.6 to -17 meters). The average depth Middle Loch is -28 feet (-8.5 meters), with a range of -4 to -53 feet (-1.2 to -16 meters). The average depth of West Loch is -33 feet (-10 meters), with a range of -3 to -59 feet (-0.9 to -18 meters). The average depth of the entrance channel is -44 feet (-13 meters), with a range of -7 to -94 feet (-2 to -29 meters). In Māmala Bay just outside the entrance channel, average depth is -53 feet (-16 meters), with a range of -10 to -160 feet (-3 to -49 meters) (NOAA, 2021b; NAVFAC HI, 2016).

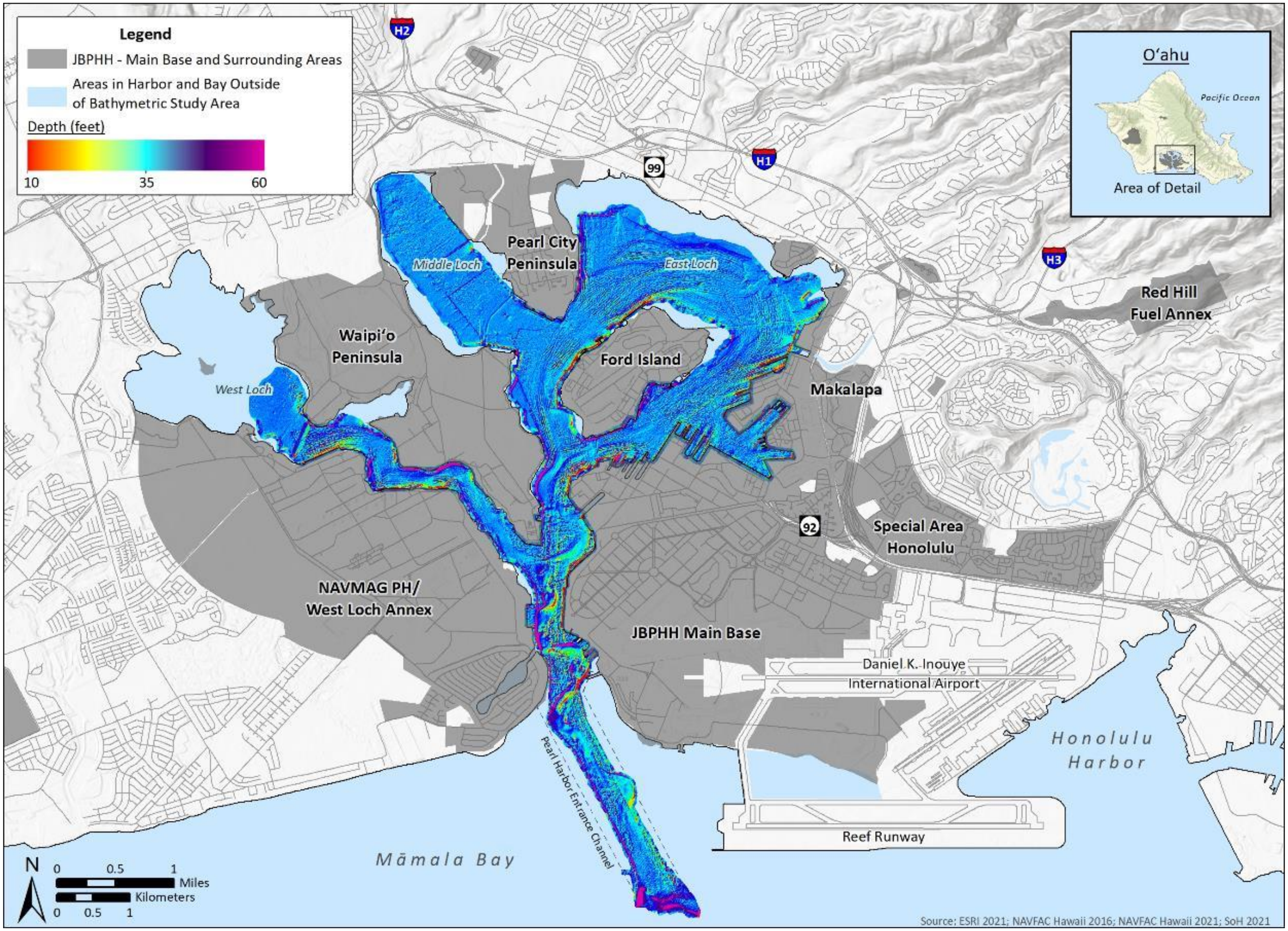


Figure 4-10 Pearl Harbor Bathymetry

Surface water circulation in Pearl Harbor is driven primarily by northeasterly trade winds. Inside Pearl Harbor, the trade winds drive a surface current out of the Harbor while a return flow occurs into the harbor in the mid and bottom portions of the water column. The stratification of salinity and temperature (from the mixing of saltwater and freshwater) in the Harbor play a role in the development of the wind-driven two-layer current flows within the Harbor. Salinity is lower near the surface of the water and higher near the bottom, and temperatures are warmer near the surface of the water and lower near the bottom. These conditions create vertical variability of density in the water column, allowing less dense surface water to slide on top of the denser water lower in the water column. In the Main Channel and throughout East Loch, average surface water residence time is 1 to 3 days, and maximum residence time for bottom waters is approximately 6 days (NAVFAC PAC, 2018a; Grovhoug, 1992). Currents inside Pearl Harbor, inside the mouth of the Harbor, and outside of the Harbor were measured during the period of July through September 2015 (NRH, 2020). Average current speed in Southeast Loch near the JPPHH Turning Basin is 0.04 meters/second (m/s) and the maximum velocity recorded was 0.26 m/s. Average current speed near Bishop Point, inside the mouth of Pearl Harbor, is 0.09 m/s and the maximum velocity recorded was 0.33 m/s. Average current speed outside the mouth of Pearl Harbor at Buoy 2 is 0.09 m/s and the maximum velocity recorded was 0.51 m/s, or 0.99 knots (NRH, 2020).

4.4.1.2 Turbidity and Water Quality

Surface water circulation is primarily a result of the northeasterly trade winds. Water residence time in the Main Channel and throughout East Loch is 1 to 3 days for surface waters, and approximately 6 days for bottom waters (NAVFAC PAC, 201 attempt 8b; DON, 2001).

Pearl Harbor receives saltwater input from the Pacific Ocean via Māmala Bay and the Main Channel of Pearl Harbor. The harbor is a natural estuary where the harbor water is more saline nearest the ocean and less saline with distance away from the ocean. Pearl Harbor also receives freshwater input from the Waimalu, Waipahu-Waiawa, and Pearl Harbor aquifer systems and surface water sources such as perennial streams and rivers within the Hālawa, ʻAiea, Kalauao, Waimalu, Waiawa, Waikele, Kapakahi, Waipiʻo, and Honouliuli watersheds (see Figure 4-7) (USGS, 1999; SOH Division of Aquatic Resources [DAR], 2008; NAVFAC PAC, 2018b).

There are five perennial streams that drain into Pearl Harbor (ʻAiea, Kalauao, Waimalu, Waimano, and Hālawa), the last of which drains into the harbor just north of Southeast Loch (see Figure 4-7) (NAVFAC PAC, 2011). Additional intermittent freshwater input comes from point and non-point wastewater sources through controlled stormwater infrastructure and uncontrolled urban/terrestrial runoff, respectively.

A major water quality analysis of the harbor was undertaken to collect and synthesize water quality data collected from 2016 to 2019 (NAVFAC PAC, 2020a). Major trends identified by that study include salinity gradients whereby the surface waters are of low salinity and the mid-depth and bottom waters are of similar salinities. Additionally, the water chemistry data collected during the sampling events, when compared to HDOH-specific water quality standard criteria, indicated that overall, the waters of the harbor are within water quality compliance. Due to run off from surrounding streams and urban watersheds increased turbidity, suspended sediment and freshwater input were observed during storm events in Pearl Harbor estuary. As described in Section 4.4.1.1, *Bathymetry and Currents*, stratification of fresh turbid water occurs during rain events, and storm events create short periods of exceedances of HDOH-specific water quality criteria in surface waters including increases in turbidity and sediment. The post-storm conditions are likely short-lived due to the active circulation of harbor waters, as the study concluded that during “normal” conditions, the waters of Pearl Harbor are in compliance with HDOH standards (NAVFAC PAC, 2020a).

4.4.1.3 Waves and Storms

The lack of a continental shelf in steep volcanic islands leads to significant changes in hurricane inundation potential, with wave setup and runup increasing in importance and wind-driven surge decreasing when compared to more gently-sloped mainland regions (Kennedy et al., 2012). Pearl Harbor is vulnerable to hurricanes, tsunamis, and coastal flooding; however, is generally protected from waves within the estuary. According to the SOH Emergency Management Agency, all of the Pearl Harbor coastline is in the extreme tsunami evacuation zone specifying specific building codes and emergency guidelines. Tide range in the harbor is minimal due to the narrow harbor opening and is typically 2 feet (0.6 meter) and possibly as much as 2.8 feet (0.85 meter) during spring tides (NAVFAC PAC, 2016).

As part of their siting study for a NOAA facility on Ford Island, NOAA conducted a Tsunami Inundation Study to determine the likelihood of inundation from large storms and tsunamis (NOAA, 2006). This study was based on available information on past distant tsunamis striking Pearl Harbor, as well as scenarios of distant tsunamis from the major subduction zone sources throughout the Pacific region. The study concluded that results of past tsunamis or 18 other modeled wave runup scenarios would only result in water level increases of less than 5 feet (1.5 meters) above mean high water. Larger wave heights and higher velocities would be expected under modeled scenarios, in the Pearl Harbor Entrance Channel, West Loch, and the channel near Hospital Point (NOAA, 2006). Further discussion of tsunami and flood zones within the study area can be found in Section 4.2.6, *Hydrology*.

4.4.2 JBPHH Main Base-administered Submerged Lands

As detailed in Section 1.3, *Scope*, OPNAVINST 5090.1 (DON, 2021d) Section 12-3.4b states that “Navy INRMPs must address installation watersheds, shorelines, and nearshore areas such that benefits are provided to aquatic species and habitats in waters adjacent to Navy installations.” Therefore, in addition to terrestrial natural resources, this INRMP also addresses marine natural resources associated with JBPHH-administered and submerged lands or nearshore waters. For the purposes of this INRMP and in accordance with OPNAVINST 5090.1 (Section 12-5.38) (DON, 2021d) and DoDI 4715.03 (DoD, 2018), nearshore waters are defined as those waters and submerged lands adjoining the installation from the mean high water mark (i.e., the line on the shore established by the average of all high tides) to the boundaries of installation waterfront activities where the DON controls access, and that are subject to the immediate authority of the JBPHH Installation Commanding Officer or tenant command.

The NDSA and Training Areas (referred to as NDSA and Nearshore Training Areas) covered by this INRMP are detailed in Section 4.1.1, *Installation Information*, and Figure 4-2. The natural resources discussed, and species inventoried for Nearshore Training Areas are covered under the ocean designation, distinct from those natural resources occurring within Pearl Harbor (including NDSA).

4.4.3 Marine Habitats

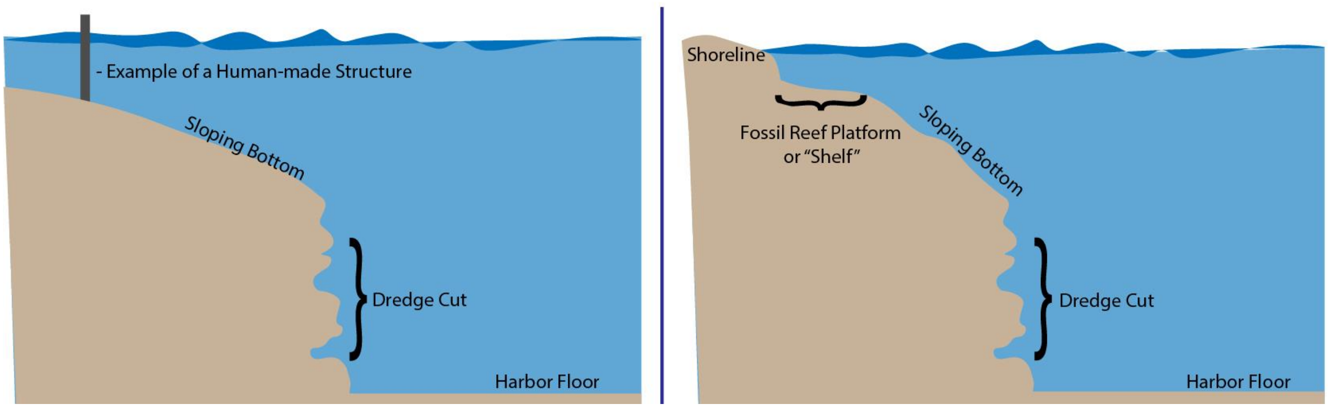
4.4.3.1 Benthic Environment

The benthic environment of Pearl Harbor can be classified into five separate categories: fossil reef platform, sloping bottom, dredge cut walls (high relief), harbor floor (soft substrate), and human-made structures (NAVFAC PAC, 2020b,c,d, 2021). Table 4-10 describes the typical biotic compositions of each of these benthic environments. Figure 4-11 depicts these benthic environment categories in a schematic representation of two typical bottom cross sections within Pearl Harbor.

Table 4-10 Descriptions of the Benthic Environment within the Study Area

Benthic Environment	*Description*	*Typical Biotic Composition*
Fossil reef platform	Flat surface that extends from the shoreline	Dense mats of macroalgae, turf algae, scattered corals, sponges
Sloping bottom	Slope that extends from the shoreline or the edge of the platform, loosely consolidated coral rubble, sand, shell hash, and debris	Macroalgae, scattered corals, sponges
Dredge cut walls (high relief)	Vertical faces that comprise the channel walls	Scattered corals, other invertebrates
Harbor floor (soft substrate)	Flat silty sand bottom	Infauna (Sediment dwelling animals)
Human-made structures	Sheet piling, column pilings, and other structures used opportunistically as habitat by marine organisms	Sponges, invertebrate fouling communities, scattered corals, bivalves

Sources: NAVFAC PAC, 2018c, 2020a,c,d,e,f,g.



Source: DON, 2020d.

Figure 4-11 Schematic Showing the Profile of Parts of Pearl Harbor with (left) and without (right) a Human-made Structure

Benthic studies and focused biological surveys conducted between 2016 and 2021 provide a more detailed look at the benthic environment in specific areas, including along the Main Channel, within the harbor (NAVFAC HI, 2016, 2018; NAVFAC PAC, 2018a,b,d, 2020b,c,d,g, 2021). Appendix J-6, Photographs 1 through 7 include representative photographs and orthomosaic images of the benthic environments present within Pearl Harbor. The images were taken during these focused biological surveys and illustrate the distribution of benthic structure within Pearl Harbor.

The majority of bottom substrate within Pearl Harbor consists of soft sediment (sand and mud) and unconsolidated material (rubble). Virtually the entire sediment load discharged to the Harbor, approximately 578 tons/day, is attributable to stream flows (NAVFAC PAC 2018a). Siltation and sediment resuspension from natural and anthropogenic causes have resulted in a turbid environment in Pearl Harbor since commercial operations and dredging began in the mid-nineteenth century (NAVFAC PAC, 2011; Wolanski, 2006).

HDOH has established water quality standards (WQS) for Pearl Harbor that include turbidity indicators. The Hawaiʻi DOH WQS not-to-exceed values for Nephelometric Turbidity Unit (NTU) are given for three parameters:

- 4.00 NTUs are not to be exceeded as a geometric mean
- 8.00 NTUs are not to be exceed more than 10 percent of the time
- 15.00 NTUs are not to be exceeded more than 2 percent of the time

According to the 2018 HDOH Water Quality Monitoring Assessment (WQMA), the Pearl Harbor Estuary was listed as impaired for turbidity prior to the 2002 issue of the WQMA, and remained that way until the 2012 WQMA in which it became delisted and attained the WQS for turbidity (HDOH, 2018). The Pearl Harbor Estuary remains in attainment as of the 2020 WQMA (HDOH, 2020). Even so, brief periods of non-attainment occur following storm events (NAVFAC PAC, 2020g). The portion of Pearl Harbor considered as its coastal water body (including the mouth of Pearl Harbor and Māmala Bay) is in non-attainment for turbidity (HDOH, 2020).

The soft sediment environment of the channel floor supports benthic communities that dwell within the sediment column (infauna). Infauna are dominated by crustaceans, including copepods, amphipods, shrimp, crabs, and small, often microscopic, snails and clams. In areas with a gently sloping bottom, benthic cover consists of unconsolidated materials such as sand, coral rubble, shell hash, and debris. These areas that include some hard substrate support communities of epiflora and epifauna, including corals, sponges, and bivalves (NAVFAC PAC, 2020e).

Limestone fossil reef platforms, also known as relic reefs, are the calcium carbonate deposits produced by coral organisms during previous geological periods (Fletcher et al., 2008). These solid structures can support the growth of coral, sponges, and algae (Appendix J-6, Photographs 8 through 11). Dredging of the relic reefs creates vertical walls or dredge cut walls that terminate in either sloping bottom or sediment-covered harbor floor.

Human-made structures within Pearl Harbor include hardened shorelines, jetties, piers, pilings, quay walls, shipwrecks, wharves, and debris. These structures provide hard substrate that can support a diversity of flora and fauna. The most common types of debris observed are bottles, pipes, rope, and miscellaneous metal objects.

4.4.3.2 Pearl Harbor Shoreline Habitat

The DON berthing and maintenance operations such as dredging have greatly transformed the natural shoreline of Pearl Harbor. Much of its shoreline is surrounded by urban and industrial development. The natural shorelines are dominated by non-native species, including various mangrove species (e.g., *Rhizophora mangle*). While mangroves can provide critical fish nursery habitat (Goecke and Carstenn, 2017), on Oʻahu they have become invasive and have caused deleterious issues for native species and traditional Hawaiian fishpond systems (loko iʻa), such as ʻOkiʻokiolepe Fishpond in West Loch. Unchecked mangrove growth can overtake native wetland ecosystems, changing water flow, dissolved oxygen levels, and habitat area for native plants, birds, and fish. Section 4.3.1, *Wetlands*, describes these communities in more detail.

4.4.4 Marine Flora

Marine vegetation observed within Pearl Harbor includes algae (crustose coralline algae, turf algae, cyanobacteria, and macroalgae) and seagrass. Common species of macroalgae included *Caulerpa* *verticillata*, *Liagora* sp., *Lobophora variegata*, and the invasive gorilla ogo (*Gracilaria salicornia*) (NAVFAC PAC, 2020c,e) (see Section 4.4.9, *Marine Non-native and Nuisance Species* for more information).

During 2018–2020 surveys within Pearl Harbor (NAVFAC PAC, 2020c,f,h, 2021), the recently introduced *Halophila decipiens* (paddlegrass) (McDermid et al., 2002) was not distinguished from *Halophila hawaiiana* (endemic Hawaiian seagrass).

4.4.5 Marine Invertebrates

Animals that live on the sea floor are called benthos. Most of these animals lack a backbone and are referred to as invertebrates. Typical benthic invertebrates include sea anemones, sponges, corals, sea stars, sea urchins, worms, crabs, and bivalves. Anthozoans are a class of invertebrates that include sea anemones, soft corals, and stony corals. Non-native invertebrates are discussed in Section 4.4.9, *Marine Non-native and Nuisance Species*. Special status invertebrates are discussed further under Section 4.4.8, *Marine Protected Species*.

4.4.5.1 Corals

Corals are invertebrates that are related to anemones, jellyfish, and hydras. They are made up of invertebrate polyps and can generally be categorized as either hard or soft corals. Hard corals have calcium carbonate skeletons, grow in colonies, and can be reef-building animals that live in symbiosis with phytoplankton called zooxanthellae. They provide substrate for various life stages for other organisms such as habitat for fish; spawning, fertilization, and recruitment habitat for sessile (immobile) and mobile invertebrates; surface substrate for macroalgae; resting, protective, and feeding habitat for sea turtles; and habitat for Hawaiian monk seals.

Soft corals are flexible, have calcareous particles in their body walls for structural support, can be found in both tropical and cold ocean waters, do not build reefs, and do not always contain zooxanthellae. Corals are an ecosystem component of EFH and play a critical role for a significant number of marine species at one or more points of their life stage.

Corals addressed in this document are exclusively tropical species occurring (primarily) at depths of less than 325 feet (100 meters). The Hawaiian ecoregion has suffered a significant decline in the distribution, diversity, and abundance of coral reef organisms during the last 40 years (NOAA, 2015). However, diversity is only one measure of the biological importance of a coral reef, and the Hawaiian reefs are significant from an ecological, commercial, recreational, and cultural perspective.

The diversity of coral species within Pearl Harbor has increased in recent years. Studies conducted during 1973 and 1974 did not note the presence of any stony corals in Pearl Harbor. However, in 1999 five stony coral species were observed in Pearl Harbor including coral colonies in some of the areas previously studied in 1973 and 1974. Eight stony coral species were observed in 2002 with one or more species present at five of the 1973/1974 study locations. The 2005 marine assessment (Smith et al., 2006) noted the presence of three additional hard coral species. *Pocillopora damicornis* was the most dominant scleractinian species in the 2002 and 2005 studies, whereas *Leptastrea purpurea* was the most common coral in the 1999 study. However, nearly all of the coral colonies revisited in the 2005 study were partially or completely covered with gorilla ogo. Focused studies conducted in 2020 within the shipping channel, PHNSY, Waipiʻo, and South Ford Island observed additional native coral species, bringing the total number of species observed in Pearl Harbor since 1999 to 17 (Table 4-11 and Figure 4-12) (NAVFAC PAC, 2020c,e,f, 2021). Based on these past studies, the total number of stony corals and diversity of species within Pearl Harbor appears to have increased substantially since 1974.

Table 4-11 Native Coral Species Observed in Pearl Harbor and Nearshore Training Areas

Scientific Name	*Common Name*	*Hawaiian Name*	*Pearl Harbor*	*JBPHH Training Nearshore Areas*
Cladopsammia gracilis	Stony Cup Coral	-	Not Observed	Confirmed
Cycloseris explanulata	-	ʻĀkoʻakoʻa	Not Observed	Confirmed
Cyphastrea agassizi	Lesser Knob Coral	ʻĀkoʻakoʻa	Not Observed	Confirmed
Cyphastrea ocellina	Ocellated Coral	ʻĀkoʻakoʻa	Confirmed	Confirmed
Leptastrea bewickensis	Crust Coral	ʻĀkoʻakoʻa	Not Observed	Confirmed
Leptastrea purpurea	Crust Coral	Koʻa, ʻĀkoʻakoʻa	Confirmed	Confirmed
Leptoseris incrustans	Swelling Coral	Koʻa, ʻĀkoʻakoʻa	Confirmed	Confirmed
Lobactis scutaria	Mushroom Coral	Koʻa kohe	Not Observed	Confirmed
Montipora capitata	Rice Coral	Koʻa, ʻĀkoʻakoʻa	Confirmed	Confirmed
Montipora dilatata	Purple Rice Coral	ʻĀkoʻakoʻa	Confirmed	Confirmed
Montipora flabellata	Blue Rice Coral	Koʻa, ʻĀkoʻakoʻa	Confirmed	Not Observed
Montipora patula	Spreading Coral	-	Confirmed	Confirmed
Montipora tuberculosa	Pore Coral	ʻĀkoʻakoʻa	Not Observed	Confirmed
Montipora turgescens	Pore Coral	ʻĀkoʻakoʻa	Confirmed	Confirmed
Montipora verrilli	Pore Coral	ʻĀkoʻakoʻa	Not Observed	Confirmed
Pavona duerdeni	Flat Lobe Coral	ʻĀkoʻakoʻa	Confirmed	Confirmed
Pavona varians	Corrugated Coral	ʻĀkoʻakoʻa	Confirmed	Confirmed
Pocillopora damicornis	Lace Coral	Koʻa, ʻĀkoʻakoʻa	Confirmed	Confirmed
Pocillopora grandis	Antler Coral	-	Confirmed	Confirmed
Pocillopora ligulata	Hawaiian Cauliflower Coral	ʻĀkoʻakoʻa	Not Observed	Confirmed
Pocillopora meandrina	Cauliflower Coral	-	Confirmed	Confirmed
Pocillopora verrucosa	Warty Bushcoral	-	Confirmed	Confirmed
Porites compressa	Finger Coral	Pōhaku puna, ʻĀkoʻakoʻa	Confirmed	Confirmed
Porites evermanni	Evermann's Coral	Pōhaku puna, ʻĀkoʻakoʻa	Confirmed	Confirmed
Porites lobata	Lobe Coral	Pōhaku puna, ʻĀkoʻakoʻa	Confirmed	Confirmed
Psammocora nierstraszi	-	-	Not Observed	Confirmed

Notes: - = no data.
Sources: NAVFAC PAC, 2020c,e,h, 2021; Smith et al., 2006; Smith, 2015.

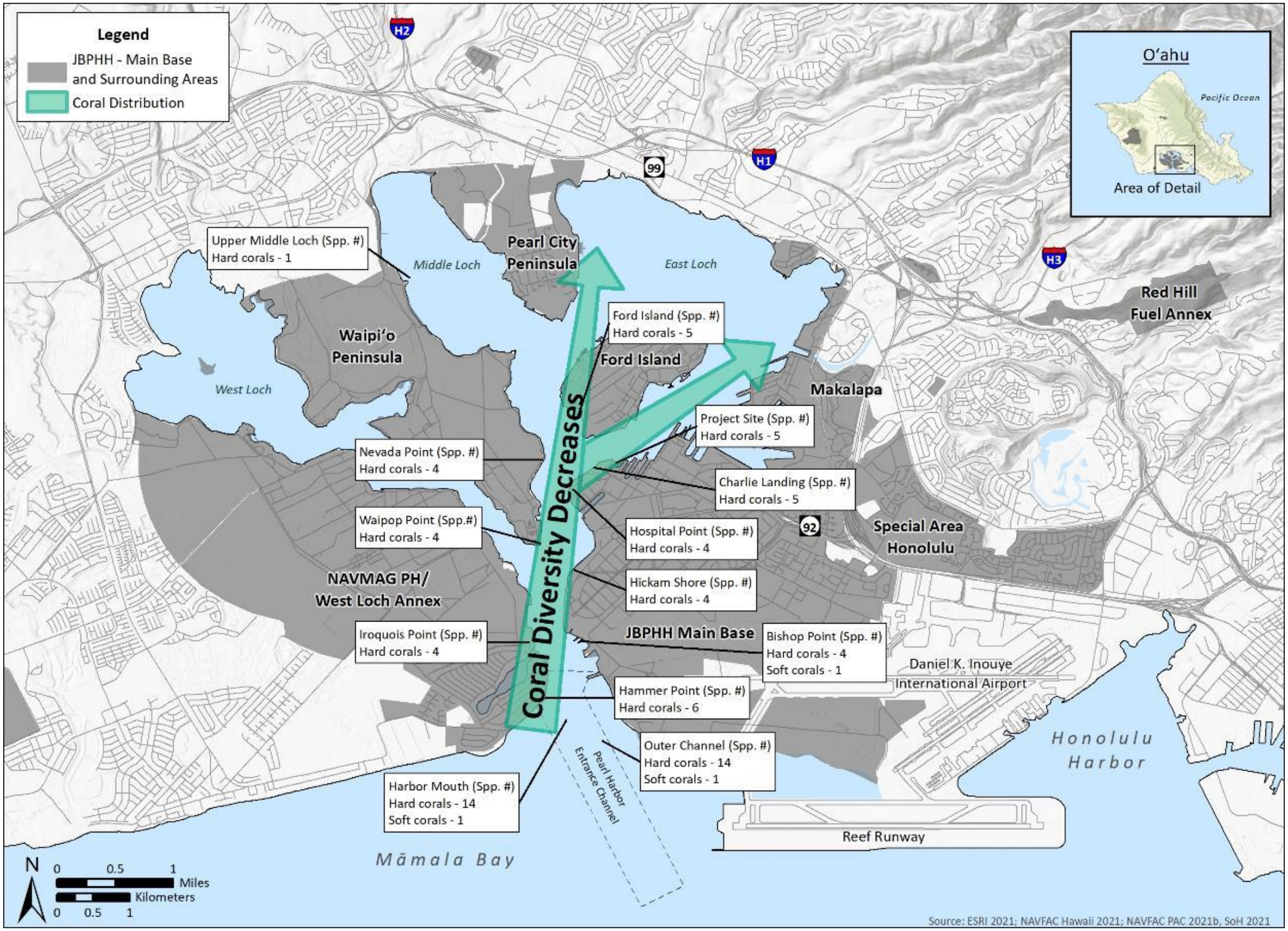


Figure 4-12 Trends in Coral Diversity in Pearl Harbor

Coral richness (defined as the number of species at a given locale) within JBPHH waters decreases as distance from the Pearl Harbor Entrance Channel increases. Most coral species prefer physical conditions that include solid substrate to settle on, salinities closer to 35 ppt, and clear water with low sediment loads. Pearl Harbor is estuarine (freshwater emanating from land mixing with ocean water) due to freshwater inputs to the northern inland area of Pearl Harbor from rivers and springs (e.g., Hālawa Stream and Waimalu Stream) located in the upper Middle and East Lochs. The rivers and springs deliver fresh water and organic material from within the watershed that lead to lower salinity conditions and muddy substrates in the inland portions of the Harbor. The area near the mouth of Pearl Harbor is characterized by "oceanic" conditions, solid substrates, and low sediment loads, hence has the highest number of coral species present. As freshwater inputs and effects of sediment input from land become greater, the resulting changes in environmental conditions become increasingly less conducive to coral occurrence in terms of both abundance (percentage of bottom cover) and species number. Only a few coral species, including *Leptastrea* spp., *Pocillopora damicornis*, and *Montipora* spp., appear to have the physiological attributes to withstand the high sediment loading in the inner harbor. While these species also occur in the outer harbor oceanic areas, they do not comprise the majority of the coral community as they do in the inner harbor. Figure 4-12 illustrates the decreasing coral diversity trend moving from the mouth of the harbor toward the lochs. Appendix J-6, Photographs 12 through 14 provide representative images of corals found within Pearl Harbor and Appendix J-6, Figure 1, includes a graph demonstrating coral species richness with distance from Pearl Harbor Entrance Channel.

The Pearl Harbor Entrance Channel (depicted on Figure 4-12) consists almost entirely of unconsolidated sediment. Proceeding offshore, the sand and rubble become increasingly coarse. The sides of the Pearl Harbor Entrance Channel and the adjacent fossilized reef platform do support substantial coral, including some of Oʻahu's best coral reefs. The reefs on the western side of the Pearl Harbor Entrance Channel are the most highly developed, with the greatest coral diversity and reef complexity in the Pearl Harbor estuary (NAVFAC PAC, 2017). The depths at which these reefs are the most well developed range from 15 to 60 feet (4.6 to 18 meters).

Outside of Pearl Harbor, along the southwest of the NDSA, sea floor percent cover by corals exceeds 25 percent where surveyed (NRH, 2020). These values are comparable to or higher than most other areas on the island of Oʻahu. The total number of scleractinian coral species present within the NDSA outside of the Pearl Harbor Entrance Channel is at least 25.

There are two primary factors impacting corals within Pearl Harbor, freshwater input from streams and springs, and the spread of invasive algae. Approximately 70 percent of the freshwater input to Pearl Harbor is derived from a complex of springs including Waiau Springs, Waimano Springs, Waiawa Springs, and Waikele Springs (Nichols et al., 1996). The pre-development discharged rates were estimated to be up to 183 mgd (692 mld), making this the largest spring complex in the Hawaiian Islands and one of the largest known for all the Pacific Islands. The most significant streams discharging into the harbor are Hālawa Stream and Waimalu Stream. Corals are limited by low levels of salinity, so the discharges from these springs and streams have and will continue to limit the spread of corals within the harbor. The DON has no control over upstream dumping into the streams. Unfortunately, substantial amounts of hazardous materials and waste, such as motor oil, batteries, and paints are illegally dumped into these streams which then discharge into Pearl Harbor. The contaminants from these streams may not be sufficient to limit the distribution of corals in the harbor but are certainly detrimental.

Non-native species also have the potential to be detrimental to corals.

Fishing within Pearl Harbor has been restricted for more than 10 years. Although not intended to benefit corals, the result has been highly significant. The large number of herbivorous fishes and generally healthy fish fauna have undoubtedly contributed to the recovery and spread of corals (Raymundo et al., 2009; Smith et al., 2006).

In the Pearl Harbor Entrance Channel and NDSA waters outside the channel, neither freshwater input nor invasive algae are a significant issue. Due to its geographic location and restrictions on access to the area, including access by fishermen and divers, there are no chronic threats to the corals and coral reefs in this zone with the exception of regional or global threats such as increased sea surface temperatures. In February 2009, the USS Port Royal ran aground within the eastern portions of the NDSA outside of Pearl Harbor. Corals were damaged and destroyed as a result of the grounding. While highly regrettable, such incidents are extremely rare. Sport and commercial fishing and aquarium fish collection take place at the eastern and western edges of the NDSA off Hickam and Iroquois Point. This fishing includes the use of wire fish traps which are often lost and remain on the sea floor catching fish for years. Further reduction or control of fishing from the NDSA would be highly beneficial to corals.

Potential factors affecting coral and coral reefs in the NDSA outside of the Pearl Harbor Entrance Channel are coral bleaching, ocean acidification, and big wave events. At intervals of approximately 20 years, exceptionally large wave events occur and destroy many of the shallow reef areas to depths of 15 to 25 feet (4.6 to 7.6 meters). The last such large wave event occurred after the salvage of the USS Port Royal, in March 2009. Waves in excess of 18 feet (5.5 meters) swept away many corals.

4.4.5.2 Non-Coral Invertebrates

A total of 219 species of non-coral invertebrates have been identified in Pearl Harbor during past surveys. Of this total, 44 non-coral invertebrates have been observed within the Nearshore Training Areas. However, as stated previously, the open ocean and mesophotic reefs are not as well studied within the Nearshore Training Areas as Pearl Harbor, given the amount of area and logistical challenges with surveying deeper waters (see Appendix J-7 for a list of marine species known to occur or with potential to occur within the study area). Surveys throughout the harbor have not observed sessile marine invertebrates on the surface of soft sediment. There has been evidence of mobile invertebrates and sediment infauna (NAVFAC PAC, 2017, 2020d,h).

Mollusks include a diverse set of invertebrates that can be found in Pearl Harbor, from those with one shell (univalves such as snails and other gastropods), two shells (bivalves such as oysters), and octopus, which are found throughout Pearl Harbor, but sparsely distributed, and usually as solitary individuals. Diversity of mollusks, like most marine diversity of Hawaiian waters, is limited but exhibits high levels of endemism (Wells, 2001). Recent surveys within Pearl Harbor have cataloged 50 species of mollusks including four species of bivalves and an unidentified group of species. Many are difficult to identify due to fouling and sediment cover. In addition, no night surveys have been conducted and therefore these surveys may not have accounted for additional mollusks in JBPHH. While living individuals are rarely observed, remnant shells are extremely common as a component of the benthic surface and on man-made structures.

Historically, oysters were more abundant and reached an estimated 36 million in West Loch in the 1960s; however, this was possibly due to a ready, albeit polluted, supply of particulate food. Coles et al. (1997) states that throughout West Loch, hard surfaces, including metal debris and mangrove prop roots, are often dominated by oysters that may have descended from oysters introduced to the area in the 1860s and 1920s. Oysters still make up a sizable portion of the live cover in Western Loch; up to 10 percent of certain areas (Smith et al., 2006). Evidence of past high abundance is observable at various locations across the areas, such as the fossil oyster reef near the corner of piers K-1 and Y-3.

In 2019, the DON, Oʻahu Waterkeepers and the Pacific Aquaculture, and the Coastal Resources Center began a collaborative pilot study to utilize native oysters (*Dendostrea sandvicensis*) to improve water clarity and quality in Pearl Harbor (RCUH, 2020c). The pilot study is ongoing. In 2017, a pilot study using non-native (and non-reproducing) oysters for bioremediation was found to be successful in metal removal from the water column and supported the growth of other filter feeders (Bienfang, 2017).

Focused surveys within Pearl Harbor conducted in 2020 indicate that sponges and remnants of bivalves were common throughout the main shipping channel (Wells et al., 2020). While these filter-feeding invertebrates provide a function of removing organic material from the water column, the magnitude of this function cannot be quantified from the data collected in this study. However, sponges are abundant and they may be providing an important functional role. Other common non-coral invertebrates also filter the water and sediments, such as sea cucumbers. The most abundant species is the conspicuous sea cucumbers (*Opheodesoma spectabilis*), which are particularly common on most substrates including soft bottom (Appendix J-6, Photograph 15).

4.4.6 Marine Fishes

Fish are vital components of the marine ecosystem. They have great ecological and economic aspects. Currently, approximately 622 species of shorefishes are known to occur around the Insular Pacific-Hawaiian Large Marine Ecosystem. The high number of species that are found only in Hawaiʻi can be explained by its geographical and hydrographical isolation; 25 percent of fishes that occur in Hawaiʻi are found only in the Hawaiian Islands (Randall, 2007; Friedlander, 2020). Migratory open ocean fishes, such as the larger tunas, the billfishes, and some sharks, are able to move across the great distance that separates the Hawaiian Islands from other islands or continents in the Pacific. Coral reef fish communities in the Hawaiian Islands (excluding Nihoa) show a consistent pattern of species throughout the year. Exceptions include the seasonal distributions of migratory, open ocean species. Several of the reef fish species (bigeye scad [*Selar crumenophthalmus*], mackerel scad [*Decapterus macarellus*], goatfishes [Mullidae], and squirrelfishes [Holocentridae]) also show seasonal fluctuations which are usually related to movements of juveniles into new areas or spawning activity (U.S. Navy Office of Naval Research, 2001).

Historically, Pearl Harbor has had significant fishery resources and under the jurisdiction of the DON, has allowed fishery resources to exist with little or no fishing pressure. The exception has been the permits issued to the live-bait skipjack tuna or aku vessels seeking bait in the harbor. This industry has declined in recent years due to changes in the industry and the prevalence of long-line fishing techniques. Aku fishing vessel access to Pearl Harbor ceased after September 11, 2001. Most other types of commercial fisheries and aquaculture are not compatible with the DON's military mission and security concerns for Pearl Harbor.

Pearl Harbor and Māmala Bay provide habitat for many fishes, including endemic species. A total of 126 endemic species have been documented to date in Pearl Harbor and 114 species in the Nearshore Training Areas (see Appendix J-7 for a list of marine species). However, as stated previously, the open ocean and mesophotic reefs are not as well studied within the Nearshore Training Areas as Pearl Harbor given the amount of area and logistical challenges with surveying deeper waters. The most commonly observed species vary by location. For example, ringtail surgeonfish (*Acanthurus blochii*) and bullethead parrotfish (*Chlorurus sordidus*) were most frequently observed near Charlie Landing. Other commonly observed species around coral and algae are sergeant majors (*Abudefduf abdominalis*), Moorish idols (*Zanclus cornutus*), brown surgeons (*Acanthurus nigrofuscus*), yellow tangs (*Zebrasoma flavescens*), and the endemic Hawaiian humbug or Dascyllus (*Dascyllus albisella*). Representative images of fish schools in Pearl Harbor are shown in Appendix J-6, Photographs 16 and 17. The greatest number of species as well as individual fish is usually found around vertical structures, such as corals. Also, the sloping bottom and dredge cut wall habitats have similar numbers of fish species and individuals and sometimes twice as many species than around wharf pilings.

A creel survey conducted for 1 year (June 1, 2015 to May 31, 2016) documented 39 species representing 19 families observed in fishermen's catch during the survey period (Wolfe et al., 2017). Pole fishing was the dominant fishing gear type and was used for approximately 97.4 percent of the 101,313 gear-hours, which was the estimated total annual fishing effort (Wolfe et al., 2017). Therefore, while fishing is restricted in large areas in Pearl Harbor, it has the highest fishing intensity recorded in any creel survey conducted across the Hawaiian Archipelago (Delaney et al., 2017). This is probably due to the densely populated areas around Pearl Harbor. In the creel survey, the top three taxa caught by weight were: juvenile jacks (*Caranx* spp.; pāpio), bonefishes (*Albula* spp.; ʻōʻio), and golden trevally or ʻulua aukea (*Gnathanodon speciosus*; paopao). Also, over half of the young jacks were illegal due to being undersized (Wolfe et al., 2017). These species are all native species and highly prized by fishers. Non-native fish species are discussed in Section 4.4.9, *Marine Non-native and Nuisance Species*. Special status fish are discussed further under Section 4.4.8, *Marine Protected Species*.

4.4.7 Essential Fish Habitat

The MSFCMA, as amended by the Sustainable Fisheries Act of 1996 (PL 104-267), requires that regional Fishery Management Councils, through federal Fishery Management Plans, describe and identify EFH for each federally managed species; minimize, to the extent practicable, adverse effects on such habitat caused by fishing; and identify other actions to encourage the conservation and enhancement of such habitats. EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (16 U.S.C. 1802 [10]).

To protect this resource, NMFS works with the regional Fishery Management Councils to identify the essential habitat for every life stage of each federally managed species using the best available scientific information. EFH has been described for nearly 1,000 managed species to date. EFH includes all types of aquatic habitat including wetlands, coral reefs, seagrasses, and rivers; all locations where fish spawn, breed, feed, or grow to maturity.

All waters and submerged lands (i.e., the water column and bottom) of Pearl Harbor and the Nearshore Training Areas closest to the coast are designated as EFH and support various life stages for some of the management unit species (MUS) described in the Pelagic (Western Pacific Regional Fishery Management Council [WPRFMC], 2009a) and Hawaiʻi Archipelago Fishery Ecosystem Plan (WPRFMC, 2009b) with amendments (WPRFMC, 2016). In 2019, NMFS reclassified certain MUS in the Pacific Islands as ecosystem component species (ECS) (Federal Register, 2019). The MUS and ECS life stages that occur within Pearl Harbor of the Nearshore Training Areas are listed in Table 4-12. There are no HAPCs within Pearl Harbor.

Table 4-12 Management Unit Species and Ecosystem Component Species Relevant Life Stages

Scientific Name	***Common Name***	***Hawaiian Name or Japanese Name***	***Life Cycle/ Behavior***	***Study Area Occurrence****
Bottomfish MUS – Shallow				
Aprion virescens	Gray Jobfish	Uku	eggs, larvae, juveniles, and adults	Confirmed in nearshore waters
Bottomfish MUS – Intermediate				
Aphareus rutilans	Ironjaw or Silverjaw Snapper	Lehi	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Hyporthodus quernus	Hawaiian Grouper	Hapuʻupuʻu	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Pristipomoides filamentosus	Pink Snapper	Opakapaka	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Bottomfish MUS – Deep				
Etelis carbunculus	Squirrelfish Snapper	Ehu	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Etelis coruscans	Scarlett, Red, or Longtail Snapper	Onaga	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Pristipomoides seiboldii	Von Siebold's Snapper	Kalekale	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Pristipomoides zonatus	Flower or Brigham's Snapper	Gindai	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Seamount Groundfish MUS				
Beryx splendens	Alfonsin	Kinmedai	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Hyperoglyphe japonica	Ratfish	Medai	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Pentaceros richardsoni	Pacific armorhead	Kusakari Tsubodai	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Pelagic MUS				
Thunnus alalunga	Albacore Tuna	Ahi Palaha	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Thunnus obesus	Bigeye Tuna	Ahi Poʻonui	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Thunnus thynnus	Bluefin Tuna	-	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters

Scientific Name	*Common Name*	*Hawaiian Name or Japanese Name*	*Life Cycle/ Behavior*	*Study Area Occurrence**
Xiphins gladius	Swordfish	Aʻuku	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Crustacean MUS				
Heterocarpus spp.	Deepwater Shrimp	-	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Ranina ranina	Kona Crab	Pāpaʻi kualoa	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Hawaiʻi Coral ECS				
Acanella sp.	Bamboo Coral	-	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Antipathes griggi	Black Coral	ʻEkaha Kū Moana	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Antipathes grandis	Black Coral	ʻEkaha Kū Moana	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Hemicorallium laauense	Red Coral	-	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Kulamanamana haumeaae	Gold Coral	-	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Myriopathes ulex	Black Coral	ʻEkaha Kū Moana	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters
Pleurocorallium secundum	Pink Coral	-	eggs, larvae, juveniles, and adults	Within 5 miles nearshore waters

Notes: MUS = management unit species; ECS = Ecosystem Management Species; - = no data.
* = Definitions of Study Area Occurrence terms are provided in Appendix J-4.
Sources: WPRFMC, 2009a,b, 2016, 2018; Federal Register, 2019.

4.4.7.1 Bottomfish and Seamount Groundfish Management Unit

Most of the biological and ecological information about bottomfish and seamount groundfish species is unknown, with very little evidence about life histories, habitat use, foraging behavior, or spawning behavior (WPRFMC, 2009b). To reduce the complexity and the number of EFH identifications required for individual species and life stages, the WPRFMC designated EFH for bottomfish assemblages based on the ecological relationships among species and their preferred habitat (Table 4-13). These species complexes are grouped by the known depth distributions of individual Bottomfish MUS throughout the Western Pacific Region. Based on these descriptions, the EFH for all stages can be found within Pearl Harbor and the Nearshore Training Areas.

Table 4-13 Bottomfish and Seamount Groundfish EFH Descriptions for Each life Stage of Species Assemblages

Species Assemblage	*EFH – Eggs*	*EFH – Post-hatch Pelagic*	*EFH – Post-settlement*	*EFH – Subadult*
Bottomfish Shallow Complex	Water column from 0–787 feet (0–240 meters) Shoreline to EEZ outer boundary			
Bottomfish Intermediate Complex	Water column from 0–1,050 feet (0– 320 meters) Shoreline to EEZ outer boundary		Water column from 131–1,050 feet (40–320 meters) Shoreline to EEZ outer boundary	
Bottomfish Deep Complex	Water column from 0–1,312 feet (0– 400 meters) Shoreline to EEZ outer boundary		Water column from 262–1,312 feet (80–400 meters) Shoreline to EEZ outer boundary	
Seamount Groundfish	Pelagic waters 0–1,968 feet (0–600 meters) Within EEZ north of 29° N and west of 179° W		Benthic or benthopelagic waters from 394–1,968 feet (120–600 meters) Within EEZ north of 29° N and west of 179° W	Benthopelagic waters from 394–1,968 feet (120–600 meters) Within EEZ north of 29° N and west of 179° W

Notes: EEZ = Exclusive Economic Zone; EFH = Essential Fish Habitat.
Source: WPRFMC, 2018.

The seamount groundfish complex consists of three species: pelagic armorheads (*Pseudopentaceros richardsoni*), alfonsins (*Beryx decadactylus*), and ratfish (*Chimaera monstrosa*). These species dwell at 656–1,968 feet (200–600 meters) on the submarine slopes and summits of seamounts. The life histories and distributional patterns of seamount groundfish are poorly understood. Data are lacking on the effects of oceanographic variability on migration and recruitment of individual MUS. On the basis of the best available data, the WPRFMC designated the EFH for the adult life stage of the seamount groundfish complex as all waters and bottom habitat bounded by latitude 29° North and longitude 179° West. Based on these descriptions, the EFH for all stages can be found within Pearl Harbor and portions of the Nearshore Training Areas.

4.4.7.2 Pelagic Management Unit

Based on the best available scientific information of the biological requirements for each life stage (i.e., egg, larvae, juvenile, adult) of all Pelagic Management Unit Species (PMUS), EFH designation ensured that sufficient habitat in good condition is available to maintain a sustainable fishery and the managed species' contribution to a healthy ecosystem (WPRFMC, 2009a). To reduce the complexity and the number of EFH identifications required for individual species and life stages, designated EFH for the PMUS includes temperate species, tropical species, sharks, and squid based on the ecological relationships among species and their preferred habitat (Table 4-14). The temperate species complex includes those PMUS that are found in greater abundance in higher latitudes such as swordfish (*Xiphias gladius*) and bigeye tuna (*Thunnus obesus*), bluefin tuna (*Thunnus thynnus*), and albacore tuna (*Thunnus alalunga*). The EFH for all stages of PMUS can be found within Pearl Harbor and the Nearshore Training Areas.

Table 4-14 Essential Fish Habitat Descriptions for Each Life Stage for Pelagic, Coral Reef, and Crustaceans Ecosystems

Species Assemblage	*EFH – Eggs and Larvae*	*EFH – Juveniles and Adults*
Pelagic	• Water column down to 656 feet (200 meters) • Shoreline to EEZ boundary	• Water column down to 3,281 feet (1,000 meters) • Shoreline to EEZ boundary
Coral Reef	Known precious coral beds in the Hawaiian Islands at: • Keāhole • Makapuʻu • Kaʻena • Westpac beds	• Brooks Banks beds • 180 Fathom gold/red coral beds • Miloliʻi • S. Kauaʻi • ʻAuʻau Channel black coral beds
Crustaceans	Kona crab: • Water column down to 492 feet (150 meters) • Shoreline out to EEZ boundary	Kona crab: Bottom from shoreline down to 328 feet (100 meters)
	Deepwater shrimp: Outer reef slopes between 984 and 2,297 feet (300 and 700 meters)	Deepwater shrimp: Outer reef slopes between 1,804 and 2,297 feet (550 and 700 meters)
Hawaiian Coral Reef Ecosystem Component Species	• Water column and benthic substrate to depth of 328 feet (100 meters) • Shoreline out to the EEZ boundary	

Notes: EEZ = Exclusive Economic Zone; EFH = Essential Fish Habitat.
Source: WPRFMC, 2018.

4.4.7.3 Crustaceans Management Unit

In Hawaiʻi, the Crustacean MUS for EFH comprise the Kona crab (*Ranina ranina*) based on the ecological relationships among species and their preferred habitat. Pearl Harbor and portions of the Nearshore Training Areas overlap EFH for all life stages of the Kona crab and deepwater shrimp.

4.4.7.4 Hawaiʻi Coral Reef Ecosystem Component Species

In 2019, NMFS reclassified the coral reef ecosystem MUS in Hawaiʻi as the Hawaiʻi coral reef ECS (Federal Register, 2019). ECS are defined as not requiring conservation and management and are not managed using annual catch limits. Management measures for ECS may include requirements to, for example, collect data, minimize bycatch or bycatch mortality, protect the associated role of ECS in the ecosystem, and/or address other ecosystem issues.

4.4.7.5 Habitat Areas of Particular Concern

There are no HAPCs established for JBPHH.

4.4.8 Marine Protected Species

Marine protected species are defined as federally-listed, proposed, or candidate species under ESA, listed as endangered or threatened by the State of Hawaiʻi, marine mammals protected under the MMPA, or those species designated as SOH's Species of Greatest Conservation Need (SGCN). Fourteen federally ESA-listed marine species are known to occur or potentially occur within the marine waters/submerged lands of Pearl Harbor and the Nearshore Training Areas. Many of these federally-listed species are also SOH-listed. An additional 29 SGCN species are known to occur or potentially occur within the marine waters/submerged lands of Pearl Harbor and the Nearshore Training Areas (Table 4-15). Federally-listed species that have been confirmed within Pearl Harbor are described in more detail below. Other species listed in the table below are not given detailed discussion due to either their rarity or they have not been confirmed present.

Table 4-15 Federally- and SOH-listed Marine Species with Potential to Occur at Pearl Harbor and Nearshore Training Areas

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence***
Marine Mammal Species				
Balaenoptera borealis	Sei Whale	-	FE, SGCN	Within 5 miles nearshore waters
Balaenoptera musculus	Blue Whale	Koholā Polū	FE, SGCN	Within 5 miles nearshore waters
Balaenoptera physalus	Fin Whale	-	FE, SE, SGCN	Within 5 miles nearshore waters
Megaptera novaeangliae	Humpback Whale	koholā	SE, SGCN, MMPA	Confirmed
Neomonachus schauinslandi	Hawaiian Monk Seal	Īlioholoikauaua	FE, SE, SGCN, MMPA	Confirmed
Physeter macrocephalus	Sperm Whale	Palaoa, Koholā Kēpama	FE, SE, SGCN, MMPA	Within 5 miles nearshore waters
Pseudorca crassidens	Main Hawaiian Islands Insular False Killer Whale DPS	-	FE, SE, SGCN	Confirmed
Stenella longirostris	Spinner Dolphin	Naia	SGCN, MMPA	Confirmed in nearshore waters
Reptilian Species				
Caretta caretta	Loggerhead Turtle (North Pacific DPS)	-	FE, ST	Within 5 miles nearshore waters
Chelonia mydas	Green Sea Turtle (Central North Pacific DPS)	Honu	FT, ST	Confirmed
Dermochelys coriacea	Leatherback Turtle	-	FE	Within 5 miles nearshore waters
Eretmochelys imbricata	Hawksbill Turtle	Honuʻea	FE, SE	Confirmed
Lepidochelys olivacea	Olive Ridley Turtle	-	FT, ST	Within 5 miles nearshore waters
Fish Species				
Atherinomorus insularum	Hawaiian Silverside	ʻIao	SGCN	Confirmed
Caranx ignobilis	Giant Trevally	ʻUlua Aukea	SGCN	Confirmed (K. Perez, personal communication, 2022)
Carcharhinus longimanus	Oceanic Whitetip Shark	-	FT	Within 5 miles nearshore waters
Chlorurus perspicillatus	Spectacled Parrotfish	Uhu Uliuli, Uhu ʻAhuʻula	SGCN	Confirmed

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence***
Coris venusta	Elegant Coris	Hinālea	SGCN	Confirmed
Elops hawaiensis	Hawaiian Tenpounder	Awaʻaua	SGCN	Confirmed
Encrasicholina purpurea	Hawaiian Anchovy	Nehu	SGCN	Confirmed
Hippocampus kuda	Smooth Seahorse	-	SGCN	Confirmed
Kuhlia xenura	Hawaiian Flagtail	Āholehole	SGCN	Confirmed
Manta birostris	Giant Manta Ray	Hāhālua	FT	Within 5 miles nearshore waters
Oxyurichthys lonchotus	Goby	Oʻopu	SGCN	Confirmed
Parupeneus porphyreus	Whitesaddle Goatfish	Kūmū	SGCN	Confirmed
Coral Species				
Cyphastrea ocellina	Ocellated Coral	ʻĀkoʻakoʻa	SGCN	Confirmed
Leptastrea bewickensis	Crust coral	Ākoʻakoʻa	SGCN	Within 5 miles nearshore waters
Leptastrea purpurea	Crust Coral	Koʻa, ʻĀkoʻakoʻa	SGCN	Confirmed
Leptoseris incrustans	Swelling Coral	Koʻa, ʻĀkoʻakoʻa	SGCN	Confirmed
Montipora capitata	Rice Coral	Koʻa, ʻĀkoʻakoʻa	SGCN	Confirmed
Montipora dilatata	Purple Rice Coral	Ākoʻakoʻa	SGCN, RT	Confirmed
Montipora flabellata	Blue Rice Coral	Koʻa, ʻĀkoʻakoʻa	SGCN, RT	Confirmed
Montipora patula	Spreading Coral	Ākoʻakoʻa	SGCN	Confirmed
Montipora tuberculosa	Pore Coral	Ākoʻakoʻa	SGCN	Within 5 miles nearshore waters
Montipora turgescens	Pore Coral	Ākoʻakoʻa	SGCN, RT	Confirmed
Montipora verrilli	Pore Coral	Ākoʻakoʻa	SGCN	Within 5 miles nearshore waters
Coral Species (continued)				
Pavona duerdeni	Flat Lobe Coral	Ākoʻakoʻa	SGCN	Confirmed
Pavona varians	Corrugated Coral	Ākoʻakoʻa	SGCN	Confirmed
Pocillopora damicornis	Lace Coral	Koʻa, ʻĀkoʻakoʻa	SGCN	Confirmed
Pocillopora ligulata	Hawaiian Cauliflower Coral	Ākoʻakoʻa	SGCN	Within 5 miles nearshore waters
Pocillopora meandrina	Cauliflower Coral	-	SGCN, RT	Confirmed
Pocillopora verrucosa	Warty Bushcoral	-	SGCN	Confirmed

Scientific Name	Common Name	Hawaiian Name	Regulatory Status*	Study Area Occurrence**
Porites compressa	Finger Coral	Pōhaku puna, ʻĀkoʻakoʻa	SGCN	Confirmed
Porites evermanni	Evermann's Coral	Pōhaku puna, ʻĀkoʻakoʻa	SGCN	Confirmed
Porites lobata	Lobe Coral	Pōhaku puna, ʻĀkoʻakoʻa	SGCN	Confirmed
Psammocora nierstraszi	-	-	SGCN	Within 5 miles nearshore waters
Non-Coral Invertebrates				
Nerita picea	Black Nerite	Pipipi Kai	SGCN	Confirmed
Octopus cyanea	Octopus	Heʻe Mauli	SGCN	Within 5 miles nearshore waters
Pinctada margaritifera	Black-lipped Pearl Oyster	-	SGCN	Confirmed
Flora				
Halophila hawaiiana	Hawaiian Seagrass	-	SGCN	Within 5 miles nearshore waters

Notes: DPS = distinct population segment; FE = federally-listed endangered; FT = federally-listed threatened; MMPA = Marine Mammal Protection Act; SE = state-listed endangered; SGCN = State of Hawaiʻi Species of Greatest Conservation Need; ST = state-listed threatened; - = not available.
*Definitions provided in Appendix I. **Definitions of Study Area Occurrence terms are provided in Appendix J-4.

4.4.8.1 Flora

No federally- or SOH-listed marine flora species have been observed within Pearl Harbor or the Nearshore Training Areas. Only one aquatic SGCN plant species, Hawaiian seagrass, has been observed within Pearl Harbor and the Nearshore Training Areas (see Section 4.4.4, *Marine Flora*, Table 4-15).

4.4.8.2 Corals

There are no federally-listed corals in Hawaii. Sixteen coral species found within Pearl Harbor are considered SGCN and 21 SGCN coral species are found within the open ocean areas of the Nearshore Training Areas (see Table 4-15).

4.4.8.3 Non-Coral Invertebrates

No federally- or SOH-listed non-coral invertebrate species have been observed within Pearl Harbor or the Nearshore Training Areas. Three non-coral invertebrate species found within Pearl Harbor or the Nearshore Training Areas are considered SGCN (see Table 4-15). These species include the black nerite, octopus, and the black-lipped pearl oyster (*Pinctada margaritifera*).

4.4.8.4 Fishes

Of the species of fish that have been observed in Pearl Harbor and the Nearshore Training Areas, none are federally- or SOH-listed, and four are SGCN species. These SGCN species include the giant trevally, the Hawaiian anchovy, Hawaiian flagtail, and the goby. The giant manta ray and the oceanic whitetip shark are federally threatened fish species that occur within the open ocean areas of the Nearshore Training Areas and have the potential to occur but have not been observed within Pearl Harbor.

Giant Manta Ray

Giant manta rays are visitors to productive coastlines with regular upwelling, including oceanic island shores, and offshore pinnacles and seamounts. They utilize sandy bottom habitat and seagrass beds, as well as shallow reefs, and the ocean surface both inshore and offshore. The species ranges globally and is distributed in tropical, subtropical, and temperate waters. They migrate seasonally usually more than 621.4 miles (1,000 km); however, not likely across ocean basins (NOAA, 2016). Giant manta rays are found throughout the Hawaiian Islands, but large aggregations are known to occur along the Kona coast off the Big Island of Hawaiʻi, with hundreds of individuals participating in the aggregation (Defenders of Wildlife, 2015). These aggregations are likely timed to peak seasonal abundances of prey such as zooplankton.

Most estimates of subpopulations are based on anecdotal observations by divers and fishermen, with current numbers estimated between 100 and 1,500 individuals (Miller and Klimovich, 2016). In general, giant manta ray populations have declined, except in areas where they are specifically protected, such as the Hawaiian Islands (NOAA, 2016).

Threats to giant manta rays include fisheries bycatch from commercial and artisanal fisheries as well as targeted fishing for the gillraker trade. Other potential threats include degradation of coral reefs, interaction with marine debris, marine pollution, and boat strikes (Food and Agriculture Organization of the United Nations, 2013).

Oceanic Whitetip Shark

Oceanic whitetip sharks are found worldwide in warm tropical and subtropical waters between the 30° North and 35° South latitude near the surface of the water column (Young et al., 2017). Oceanic whitetips occur throughout the Central Pacific, including the Hawaiian Islands south to Samoa Islands, and in the eastern Pacific from southern California to Peru, including the Gulf of California. This species has a clear preference for open ocean waters, with abundances decreasing with greater proximity to continental shelves. Preferring warm waters near or over 68°F (20°C), and offshore areas, the oceanic whitetip shark is known to undertake seasonal movements to higher latitudes in the summer (NOAA, 2016) and may regularly survey extreme environments (deep depths, low temperatures) as a foraging strategy (Young et al., 2017).

Threats include pelagic longline, purse seine, and gillnet fisheries bycatch (Baum et al., 2015; Defenders of Wildlife, 2015). Although there is no targeted fisheries for oceanic whitetip sharks, legal and illegal fishing activities have caused significant population declines for the oceanic whitetip shark. They have a high encounter and mortality rate caught as bycatch in tuna and swordfish longlines and the high-value fins create incentive for finning for the international shark fin trade (Young et al., 2017).

4.4.8.5 Sea Turtles

The USFWS and NMFS share federal jurisdiction for sea turtles. The USFWS is responsible for the conservation actions on land such as at nesting and basking beaches, and NMFS is responsible for conservation in the marine environment. Two sea turtle species have been documented in Pearl Harbor and the Nearshore Training Areas, the federally threatened green sea turtle (*Chelonia mydas)* and the federally endangered hawksbill turtle (*Eretmochelys imbricata*). Three other species of sea turtles have the potential to occur but have not been observed within Pearl Harbor or the Nearshore Training Areas. These include the loggerhead turtle (*Caretta caretta*), the Olive Ridley turtle (*Lepidochelys olivacea),* and the leatherback turtle *(Dermochelys coriacea).* No critical habitat has been established for sea turtles within Pearl Harbor.

Green Sea Turtles

Green sea turtles from the Central North Pacific distinct population segment (DPS) are found throughout Pearl Harbor and the Nearshore Training Areas (NAVFAC PAC, 2020b). The majority of reproductive females and males migrate to the isolated Northwest Hawaiian Islands for seasonal breeding, where more than 96 percent of the nesting occurs (Seminoff et al., 2015). A small percentage breed and nest in the Main Hawaiian Islands. Nesting areas are critical to the survival of the species. Nesting occurs on sandy beaches above the high tide mark; upon hatching, hatchlings enter the ocean where they presumably take up a pelagic existence until attaining a carapace length of about 12 inches (30 cm). At this size, young green sea turtles take up residence in nearshore waters around the Main Hawaiian Islands. Approximately 200–500 female green sea turtles nest annually in Northwest Hawaiian Islands. The NMFS sea turtle stranding database comprises 5,231 records that were collected from Oʻahu between 1975 and 2016, and from this database, all but 79 records were green sea turtles (NOAA Pacific Islands Fisheries Science Center [PIFSC], 2017). The DON biologists regularly survey the beach along Iroquois Point during sea turtle nesting season and have not observed any nesting activity (RCUH, 2021).

Seagrass (*Halophila decipiens* and *H. hawaiiana*) and macroalgae (McDermid et al., 2007) as well as proteinaceous invertebrates such as sponges, shrimps, tunicates, and echinoderms (Russell et al., 2011) make up the diet of the green sea turtle. Seagrass has been documented in Pearl Harbor from the Main Channel to Middle Loch (NAVFAC PAC, 2018d, 2020f).

Past surveys have indicated that sea turtles were more common in certain areas, especially around the harbor entrance, the Main Channel, and the channel of West Loch (Figures 4-13 through 4-18). During the November 2013–December 2014 shore station survey, there were 168 distinct sightings of green sea turtles and 36 distinct sightings of unidentified sea turtles. There were 31 distinct sightings of green sea turtles, and no distinct sightings of unidentified turtles during the September 2015 and November 2015 surveys. There were 74 distinct sightings of green sea turtles and 23 distinct sightings of unidentified sea turtles during the November 2013–December 2014 boat surveys. It is probable that the unidentified sea turtles were green sea turtles, but a positive identification could not be made, usually due to a brief or distant sighting. Sea turtles were recorded during every survey except one, implying that there is a year-round presence and that there may be seasonal occurrence peaks in the winter and a lull in the spring. The shore survey stations south of Iroquois Point, Hickam Harbor, and the southwest end of Ford Island had more sightings across a year of sampling than all of the other stations (NAVFAC HI, 2016).

Studies were conducted to investigate potential turtle resting habitat within Pearl Harbor (Applied Research Laboratory, 2021). These resting habitats (hereafter referred to as “caves”) are primarily found in undercut indentations at the base of the vertical limestone fossil reef walls that were dredged to create Pearl Harbor channels and inlets. Turtles appear to use these caves as resting areas. Turtle caves are differentiated from other undercut areas by the presence of freshly abraded surfaces on the walls and sides of the caves, as well as the presence of white sand or gravel on the floor and are distributed around Pearl Harbor on both sides of the channel. Recent surveys of turtle resting areas at Pearl Harbor Naval Shipyard and Intermediate Maintenance Facility (PHNSY & IMF), South Ford Island, and Waipio Point concluded that resting areas within PHNSY & IMF were used infrequently. Use of resting areas located at South Ford Island were not significantly different from PHNSY & IMF. Turtle resting areas at Waipio Point recorded more frequent use and during day and nighttime observations (Applied Research Laboratory, 2021).

Figure 3.11-20 through Figure 3.11-23 in the PHNSY & IMF Dry Dock and Waterfront Production Facility EIS (DON, 2022) depict locations of green turtle sightings and potential turtle resting areas (e.g., caves, see EIS Figure 3.11-20) that were observed during focused surveys in 2020 and 2021 (NAVFAC PAC, 2021). A high density of these caves was found along dredge cut walls around Bulkhead 1461, at Nevada Point, and at Hospital Point. The Proposed Action described in this EIS, if implemented, would affect approximately 36 of these turtle resting areas (33 caves within the dredge footprint would be removed at PHNSY & IMF, and 3 caves would be temporarily impacted at Waipio Peninsula).

Turtles appear to use these caves as resting areas (Photo 4-10). Turtle caves are differentiated from other undercut areas by the presence of freshly abraded surfaces on the walls and sides of the caves, as well as the presence of white sand or gravel on the floor. Figures 4-13 through 4-18 show locations of green sea turtle sightings and potential turtle caves that were observed during SIOP surveys from 2019-2022 (NAVFAC PAC, 2022c). There were no new green sea turtle sightings during the 2022 SIOP survey. No individuals of the four other species (hawksbill, loggerhead, leatherback, and olive ridley) rarely found in Hawaiʻi were observed (NAVFAC PAC, 2022c).

Photo 4-10: Green sea turtle observed resting inside a cave at the base of a dredge cut wall in the Southeast Loch of Pearl Harbor.

The main threats to the species are disease, habitat degradation, fisheries bycatch, predation, human disturbance and activities, vessel strikes, marine debris, and climate change such as increased temperatures, SLR, ocean acidification, and increased storm frequency leading to erosion (DLNR, 2015a).

Hawksbill Turtle

Hawksbill turtles are most often found in shallow water around reefs, bays, and inlets. Nesting areas are critical to the survival of the species, which prefers areas with woody cover for nesting. In the Main Hawaiian Islands, there is a shortage of information on all aspects of hawksbill turtle life history, especially compared to the greater amount of information collected for green sea turtles. Approximately 200–500 female green sea turtles nest annually in Northwest Hawaiian Islands, while only an average of 14 female hawksbill turtles annually have been recorded since 1993 nesting in the Main Hawaiian Islands. There has been nesting documented on four of the Main Hawaiian Islands with the vast majority (86%) of nests occurring on the southern coast of Hawaiʻi island followed by Molokaʻi, Maui, and Kauaʻi (Gaos et al 2021). PIFSC turtle strandings data from 1984 to 2018 found 111 total hawksbill strandings compared to the approximately 9,700 green turtle strandings in the same 34-year period (Brunson et al., 2022).

Sea turtle survey dives have been conducted in Pearl Harbor and the Pearl Harbor Entrance Channel on a quarterly basis between 2000 and 2011. Of the 694 individual turtles that were counted during these in-water surveys, only one hawksbill turtle was identified positively near Āhua Reef (i.e., outside main entrance; NAVFAC PAC, 2018d). Additionally, during the 2013–2020 shore and vessel surveys in Pearl Harbor, no hawksbill turtles were recorded (NAVFAC HI, 2016; NAVFAC PAC, 2020h).

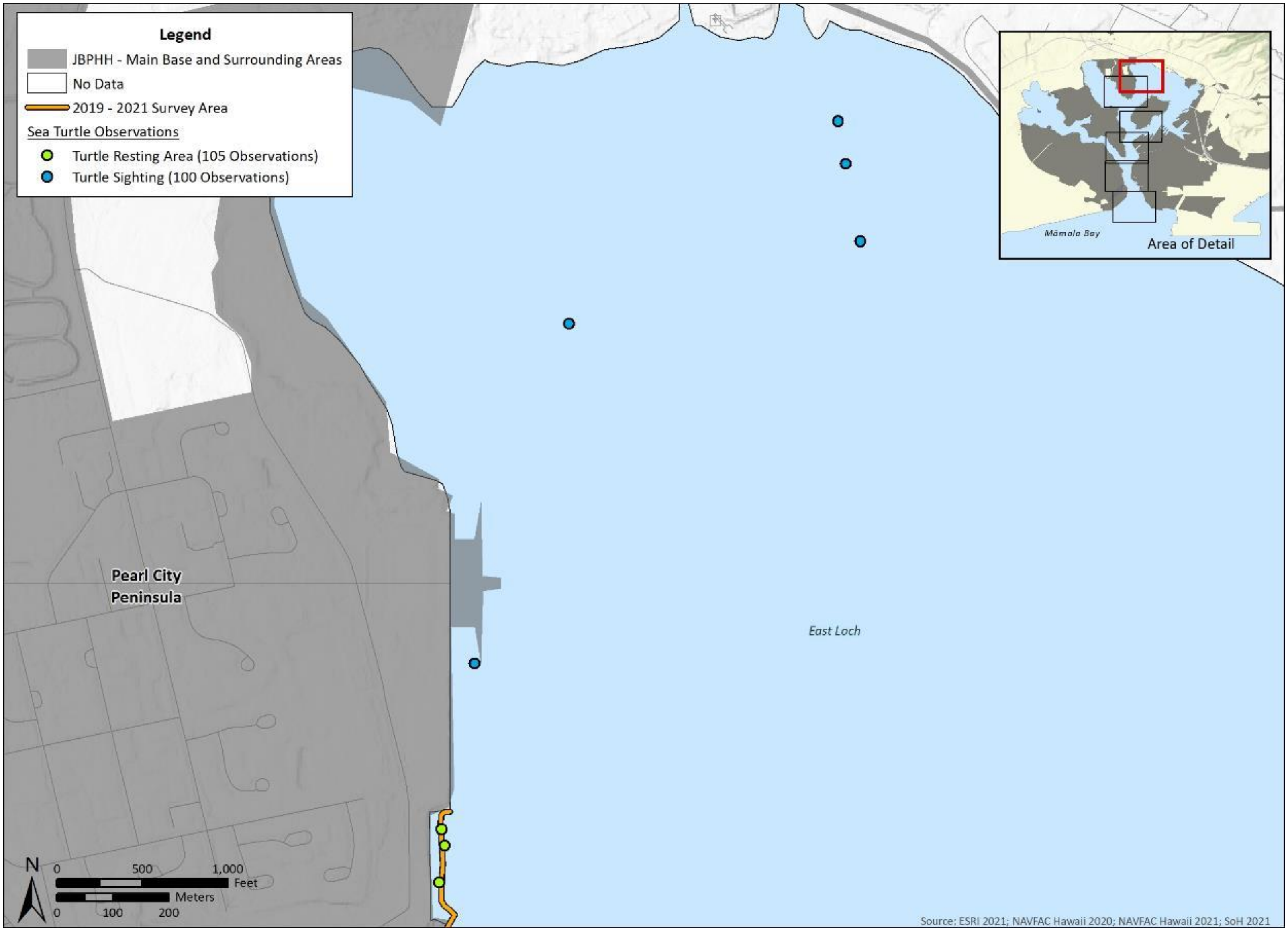


Figure 4-13 Green Sea Turtle Sightings and Resting Areas

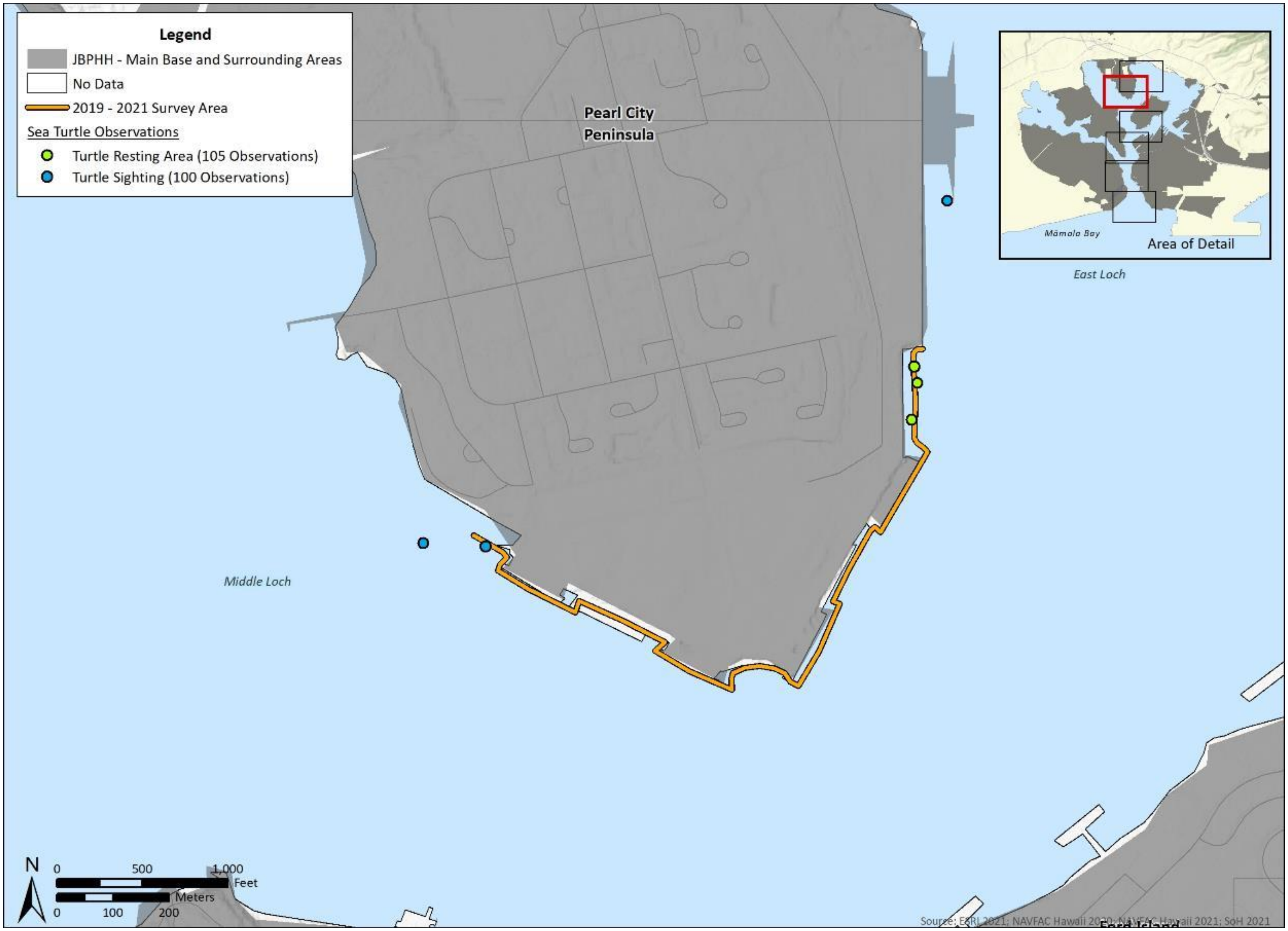


Figure 4-14 Green Sea Turtle Sightings and Resting Areas

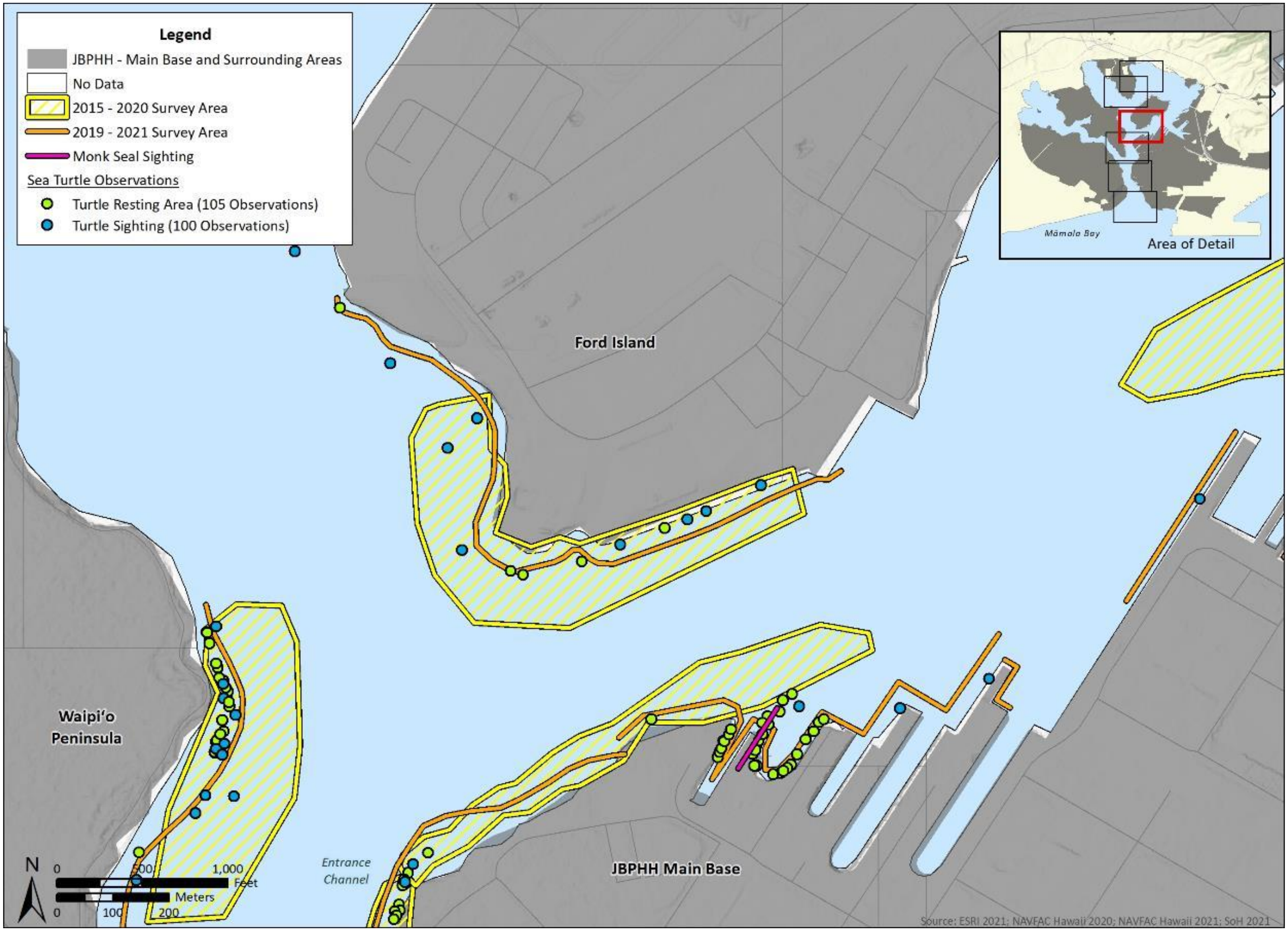


Figure 4-15 Green Sea Turtle Sightings and Resting Areas and Hawaiian Monk Seal Sighting Location

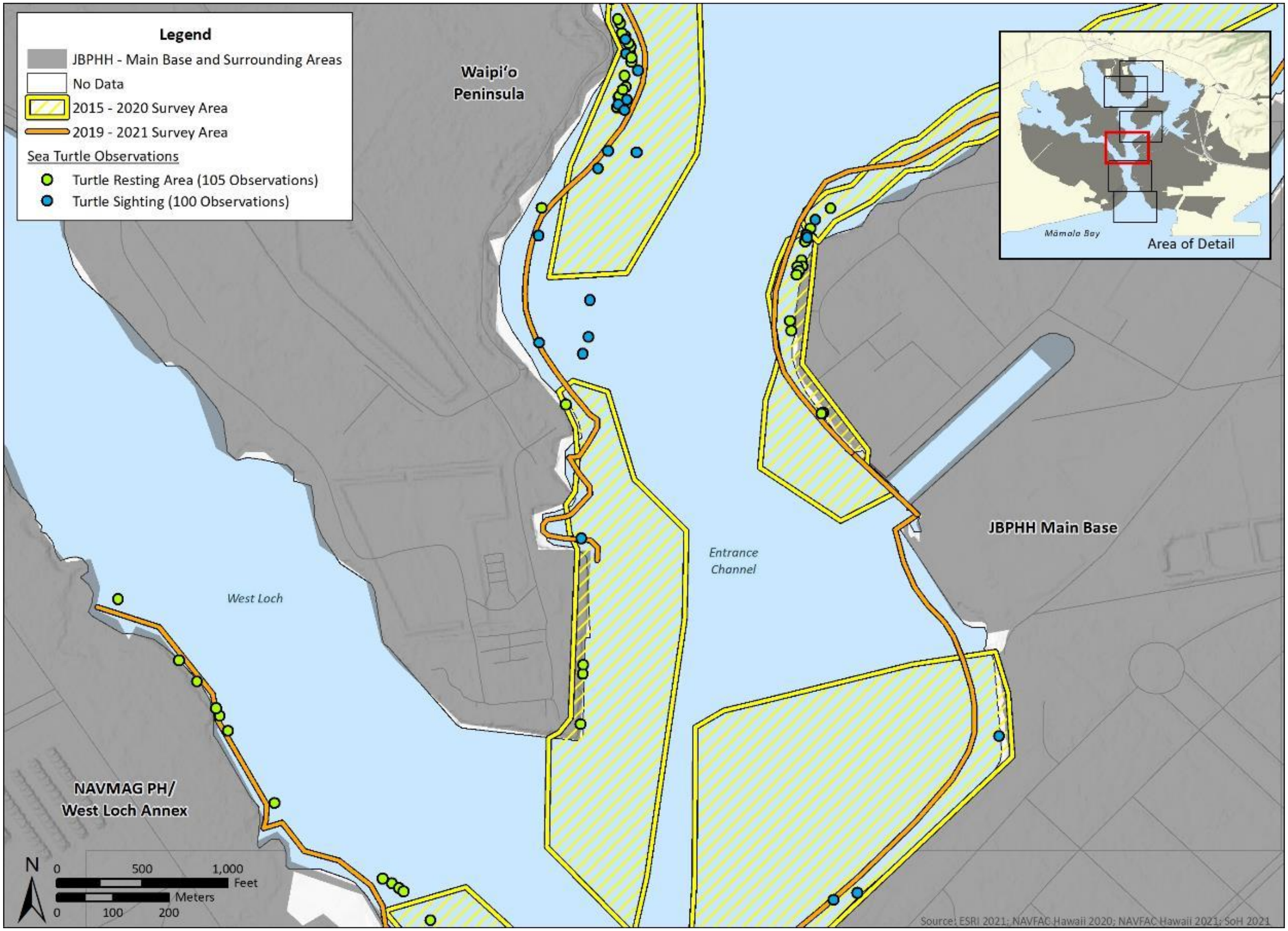


Figure 4-16 Green Sea Turtle Sightings and Resting Areas

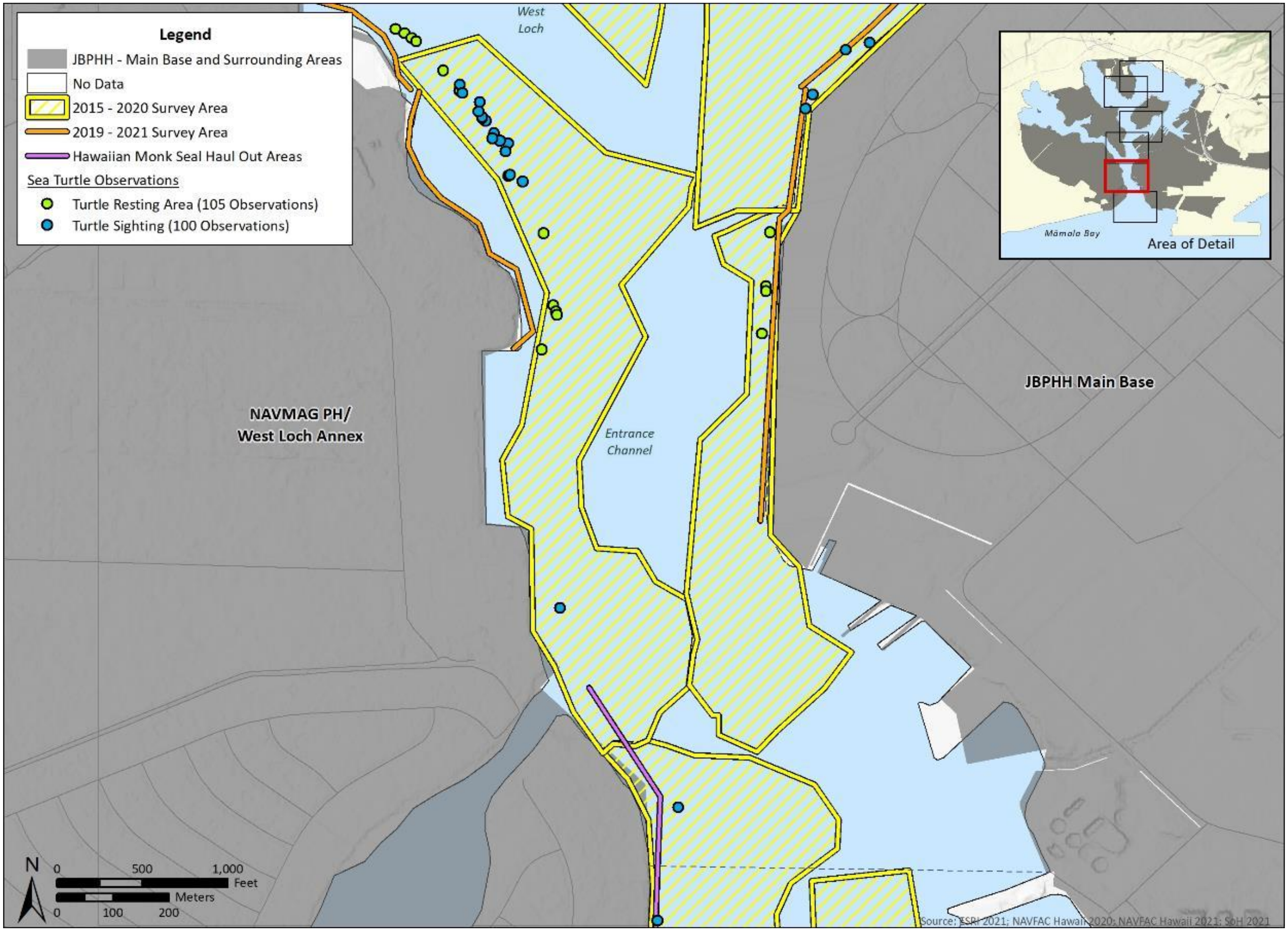


Figure 4-17 Green Sea Turtle Sightings and Resting Areas and Hawaiian Monk Seal Haul-out Locations

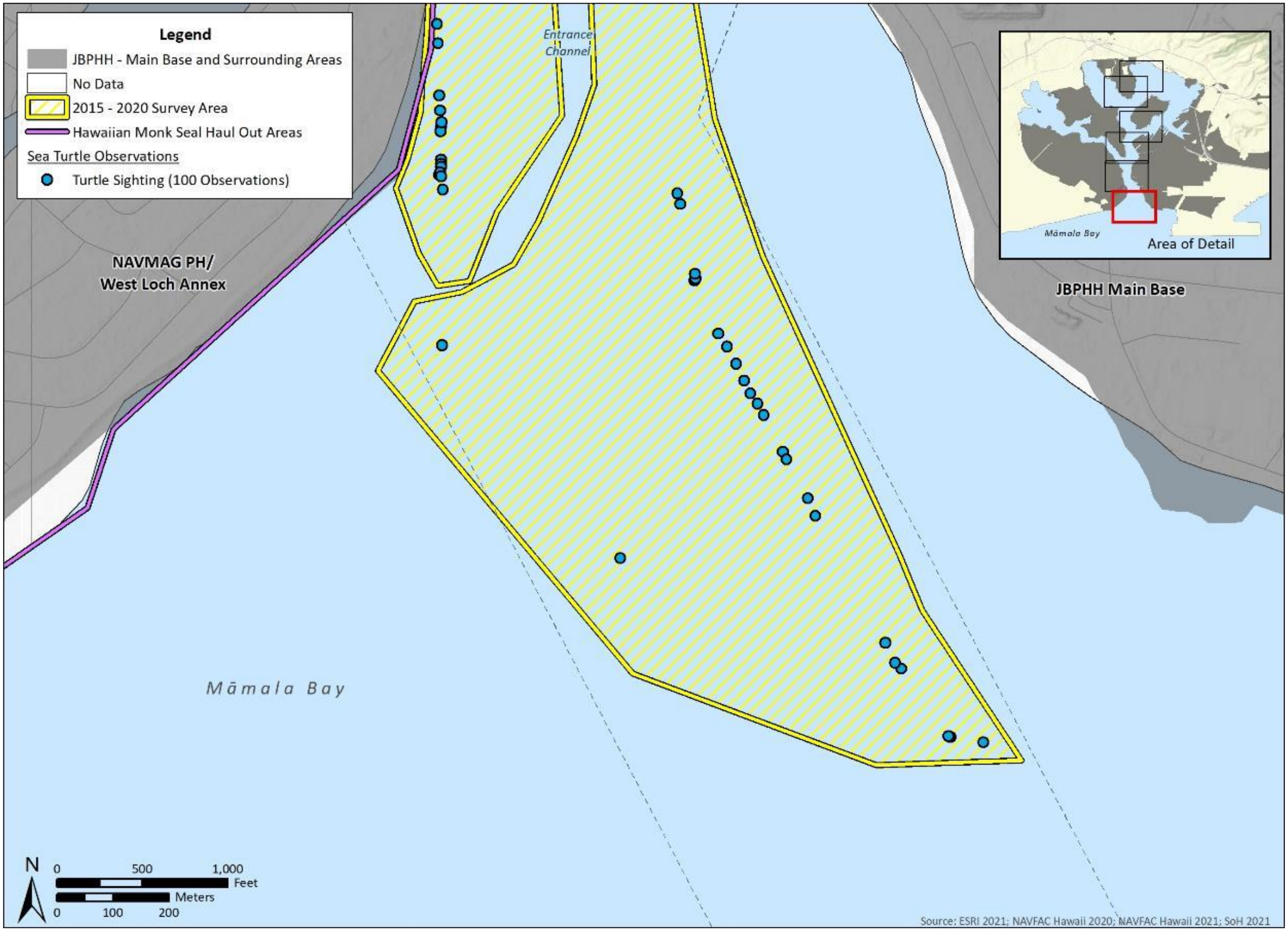


Figure 4-18 Green Sea Turtle Sightings and Resting Areas and Hawaiian Monk Seal Haul-out Locations

Outside of the surveys, there had been five documented sightings of hawksbill turtles in Pearl Harbor or the Pearl Harbor Entrance Channel. The first occurred on March 14, 2004 (Smith et al., 2006) near Bishop Point; the second sighting was on October 23, 2008 near Channel Marker Buoy No. 6 in the Pearl Harbor Entrance Channel; the third was a hawksbill turtle stranding at the Waiau Hawaiian Electric power plant on April 11, 2020; the fourth and fifth were spotted in April 2021 and November 2021, respectively, at the same location on Ford island dock near Essex Street (Nedved, personal communication, 2022).

The main threats to the global species populations are unsustainable harvest for their shells and the reduction of nesting beaches due to construction and human presence. Marine debris from active and ghost fishing lines and lay nets cause incidental take while pollutants and boat collisions may also be threats (DOFAW, 2005). In Hawaiʻi, interactions with nearshore fishing gear have been identified as the primary threat to population growth (Brunson et al., 2022).

Leatherback Turtles

Leatherback turtles are regularly sighted by fishermen in offshore waters surrounding the Hawaiian Islands, generally beyond the 3,800-foot (1,158-meter) depth contour, and especially at the southeastern end of the island chain and off the northern coast of Oʻahu. Leatherbacks encountered in these waters, including those caught accidentally in fishing operations, may be migrating through waters surrounding Hawaiʻi (NMFS and USFWS, 1998). Sightings and reported interactions with the Hawaiʻi longline fishery commonly occur around seamount habitats above the Northwestern Hawaiian Islands (from 35°North to 45°North and 175°West to 180°West) (Skillman and Balazs, 1992; Skillman and Kleiber, 1998).

The leatherback turtle occurs in offshore areas surrounding the Hawaiian Islands beyond the 328-foot (100-meter) isobath. Leatherbacks rarely occur inshore of this isobath. Incidental captures of leatherbacks have also occurred at several offshore locations around the Main Hawaiian Islands (McCracken, 2000). Although leatherback bycatches are common off the island chain, leatherback-stranding events on Hawaiian beaches are uncommon. Since 1982, only five leatherback strandings have been reported in the Hawaiian Islands. Aerial and shipboard surveys in nearshore Hawaiian waters also suggest that nearshore occurrences are extremely rare (NMFS and USFWS, 2013). Leatherbacks were not sighted during any of the NMFS shipboard surveys; their deep diving capabilities and long submergence times reduce the probability that observers could spot them during marine surveys. One leatherback turtle was observed along the Hawaiian shoreline during monitoring surveys in 2006 (NMFS and USFWS, 2013).

Both East and West DPS in the Pacific Ocean are faring poorly with a high risk of extinction. As of 2020, the index of Western Pacific DPS nesting females is 1,277 and the index of Eastern Pacific DPS is 755 nesting females (NOAA, 2020). Nesting populations have declined more than 80 percent since the 1980s, and because the threats to these subpopulations have not ceased, the International Union for Conservation of Nature has predicted a decline of 96 percent for the western Pacific subpopulation and a decline of nearly 100 percent for the eastern Pacific subpopulation by 2040 (Clark et al., 2010; NMFS, 2016; Sarti-Martinez et al., 1996).

In addition to the general threats to sea turtles described previously under green sea turtles, the primary threats to the Pacific leatherbacks are the legal and illegal harvest of leatherbacks and their eggs, and fisheries bycatch (NOAA, 2020). Although they are legally protected in nesting countries, these laws are often unenforced or ignored. Incidental capture in longline and coastal gillnet fisheries has caused a substantial number of leatherback turtle deaths, likely because leatherback turtles dive to depths targeted by longline fishermen and are less maneuverable than other sea turtle species (NMFS and USFWS, 2013). Additional threats include destruction of habitat, predation of eggs and hatchlings, vessel strikes, and pollution. Lastly, climate change may impact leatherback distribution because of changes in foraging resources like jellyfish, and reductions in hatching and nesting success (NOAA, 2020; Pike, 2014).

Loggerhead Turtles

The North Pacific Ocean DPS occurs within Hawaiʻi in habitats ranging from coastal estuaries to waters far beyond the continental shelf (Dodd, 1988). Loggerhead turtles are typically found in deeper, offshore waters when observed in Hawaiʻi. Loggerheads typically nest on beaches close to reef formations and in close proximity to warm currents (Dodd, 1988), preferring beaches facing the ocean or along narrow bays (NMFS and USFWS, 2007; Rice et al., 1984). No nesting by loggerhead turtles have been observed in Pearl Harbor.

Most of the loggerheads observed in the eastern North Pacific Ocean originate from beaches in Japan where the nesting season is late May to August. Migratory routes can be coastal or can involve crossing deep ocean waters (Schroeder et al., 2003). The species can be found hundreds of kilometers out to sea, as well as in inshore areas, such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers. Coral reefs, rocky areas, and shipwrecks are often used as feeding areas. The nearshore zone provides crucial foraging habitat, as well as habitat during nesting season and overwintering habitat.

The highest densities of loggerheads can be found just north of Hawaiʻi in the North Pacific Transition Zone (Polovina et al., 2000). The North Pacific Transition Zone is defined by convergence zones of high productivity that stretch across the entire northern Pacific Ocean from Japan to California (Polovina et al., 2004). Within this gyre, the Kuroshio Extension Bifurcation Region is an important habitat for juvenile loggerheads (Polovina et al., 2006). These turtles, whose oceanic phase lasts a decade or more, have been tracked swimming against the prevailing current, apparently to remain in the areas of highest productivity.

Loggerhead turtles have been listed as endangered in 2011 due to threats including fisheries bycatch, climate change, habitat loss, and overutilization. Although populations are increasing, it remains at risk of extinction (NOAA, 2020). Loggerhead bycatch in the Pacific occur in several fisheries including illegal, unreported, and unregulated fishing, U.S. longline fishing based in Hawaii, and international longline fisheries regulations that have significantly reduced bycatch and mortality in U.S. fisheries resulting in low impact on the North Pacific DPS but unquantified illegal, unreported, and unregulated fisheries likely pose the greatest threat to the DPS because they are not required to use any mitigation measures (NOAA, 2020).

Olive Ridley Turtles

Olive ridley turtles are found throughout much of the Pacific Ocean and are typically found in deeper, offshore waters when observed in Hawaiʻi. Their main nesting areas are located along Central America, Mexico, Western Pacific (Australia, Indonesia, and Philippines), and India. Rare instances of nesting occur in the Hawaiian Islands, with the first olive ridley nest documented in 1985 at Paia, Maui. There have been six documented nesting events throughout Hawaiʻi (USFWS, unpublished), but no nests or turtles have been observed in Pearl Harbor.

Studies from different populations of olive ridley turtles show a strong preference for neretic areas (shallow part of the sea near a coast and overlying the continental shelf) (Plot et al., 2015; Polovina et al., 2004); however, deep water foraging has been documented in the north Pacific, where prey items are scattered and less predictable and migrate widely from nesting locations (Polovina et al., 2004). Comparing olive ridley habitat use in different regions, Plot et al. (2015) suggest that the differing migration patterns observed (i.e., oceanic migrations versus neritic movements) may be attributed to specific environmental conditions of the areas in close proximity to nesting sites.

Besides the array of threats to sea turtles in general, most of the species-specific threats for olive ridleys are associated with nesting habitat loss and fishery interactions throughout their global range (NOAA, 2014). Lutcavage et al. (1997) note that impacts on nesting habitats for olive ridley turtles include construction of buildings and pilings, beach armoring and nourishment, and sand extraction. These activities have increased in many parts of the olive ridley's range and pose threats to major nesting sites in Central America as well as the Western Pacific (NMFS and USFWS, 2014).

4.4.8.6 Marine Mammals

All marine mammals are protected under the MMPA. Jurisdiction over marine mammals is maintained by NMFS and the USFWS. NMFS maintains jurisdiction over whales, dolphins, porpoises, seals, and sea lions. The USFWS maintains jurisdiction for certain other marine mammal species, including walruses, polar bears, dugongs, sea otters, and manatees. No critical habitat has been established for ESA-listed marine mammals in Pearl Harbor.

There is one federally-listed marine mammal that has been observed in Hawaiian waters at Pearl Harbor, the endangered Hawaiian monk seal or īlioholoikauaua *(Neomonachus schauinslandi*). The endangered humpback whale or koholā is not federally-listed in Hawaiʻi but is protected under the MMPA and has been seen on occasion in Pearl Harbor. One additional federally-listed species has been observed outside Pearl Harbor, within the Nearshore Training Areas, Main Hawaiian Islands insular false killer whale DPS. In addition, the spinner dolphin, a SGCN species, has also been observed within the Nearshore Training Areas.

Five additional federally endangered whale species have the potential to occur but have not been observed in Pearl Harbor or the Nearshore Training Areas. These include the sei whale (*Balaenoptera borealis*), fin whale (*Balaenoptera physalus)*, blue whale or koholā polū (*Balaenoptera musculus)*, and the sperm whale or koholā kēpama (*Physeter macrocephalus*).

Hawaiian Monk Seal

The Hawaiian monk seal is a pinniped, of the family Phocidae (Photo 4-11). Adult monk seals measure about 7 to 8 feet (2.1 to 2.4 meters) in length and weigh about 400 to 600 pounds (180 to 270 kilograms) (University of Hawaiʻi at Mānoa, 2021). Hawaiian monk seals can live up to 25 to 30 years (Marine Conservation Biology Institute, 2009). Mature Hawaiian monk seals are a silver or slate gray on their dorsal side and have a cream coloring on their stomach, chest, and throat. Between molts, their coats may fade to brown on their backs and to a yellowish tan on their fronts.

Photo 4-11: Hawaiian Monk Seal

Older seals may become darker in color as they age. All Hawaiian monk seals, except pups, undergo an annual catastrophic molt, shedding their coat and the outer layers of skin. Newborn pups of both sexes are black and weigh approximately 31 to 37.5 pounds (14 to 17 kilograms) (Kenyon and Rice 1959; Wirtz 1968). Some pups and adults have small white patches of pelage (fur) (NMFS, 2007). Pups shed their black coat at approximately 6 weeks. Following this first molt, the pups are silvery above with a creamy color below (NMFS, 2021).

There is a tendency for Hawaiian monk seals to frequent remote areas where human presence or access is limited. Most Hawaiian monk seals live in the Northwest Hawaiian Islands including the six main reproductive sites: Kure Atoll, Midway Islands, Pearl Hermes Reef, Lisianski Island, Laysan Island, and French Frigate Shoals. Smaller breeding subpopulations are also supported within the Northwest Hawaiian Islands on Necker Island (Mokumanamana) and Nihoa Island (NMFS, 2020a). Hawaiian monk seals travel to Maro Reef and Gardner Pinnacles and have occasionally been sighted on nearby island groups such as Johnston Atoll, Wake Island, and Palmyra Atoll (Rice, 1998). Sightings of Hawaiian monk seals on the Main Hawaiian Islands have increased considerably over the last 20 years (Baker and Johanos, 2004; Carretta et al., 2005; NMFS, 2021). Hawaiian monk seal observations reported from the Main Hawaiian Islands include at least 45 seals in 2000, 52 in 2001, 77 in 2005, 83 in 2006, and 153 in 2017. These numbers are likely below true abundance since they are based on non-systematic sightings of tagged and naturally marked seals (NMFS, 2007, 2020a).

Haul-out areas for pupping, nursing, and resting are primarily sandy beaches, but virtually all substrates, including emergent reef and shipwrecks, are used at various islands. Monk seals spend about two-thirds of their time in the water. They are primarily benthic foragers and will search for food in coral reef habitat and on substrate composed of talus (rock fragments) and sand on marine terraces of atolls and banks to depths exceeding 1,604 feet (500 meters). They have been observed feeding in reef caves that are also used for rest and for refuge from predators (NMFS, 2007).

The undeveloped portions of the coastline in Pearl Harbor provide resting and feeding habitat for the Hawaiian monk seal (NAVFAC PAC, 2011), and recent sightings have been documented (NAVFAC PAC, 2011; NAVFAC HI, 2016). At Pearl Harbor, Hawaiian monk seals enter occasionally but are sighted more commonly near the outer entrance channel and surrounding areas and on the fringes of the outer reef. It is common for Hawaiian monk seals to haul out along beaches at Iroquois Point (west of the entrance channel). From the NMFS PIFSC sightings database between 2003 and 2012, one Hawaiian monk seal was sighted in Pearl Harbor in 2005, 2007, and 2008, while 10 were sighted in 2009 (Wurth, 2013). Sightings of Hawaiian monk seals were documented within JBPHH between 2012 and 2018 (Johanos 2019). Figure 4-15 shows a location where a Hawaiian monk seal was observed onshore in 2008. Known haul-out locations for Hawaiian monk seal within the study area are shown in Figures 4-17 and 4-18. However, it is important to note that the public reported the majority of the NMFS Hawaiian monk seal sightings, which may be highly biased by location and reporting effort.

From 2013–2015, the NAVFAC PAC surveys did not record the presence of Hawaiian monk seals inside Pearl Harbor (NAVFAC HI, 2016). Pearl Harbor does not contain important or known foraging or resting habitats for Hawaiian monk seals. Furthermore, Pearl Harbor was exempt from (and thus does not overlap with) critical habitat designation for the Hawaiian monk seal (NMFS, 2015) (see Section 1.6.3.1, *Critical Habitat*, for further details). While Hawaiian monk seals are known to enter Pearl Harbor on occasion, they are considered rare. If Hawaiian monk seals are observed within Pearl Harbor, special protections and BMPs would be followed (see Section 4.5.1, *Protected Species and Ecosystem Monitoring and Management*).

Hawaiian monk seals are vulnerable to natural and anthropogenic factors that may affect their continued existence and recovery. The threats impacting Hawaiian monk seals have been assessed by the Hawaiian Monk Seal Recovery Team based on severity and magnitude, as well as the scope and geographic range. Crucial ongoing sources of mortality that are apparent at most sites in the Northwest Hawaiian Islands include food limitation, marine debris entanglement, and shark predation. Additional serious ongoing impact with potential for range-wide concern include disease, loss of terrestrial habitat due to environmental factors such as SLR and storms, fishery interactions from recreational fishing and gillnets, male aggression, and human interaction. Other localized impacts to Hawaiian monk seals that are not considered a serious concern at this time include biotoxins, contaminants, and vessel groundings. Detailed information on threats to Hawaiian monk seals are discussed in Appendix J-6, Table 1.

Humpback Whale

During the winter breeding season from December through April, the SOH-listed humpback whale is present in coastal waters of the Main Hawaiian Islands (primarily within water with depths of 985 feet [300 meters]). Humpback whales are known to occasionally enter Pearl Harbor. Most recently, in January 2019, a humpback whale and calf spent four days in Pearl Harbor traveling throughout the lochs (Photo 4-12). Observations of humpback whales within Pearl Harbor are documented in Table 4-16 and Appendix J-8.

Photo 4-12: Female humpback whale and calf in Pearl Harbor

Sei Whale

Sei whales have a worldwide distribution and are found primarily in cold temperate to subpolar latitudes. During the winter, sei whales are found in warm tropical waters like those around Hawaii. Although sei whales have been observed south of 20° North in the winter (Fulling et al., 2011; Horwood, 1987, 2009), they are considered absent or at very low densities in most equatorial areas. Sei whales have only been detected in the Hawaiian Islands on a few occasions. Sei whales were not sighted during aerial surveys conducted within 25 nautical miles of the Main Hawaiian Islands from 1993 to 1998 (Mobley et al., 2000). The first verified sei whale sighting made nearshore of the Main Hawaiian Islands occurred in 2007 (Smultea et al., 2007; Smultea et al., 2010) and included the first subadults seen in the Main Hawaiian Islands. The presence of these subadults was cited as evidence suggesting that the area north of the Main Hawaiian Islands may be part of a reproductive area for north Pacific sei whales (Smultea et al., 2010). A line-transect survey conducted in February 2009 by the Cetacean Research Program surrounding the Hawaiian Islands resulted in the sighting of three Bryde's/sei whales. An additional sighting occurred in 2010 off Perret Seamount (DON, 2011). On March 18, 2011 off Maui, the Hawaiian Islands Entanglement Response Network found a subadult sei whale entangled in rope and fishing gear (Bradford and Lyman, 2015; NMFS, 2011). An attempt to disentangle the whale was unsuccessful although a telemetry buoy attached to the entangled gear was reported to be tracking the whale over 21 days as it moved north and over 250 nautical miles from the Hawaiian Islands. In December 2014, a passive acoustic recording device onboard an unmanned glider located to the south of Oʻahu detected very short, low frequency downsweep vocalizations identified as potential sei whale calls and occurring occasionally during a period of approximately 2 weeks (Klinck et al., 2015).

Blue Whale

Blue whales inhabit all oceans and typically occur near the coast and over the continental shelf, though they are also found in oceanic waters, having been sighted, acoustically recorded, and satellite tagged in the eastern tropical Pacific (Ferguson, 2005; Stafford et al., 2004). Blue whales from the Central North Pacific stock are found in Hawaii, but the sighting frequency is low and the peak abundance is seasonal, occurring in the winter (Bradford et al., 2013). Whales feeding along the Aleutian Islands and in the Gulf of Alaska likely migrate to Hawaiʻi in winter (Stafford et al., 2001). In the winter of 2014–2015 (December to January), passive acoustic detections of blue whales were recorded intermittently over the 3-week period of the survey (Klinck et al., 2015).

Fin Whale

The fin whale is found in all the world's oceans and is the second largest species of whale (Jefferson et al., 2015). Fin whales prefer temperate and polar waters and are scarcely seen in warm, tropical waters (Reeves et al., 2002). Fin whales are found in Hawaiian waters (Carretta et al., 2010; Shallenberger, 1981). There are known sightings from Kauaʻi, Oʻahu, Hawaiʻi, and a single stranding record from Maui (Mobley et al., 1996; Shallenberger, 1981; DON, 2011). A single sighting was made during aerial surveys from 1993 to 1998, five sightings were made in offshore waters during a 2002 survey of waters within the Hawaiian Exclusive Economic Zone, and there were two fin whales sighted during a 2010 survey of the same area (Barlow, 2006; Bradford et al., 2017; Carretta et al., 2010; Mobley et al., 1996; Mobley et al., 2009). A single juvenile fin whale was reported off Kauaʻi during Navy-sponsored marine mammal research in 2010 (DON, 2011). Based on sighting data and acoustic recordings, fin whales are likely to occur in Hawaiian waters mainly in fall and winter (Barlow et al., 2004; Barlow, 2006; Barlow et al., 2008; Klinck et al., 2015).

North Pacific Right Whale

The North Pacific Right Whale is one of the rarest of all large whale species. There are no reliable estimates of current abundance or trends for right whales in the North Pacific. There are likely fewer than 500 North Pacific right whales remaining, and most sightings have been of single whales, though small groups have been sighted. Only about 30 individuals are estimated to remain of the Eastern stock that visits Alaskan waters (NOAA, 2022). Rare sightings of individual animals are typical of documented sightings, such as those of a single right whale on three occasions between March 25 and April 11, 1979 in Hawaiian waters (Herman et al., 1980; Rowntree et al., 1980). These individual North Pacific right whales sighted near the Hawaiian Islands are considered "vagrants" as this region is not within the typical current geographic range of this species (Reilly et al., 2008). Due to the rarity of the species, the threats to the species are unknown. However, potential threats included vessel strikes, entanglement, noise, harmful algal blooms, and climate change (NOAA, 2022).

False Killer Whale

The false killer whale is regularly found within Hawaiian waters and has been reported in groups of up to 100 over a wide range of depths and distance from shore (Baird et al., 2003; Baird et al., 2013; Bradford et al., 2012; Bradford et al., 2015; Bradford et al., 2017; Oleson et al., 2013; Shallenberger, 1981). The Main Hawaiian Islands insular false killer whale DPS is the only population protected under the ESA and is listed as endangered. The Main Hawaiian Islands insular stock boundary is a 45-mile (72-km) radius extending around the Main Hawaiian Islands, with the offshore extent of the radii connected on the leeward sides of Hawaiʻi Island and Niʻihau to encompass the offshore movements of Main Hawaiian

Islands insular stock animals within that region. The waters outside of 7 miles (11 km) from shore from Oʻahu to Hawaiʻi Island and out to the Main Hawaiian Islands insular stock boundary are an overlap zone between the Main Hawaiian Islands insular stock and Hawaiʻi pelagic stock. In the waters around Kauaʻi and Niʻihau there is also overlap between the Main Hawaiian Islands insular stock and the Northwestern Hawaiian Islands stock.

A year-round Small and Resident Population area for the Main Hawaiian Islands insular stock of false killer whales has been identified (Baird et al., 2015). Satellite tag locations from 22 individuals were mapped to grid cells. Those grid cells having a density greater than one standard deviation of the mean were considered "high-use areas" and a boundary drawn around them then constituted the identified Small and Resident Population area for the stock. NMFS used more recent unpublished data to identify high and low use areas for insular false killer whales, which was used in the designation of critical habitat (83 Federal Register 35062) 4(b)(2) report).

Figure 1-2 depicts the Main Hawaiian Islands insular false killer whale critical habitat within the vicinity of JBPHH. As discussed in Section 1.6.3.1, *Critical Habitat*, NMFS found that all areas covered in the JBPHH INRMP (including the Naval Defensive Sea Area and the Ewa Training Minefield) were ineligible for critical habitat destination (83 Federal Register 35062; 50 CFR 224; 50 CFR 226). The Navy Shipboard Electronic Systems Evaluation Facility was provided an exclusion from critical habitat designation due to National Security under section 4(b)(2) of the ESA.

Sperm Whale

Primarily, this species is found in the temperate and tropical waters of the Pacific (Rice, 1989). Their secondary range includes areas of higher latitudes in the northern Pacific, including Alaska (Jefferson et al., 2015; Whitehead and Weilgart, 2000; Whitehead et al., 2008; Whitehead et al., 2009). This species appear to have a preference for deep waters (Baird, 2013; Jefferson et al., 2015). Typically, sperm whale concentrations correlate with areas of high productivity. These areas are generally near drop offs and areas with strong currents and steep topography (Gannier and Praca, 2007; Jefferson et al., 2015).

Sperm whales occur in Hawaiian waters and are one of the more abundant large whales found in that region (Baird et al., 2003; Barlow, 2006; Bradford et al., 2017; Mobley et al., 2000). A total of 21 sperm whale sightings were made during a summer/fall 2002 shipboard survey of waters within the U.S. Exclusive Economic Zone of the Hawaiian Islands, although only four of these sightings were around the main Hawaiian Islands (Barlow, 2006). During a follow-up survey conducted in 2010, there were 41 sperm whale sightings, mainly concentrated in the northwestern portion of the U.S. Exclusive Economic Zone of the Hawaiian Islands (Bradford et al., 2017). Based on predictive habitat-based density models derived from line-transect survey data collected between 1997 and 2012 within the central North Pacific, relatively high densities of sperm whales are predicted within the U.S. Exclusive Economic Zone of the Hawaiian Islands during the summer and fall, particularly in the northwest (Forney et al., 2015). In 2015, acoustic detections of sperm whales occurred over the abyssal plain to the south of Oʻahu and did not seem to be related to bathymetric features such as seamounts (Klinck et al., 2015).

Other Marine Mammals

The SGCN-listed spinner dolphin occurs regularly offshore, but they are rare within Pearl Harbor and Nearshore Training Areas (NAVFAC PAC, 2016). Table 4-16 provides the record of marine mammal sightings in Pearl Harbor from 1998–2020 (NAVFAC HI, 2016; NMFS PIFSC, 2018; Johanos, 2019).

Appendix J-8 provides information on live sightings and observations of marine mammals within Pearl Harbor.

Table 4-16 Marine Mammal Sightings in Pearl Harbor from 1998–2020

Species	***Year***	***Sightings Location and Number***
Hawaiian monk seal *(Neomonachus schauinslandi)*	2004	100 feet off Hickam O'Club – 1
	2005	Iroquois Point – 1
	2007	Iroquois Point – 1
	2012	Iroquois Point -41
	2013	Iroquois Point – 15 Hickam Air Force Base – 1
	2014	Iroquois Point – 7
	2015	Iroquois Point – 4 Pearl Harbor – 1
	2016	Iroquois Point – 24 Pearl Harbor – 1
	2017	Iroquois Point – 14
	2018	Iroquois Point – 44 Hickam Air Force Base – 3 Pearl Harbor – 1
	2019	Iroquois Point – 27 Pearl Harbor – 1
Humpback whale *(Megaptera novaeangliae)*	2019	Pearl Harbor Entrance Channel near Buoys 7 & 8 , Near Dry Dock 4, North Side of Ford Island to Rainbow Bay Marina – cow and calf
	2020	Entrance to Middle Loch – cow and calf
Striped dolphin (*Stenella coeruleoalba*) (1)	2004	Vicinity of Pearl Harbor – 1 (Stranding)
Pygmy sperm whale *(Kogia breviceps)* (1)	2014	Vicinity of Pearl Harbor – 1 (Dead, floating)
Unidentified cetaceans	2001	Outside of Pearl Harbor (Buoys 1 & 2) – 1
	2009	Outside of Pearl Harbor (Buoys 1 & 2) – 4

Notes: (1) Pelagic species such as the striped dolphin and pygmy sperm whale most likely drifted from elsewhere into Pearl Harbor.
NOAA = National Oceanic and Atmospheric Administration.
Source: NAVFAC PAC, 2016, NMFS PIFSC 2018; Johanos, 2019

4.4.9 Marine Non-native and Nuisance Species

A complete list of all marine non-native and nuisance species known to occur in the study area can be found in Appendix J-7. Figures 4-19 through 4-33 represent non-native species observed during recent focused surveys conducted in Pearl Harbor (NAVFAC PAC, 2020c,d,g,h, 2021a,b, 2022a,b,c). However, these figures do not represent all locations of non-native species as not all areas have been surveyed.

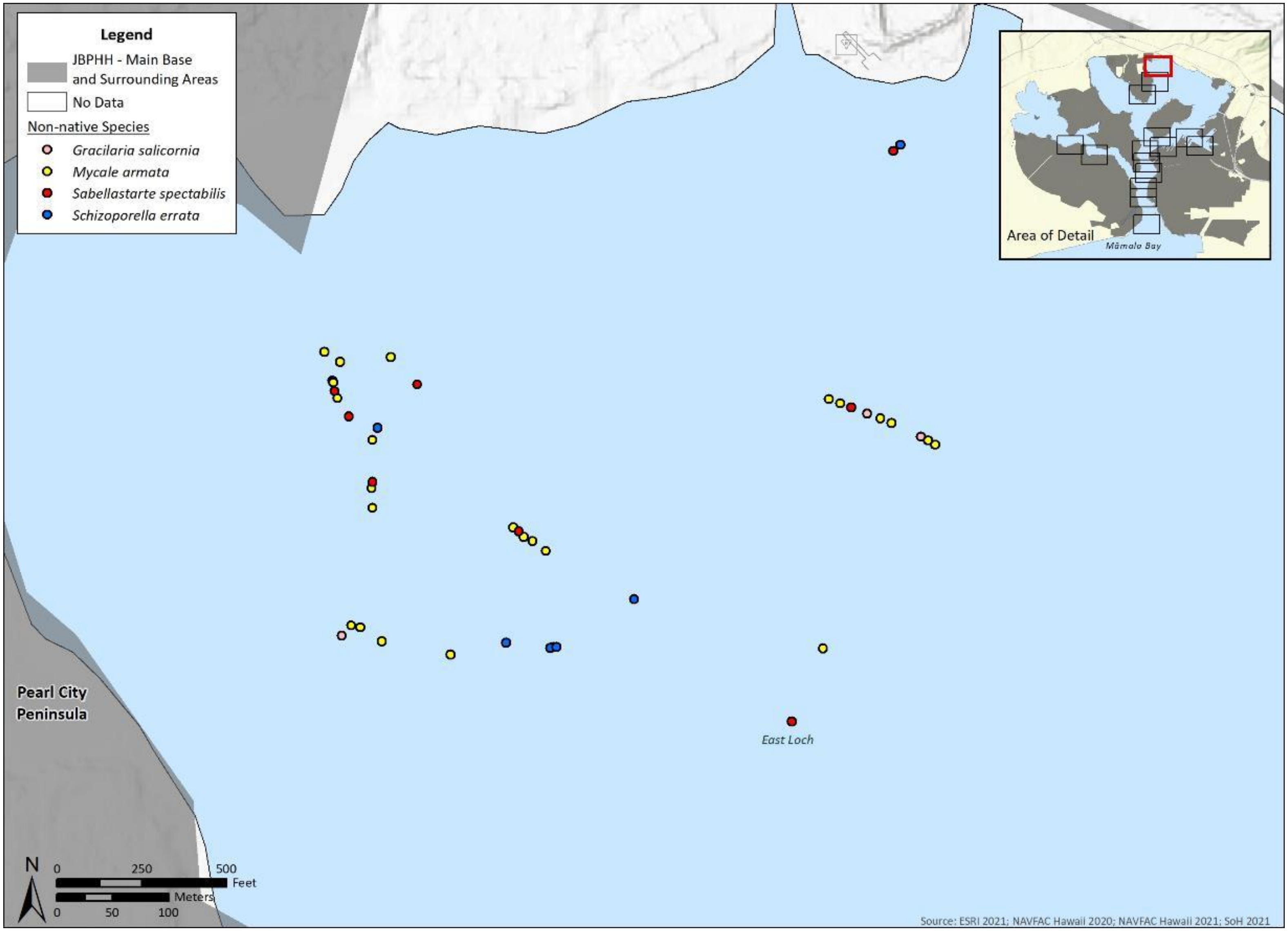


Figure 4-19 Non-native Species Observed in Pearl Harbor (2015–2022)

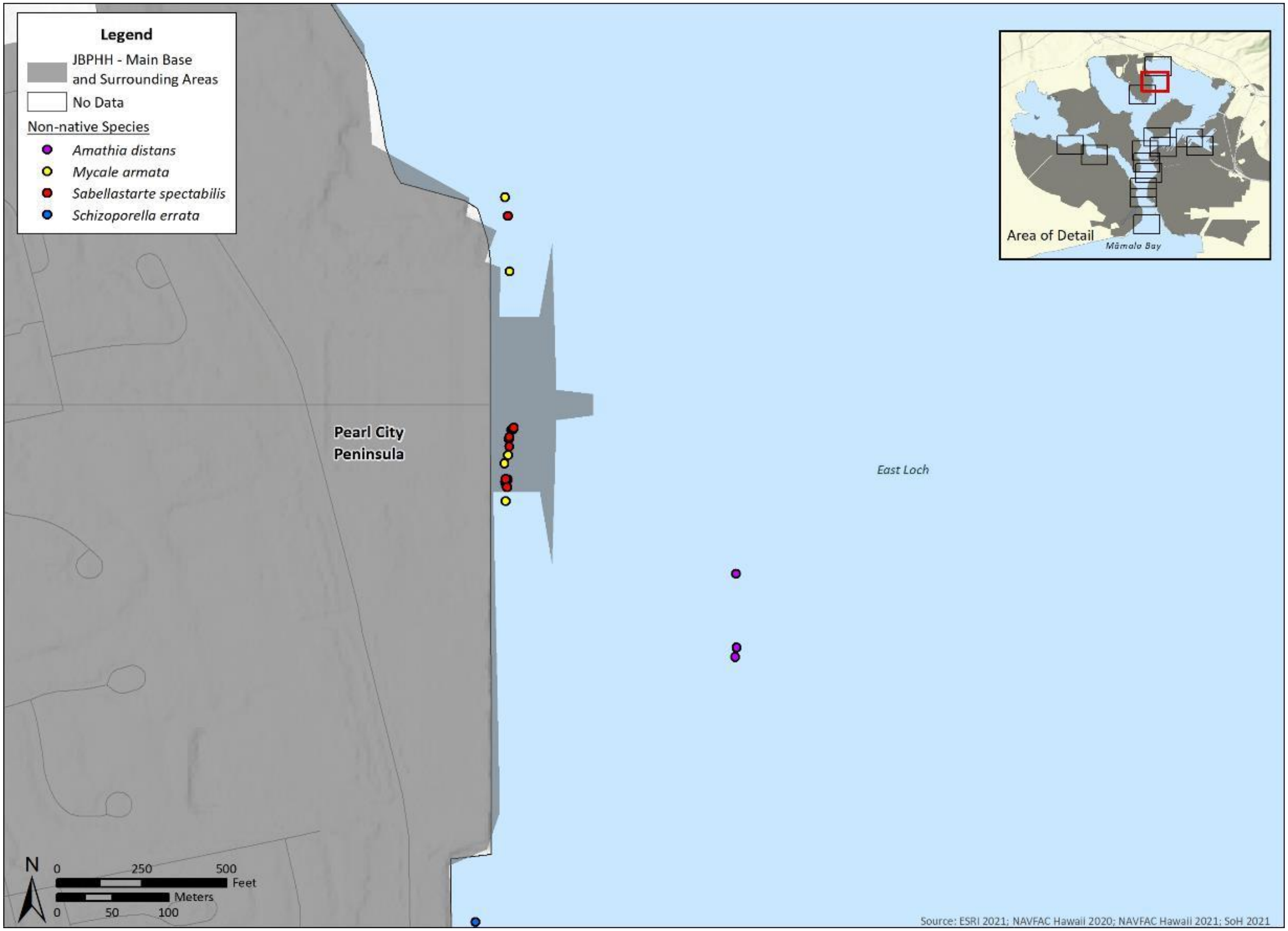


Figure 4-20 Non-native Species Observed in Pearl Harbor (2015–2022)

Figure 4-21 Non-native Species Observed in Pearl Harbor (2015–2022)

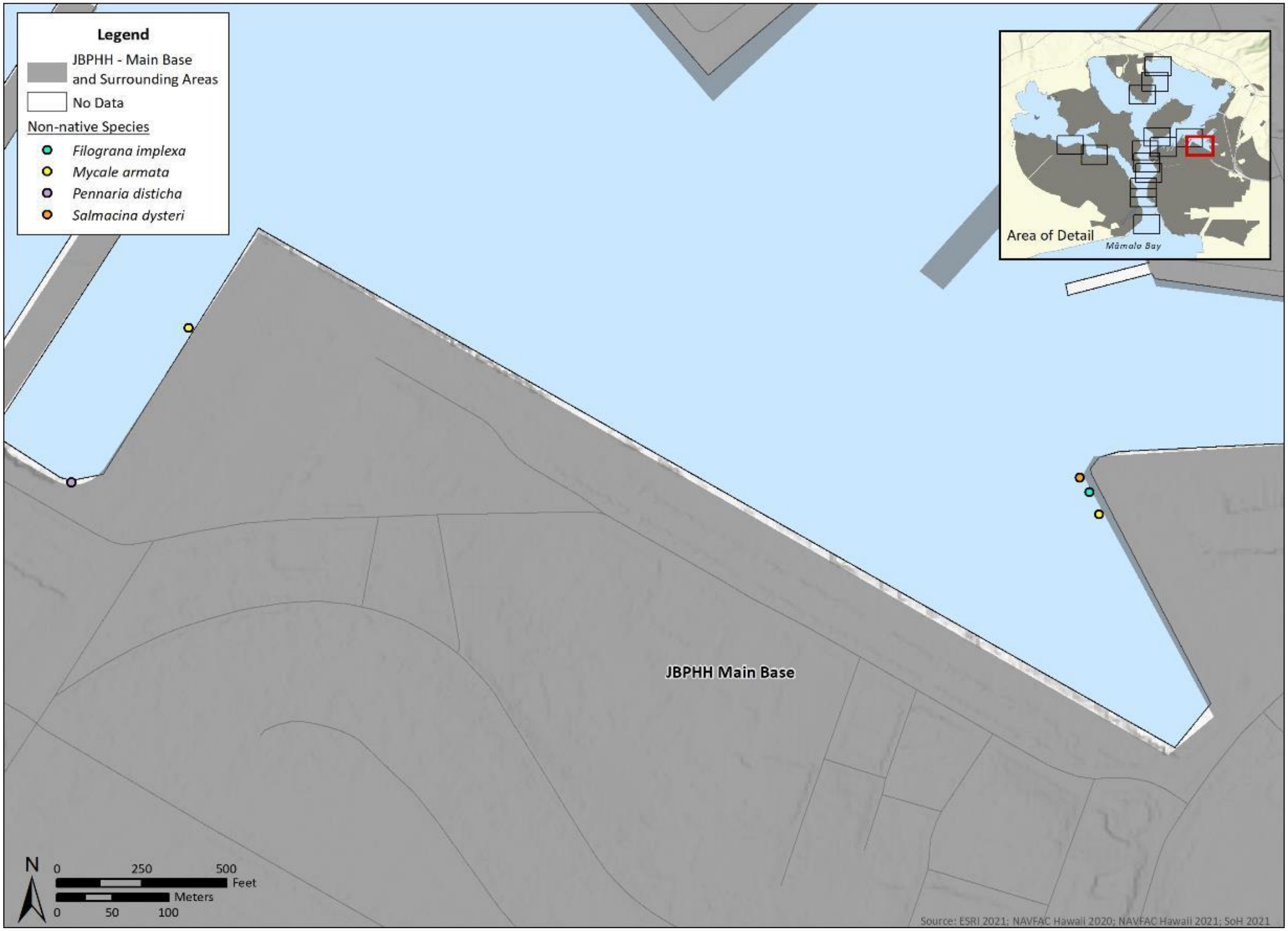


Figure 4-22 Non-native Species Observed in Pearl Harbor (2015–2022)

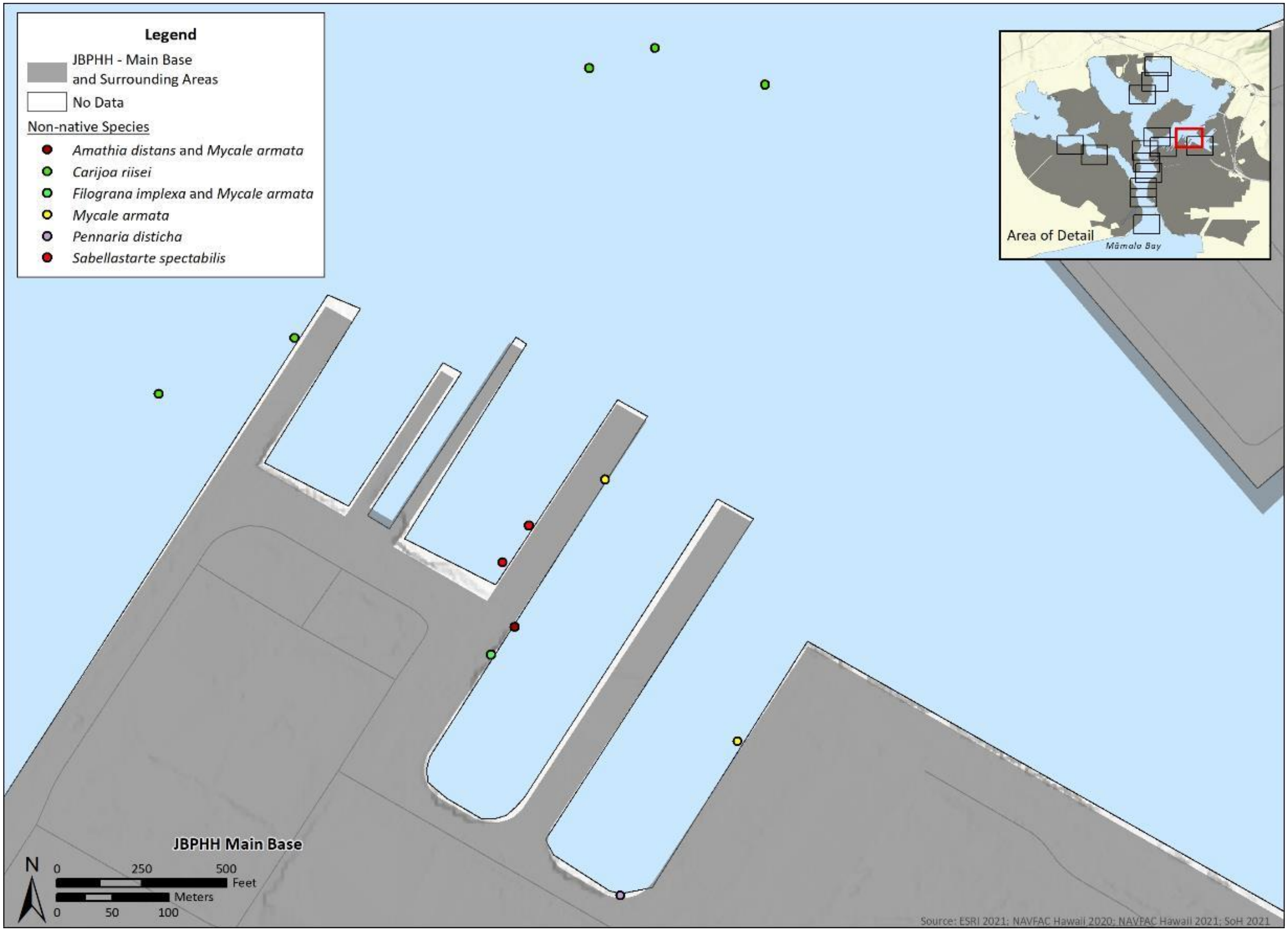


Figure 4-23 Non-native Species Observed in Pearl Harbor (2015–2022)

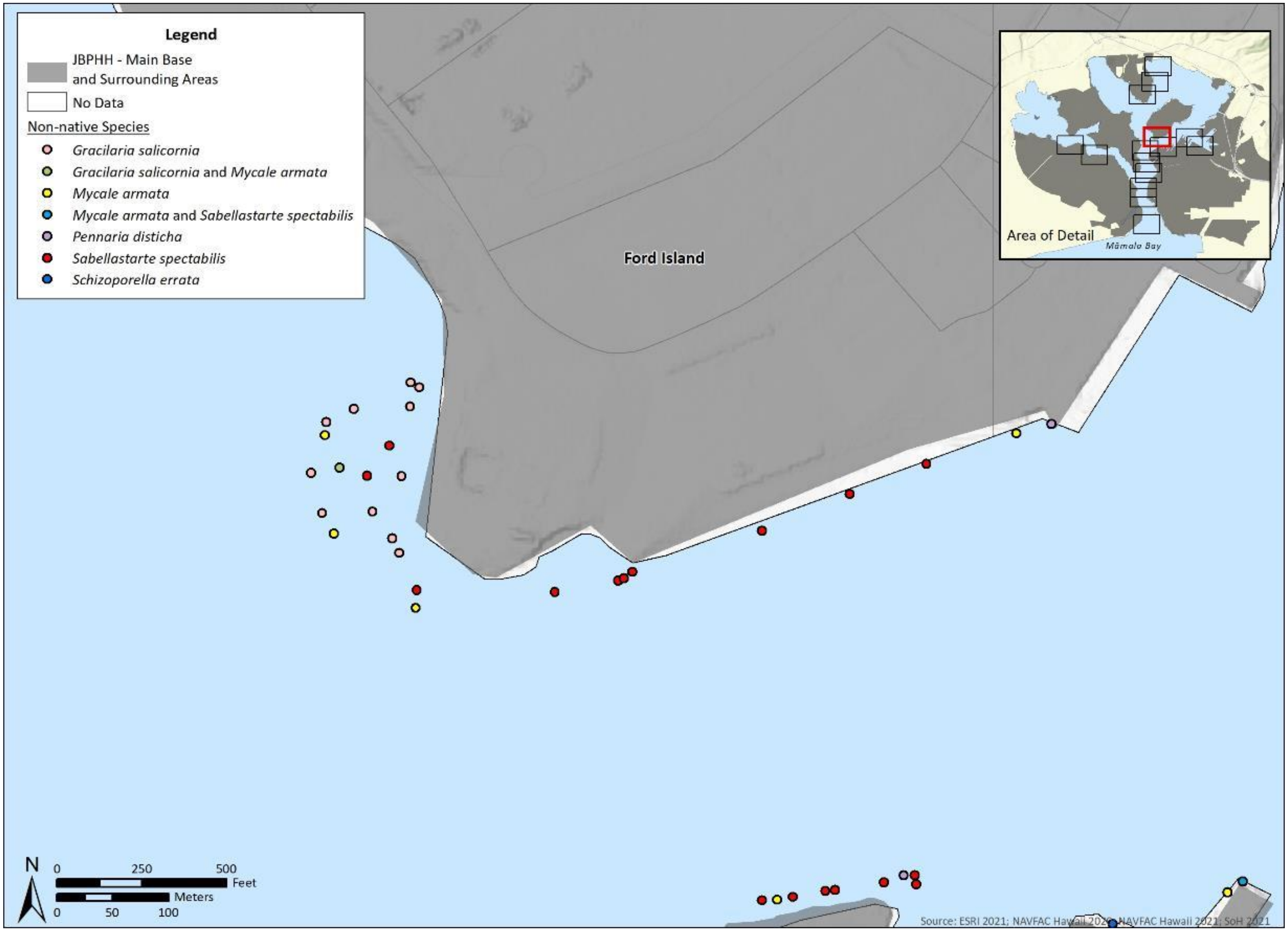


Figure 4-24 Non-native Species Observed in Pearl Harbor (2015–2022)

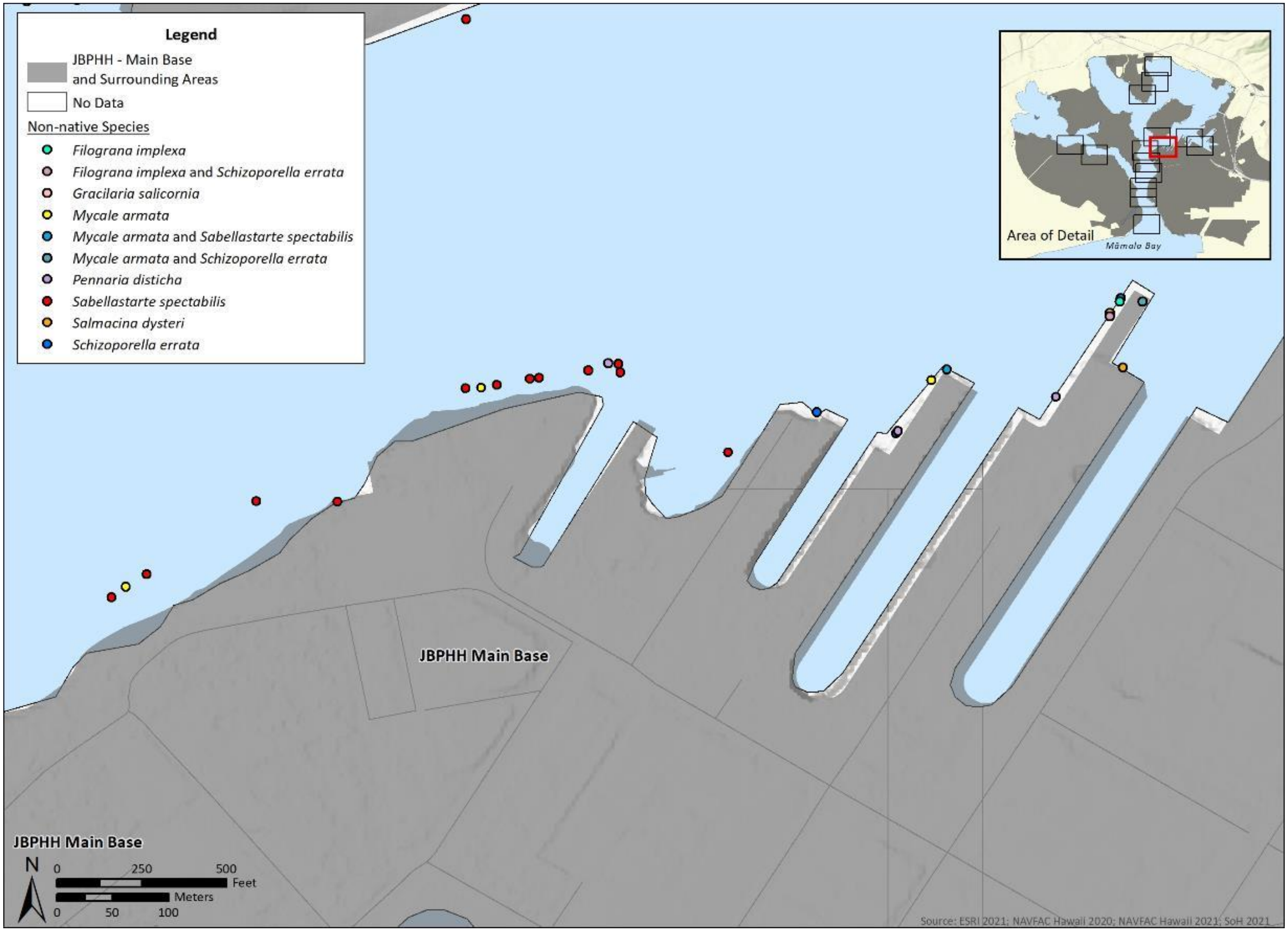


Figure 4-25 Non-native Species Observed in Pearl Harbor (2015–2022)

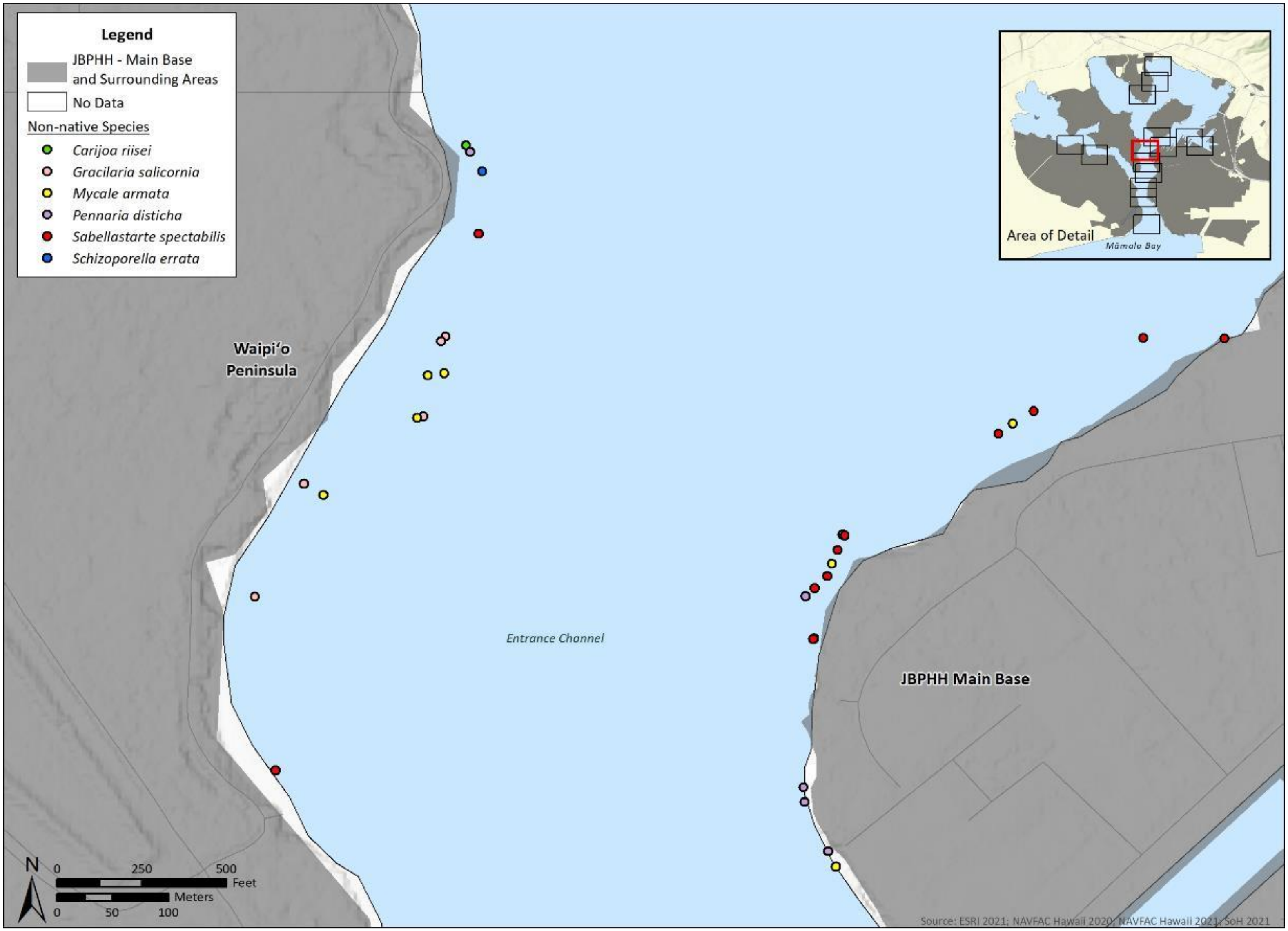


Figure 4-26 Non-native Species Observed in Pearl Harbor (2015–2022)

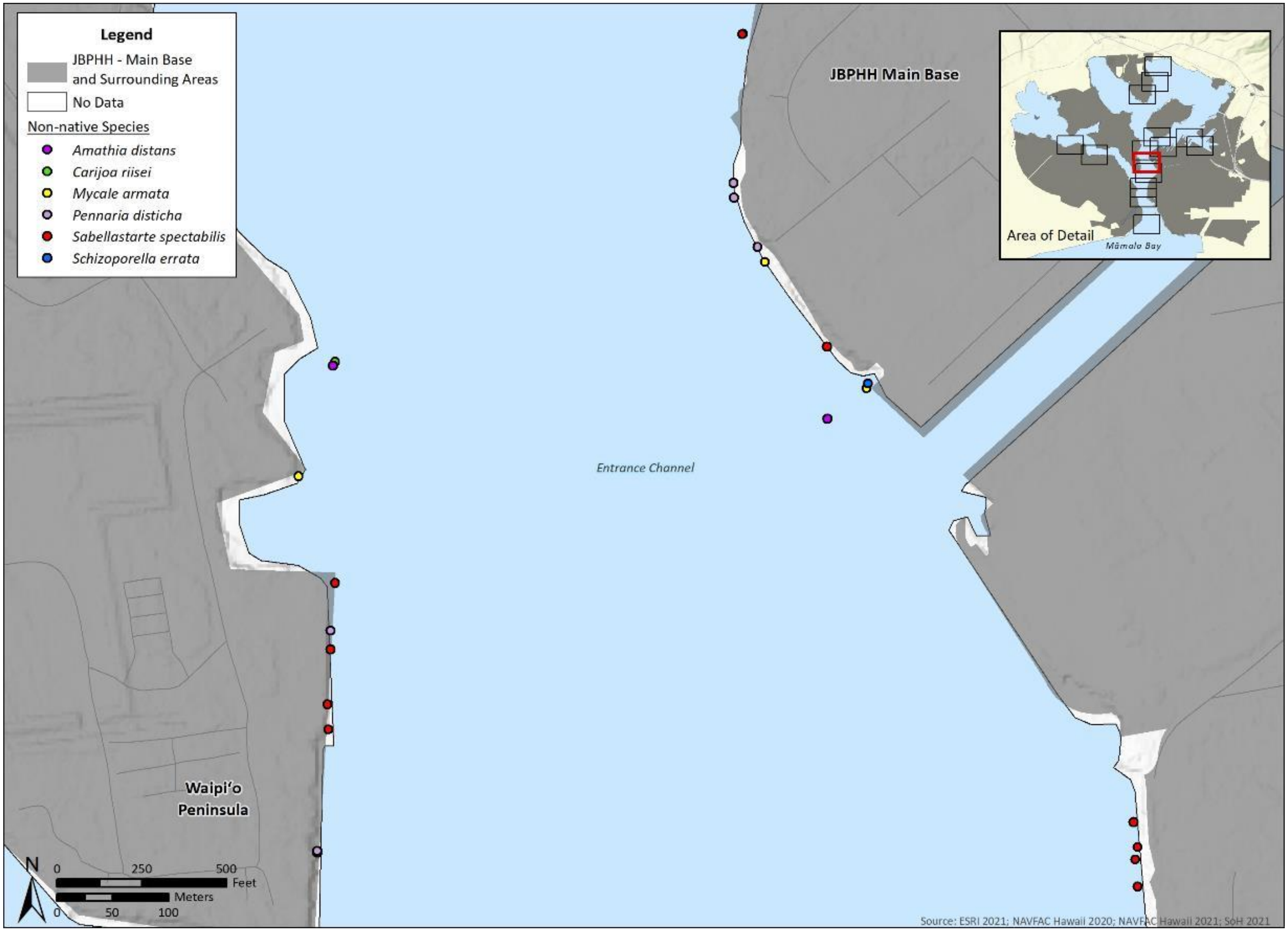


Figure 4-27 Non-native Species Observed in Pearl Harbor (2015–2022)

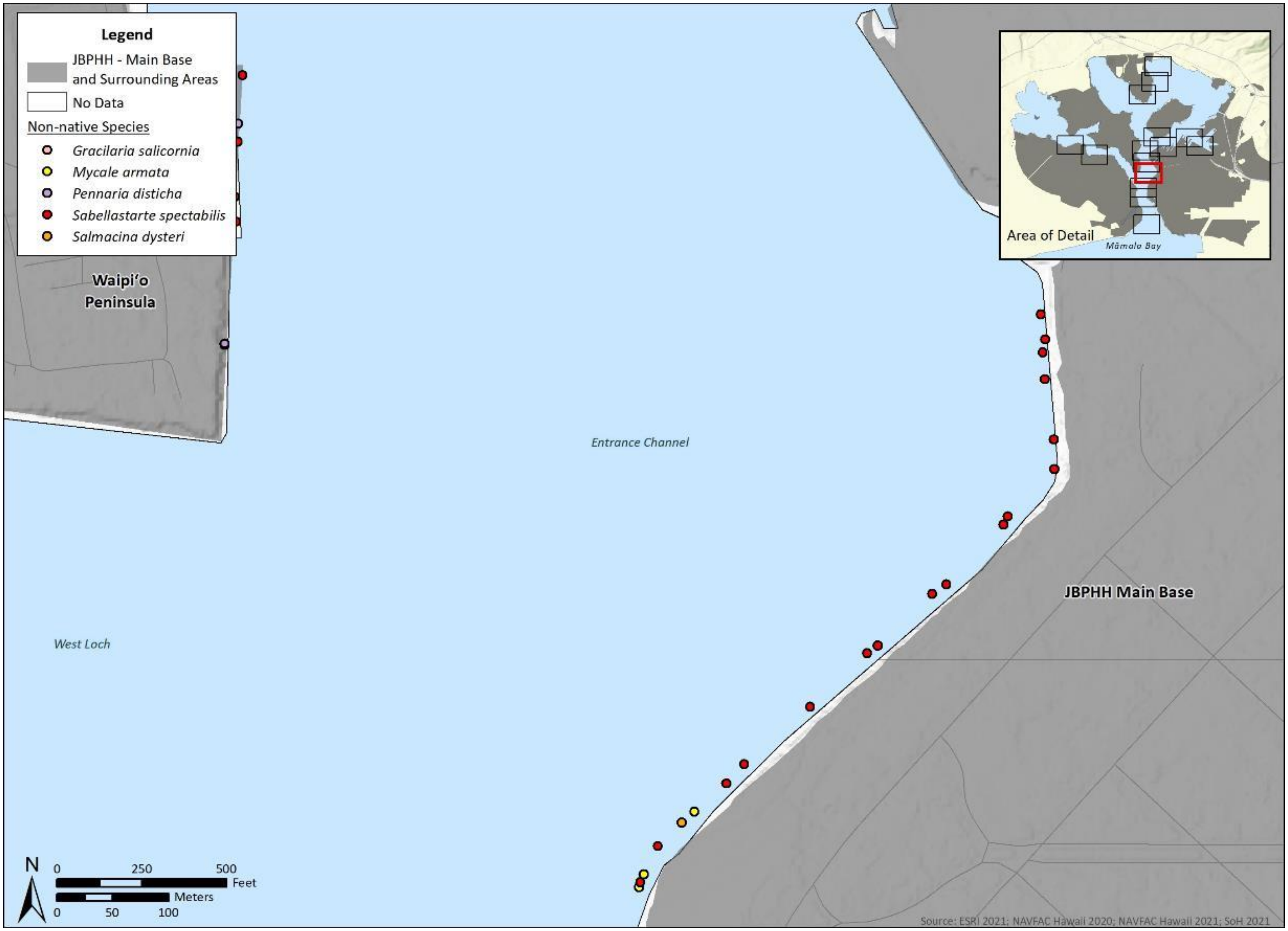


Figure 4-28 Non-native Species Observed in Pearl Harbor (2015–2022)

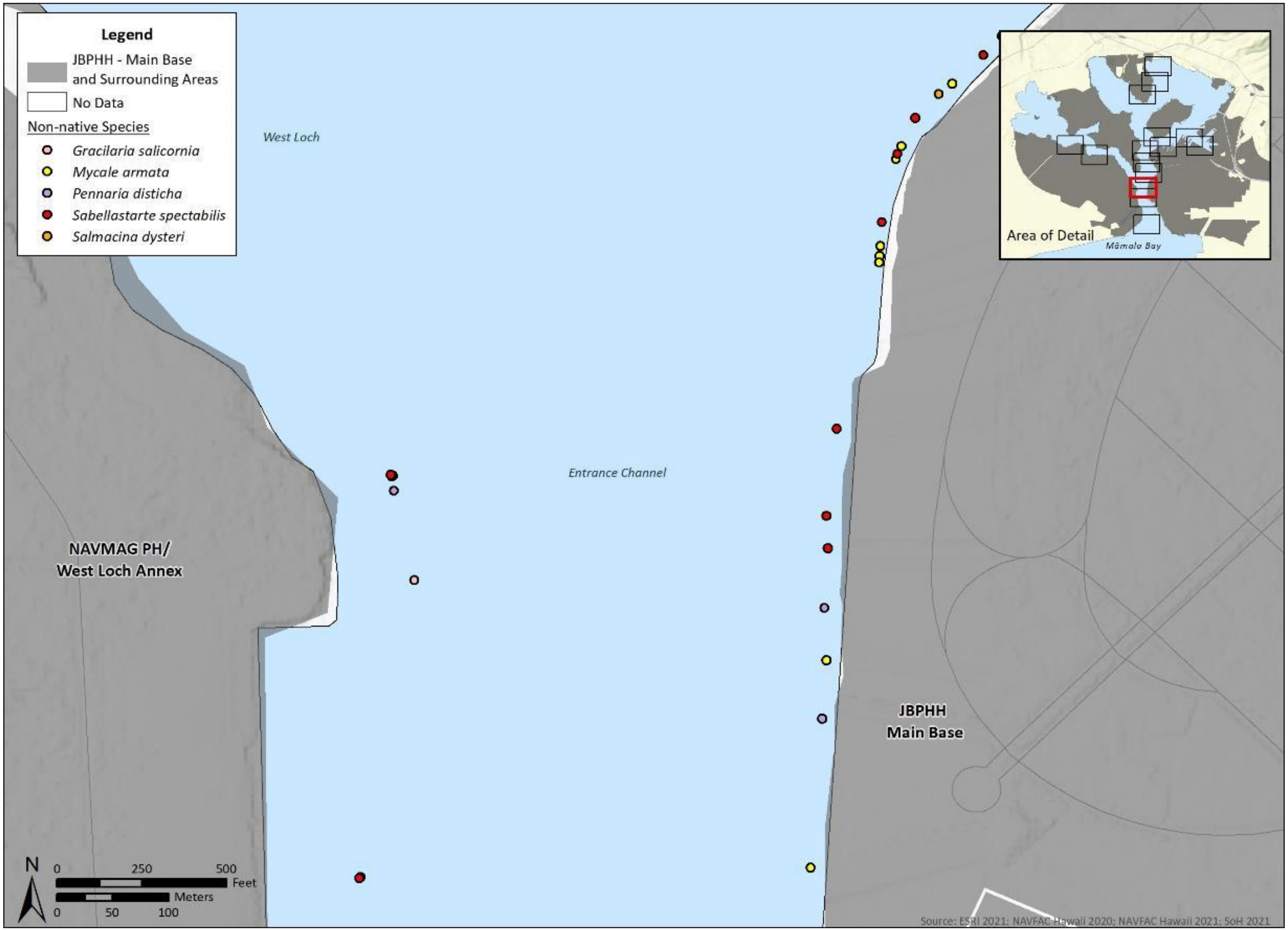


Figure 4-29 Non-native Species Observed in Pearl Harbor (2015–2022)

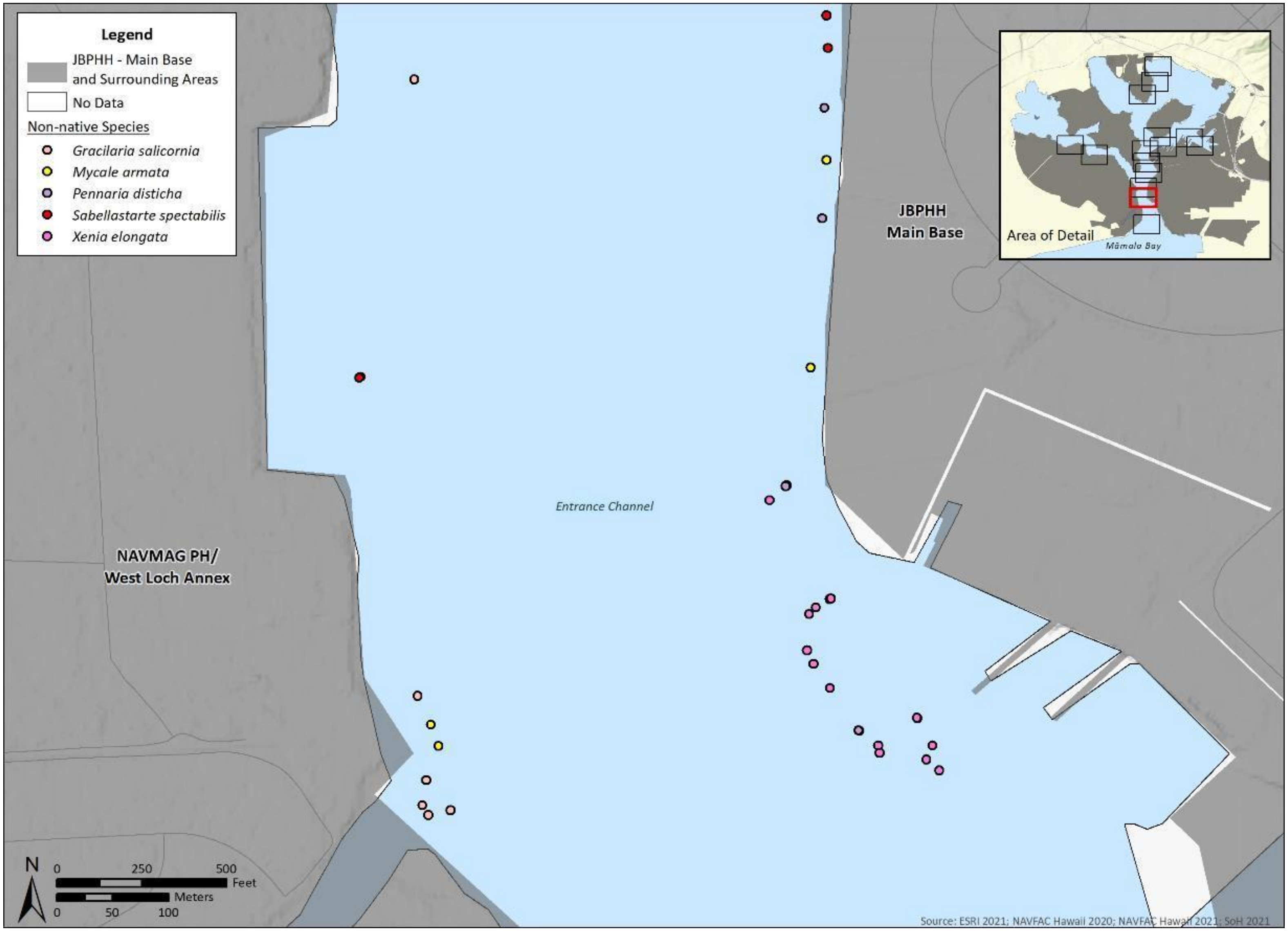


Figure 4-30 Non-native Species Observed in Pearl Harbor (2015–2022)

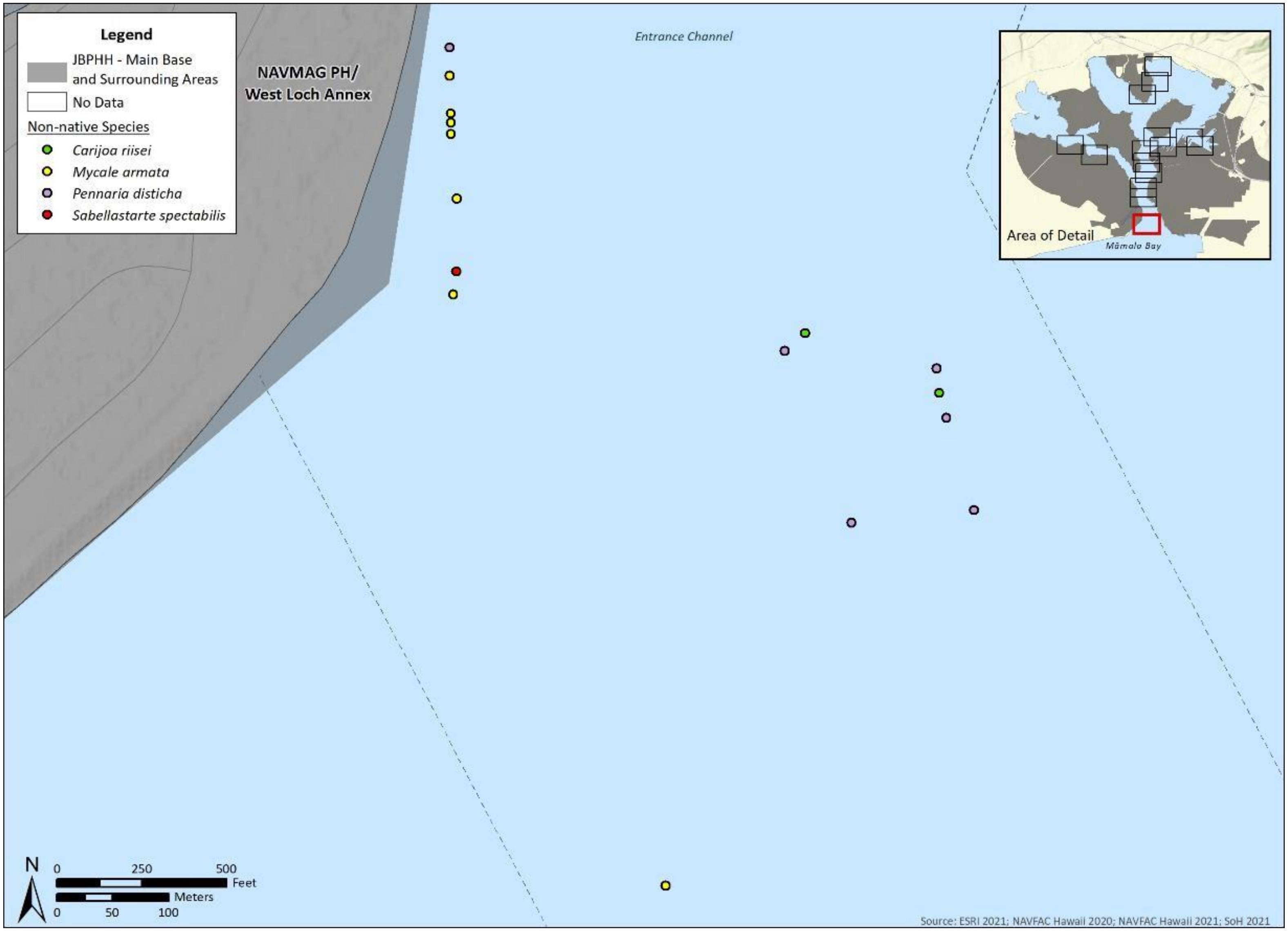


Figure 4-31 Non-native Species Observed in Pearl Harbor (2015–2022)

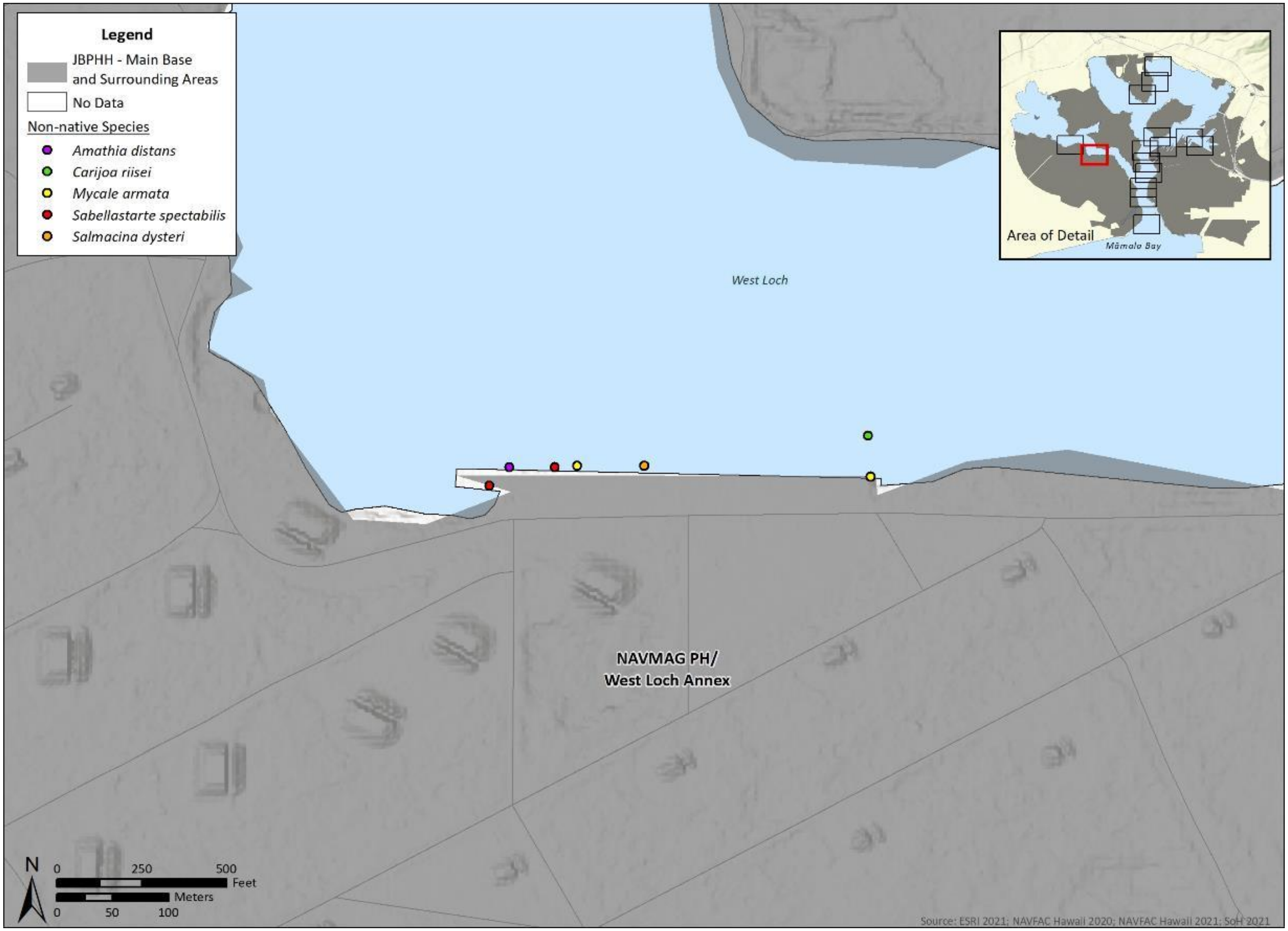


Figure 4-32 Non-native Species Observed in Pearl Harbor (2015–2022)

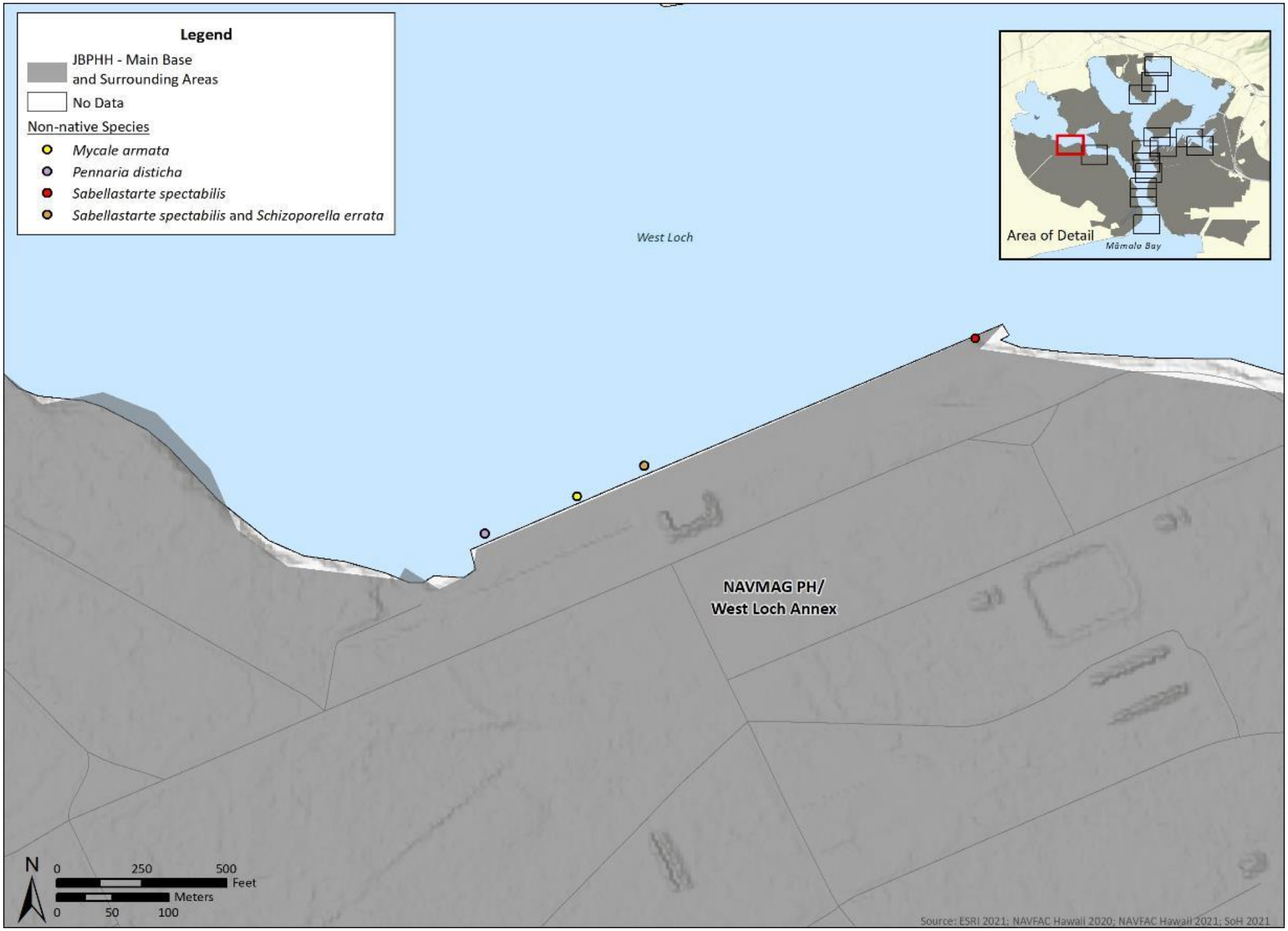


Figure 4-33 Non-native Species Observed in Pearl Harbor (2015–2022)

4.4.9.1 Flora

The dominant plants found in Pearl Harbor are species of mangroves that colonized the coastline, especially the red mangrove. This species is non-native and colonizes and damages Hawaiian fishponds. While mangroves have negative impacts by outcompeting native species for habitat, they can provide nursery habitat for fishes, including native species (Goecke and Carstenn, 2017). Section 4.4.3, *Marine Habitats*, describes these communities in more detail.

Gorilla ogo, which is classified as invasive by the SOH DAR, occurs in dense mats in shallow nearshore areas throughout Pearl Harbor (NAVFAC PAC, 2011, 2018b, 2020c,e, 2021; Rodgers et al., 2020; Smith et al., 2004; Smith et al., 2006). Gorilla ogo is a brittle seaweed with cylindrical branches 0.08–0.20 inch (2–5 mm) in diameter. Gorilla ogo grows in calm, protected waters such as tide pools and reef flats up to 12 feet (4 meters) depth and forms thick intertwining mats up to 6 inches (15 cm) thick. It is native to the Indian Ocean and South Pacific and was introduced to Hawaiʻi in 1974 for aquaculture research to produce agar. Gorilla ogo is most commonly found on Oʻahu in Kāneʻohe Bay and along the shoreline from Maunalua Bay to Pearl Harbor. It grows quickly, forming large, thick mats over the reef, overgrowing and killing coral and other seaweeds. The alga is primarily spread by fragmentation (pieces of seaweed floating to a new location). It outcompetes native alga and coral and the mats of alga prevent young, new corals and seaweeds from attaching to the bottom to grow. The impacts on the marine ecosystem are a shift from a highly diversified coral benthic community to an alga dominated community with low diversity.

Gorilla ogo is one of the most serious threats within Pearl Harbor. This alga has spread rapidly between 2005 and the present. Some areas within Pearl Harbor, which had begun to support substantial coral communities in 2005, had been partially or completely overgrown and killed by late 2009. In spite of the spread of this alga, the total biomass of coral appears to have increased since 2005. This is due to the recruitment and spread of corals at depths below 20 feet (6 meters), where light levels are too low to support gorilla ogo, and to the recruitment of corals to higher energy areas, like Hospital Point. Gorilla ogo does not appear to be able to tolerate the wave energy levels that are encountered in some areas of the harbor, thereby allowing corals to successfully recruit to areas as shallow as 3 feet (1 meter).

Other common non-native algae observed in Pearl Harbor include leather mudweed (*Avrainvillea amadelpha*) and the prickly seaweed (*Acanthophora spicifera*) (Coles et al., 2009). Prickly seaweed was unintentionally brought from Guam to Pearl Harbor in 1952 (Dailer, 2006). In addition, as mentioned under Section 4.4.4, *Marine Flora*, the invasive paddlegrass is also found in Pearl Harbor.

4.4.9.2 Fauna

Orange Keyhole Sponge

The orange keyhole sponge (*Mycale armata*) (Appendix J-6, Photographs 18 and 19) is a recent, unintentionally introduced aquatic invasive species (AIS) that is the most abundant sponge species in the Hawaiian reef ecosystem (Wang et al., 2009). This bright, red-orange sponge has a thick (up to 1.6 feet/0.5 meter), encrusting morphology that can grow to large sizes (up to 3.3 feet/1 meter diameter; DeFelice et al., 2001). The firm texture of the sponge is compressible and tears easily. Its oscules are large and conspicuous over the uneven surface, which is smooth with large ‘keyhole’ ostia.

The native range of this species extends from Australia and into the Indo-Malay region (DeFelice et al., 2001). In Hawaiʻi, this sponge occurs on the islands of Maui and Oʻahu and primarily in shallow water fouling communities (e.g., pier pilings, floating docks) of harbors and piers or dredged channels and artificial lagoons. Although the scientific details are sparse, this species likely reproduces asexually by fragmentation, which is similar in most sponges. The detrimental impact of this species is significant, as it grows over and kills native, coral lagoon-patch reef communities.

The invasive orange keyhole sponge is prevalent in Pearl Harbor. Removing this destructive species not only reduces their adverse presence in the harbor but more importantly benefits and protects the nearby coral patches, which already contain growth of this AIS. A reasonable and effective mitigation against the spread of this IS is to remove structures upon which it is thriving.

The orange keyhole sponge's adverse impact is increasing substantially in Kāneʻohe Bay, Oʻahu as it grows over coral on the reef (Coles et al., 2007). Years of scientific evidence confirmed that this sponge's long-term occupation of reef space occurred at the expense of resident, native corals by weakening the coral skeletal structure, most notably the *P. compressa*. Natural control methods are unknown, as direct predators such as fish or invertebrates are not documented. Furthermore, mechanical removal of this sponge was a highly ineffective and an unfeasible control method, based on the sponges' quick recovery rates and labor-intensive diver hours. Although more feasible, an alternative air-injection technique also proved unsuccessful as sponge regrowth occurred following treatment. There are almost no examples of effective control and little basic information about their introduction or life history parameters (Coles et al., 2007).

Associated with routine repair and maintenance activities, the DON regularly removes the orange keyhole sponge from Pearl Harbor via removal of artificial structures such as pilings, plates, floating platforms, and buoys. These projects require consultations with NMFS. The removal of sponges are generally considered an adverse effect on EFH as these provide a filtration service and function to the marine ecosystem. However, the invasive spread and coral overgrowth potential of orange keyhole sponge is considered more detrimental to the health and survival of the coral species and reef community than the benefit of the filtering function it provides. As such, the DON is not required to offset impacts to orange keyhole sponge.

Snowflake Coral

The snowflake coral (*Carijoa riisei*) occurs within Pearl Harbor and is considered an alien species of soft (non-reef forming) coral originally from the tropical Western Atlantic. Snowflake coral is a soft branching coral comprised of cylindrical 0.08–0.16 inch (2–4 mm) branches with multiple polyps, each polyp with eight white, frilly tentacles when extended. Snowflake coral overgrows corals and hard surfaces to form carpets that prevent other species from growing and is capable of explosive growth that enables it to smother competitors. The coral was first discovered in Pearl Harbor in 1972. It is believed to have been transported to Hawaiʻi on the bottom of a ship or as larvae in a ship's ballast water. *C. riisei* grows well in turbid waters rich with zooplankton and organic matter. Most commonly found in the fouling community of harbors, usually on pier pilings or wrecks that are not exposed to direct sunlight. *C. riisei* is found outside of harbors (especially along the leeward coast of Oʻahu), on shipwrecks, in sheltered and shaded crevices, or in shallow caves on deeper reefs. *C. riisei* is resistant to predation; with only one known predator identified to date—a small nudibranch. Of the 287 nonindigenous marine invertebrates found in Hawaiʻi, *C. riisei* is by far the most invasive.

Octocoral

A species of octocoral of the family *Xeniidae* was first documented in 2020 in the main shipping channel of Pearl Harbor. As a newly introduced species, the extent of its range in the harbor as well as its risk to become an IS is not yet known. In Venezuela, a similar looking species of octocoral, *Unomia stoloifera,* has successfully become an IS, dominating benthic structure on Venezuelan reefs (Ruiz-Allais et al., 2021).

Other Introduced Species

Other introduced species found within Pearl Harbor, which are not considered invasive, include erratic bryozoan (*Schizoporella errata*), sea frost worm (*Salmacina dysteri*), Christmas tree hydroid (*Pennaria disticha*), lacy tube worm (*Filograna implexa*), white bushy bryozoan (*Amathia distans*), and feather duster worm. Some of the most common fishes are non-native species including the blacktail snapper (*Lutjanus fulvus*) and blueline snapper *(Lutjanus kasmira*), which were intentionally released in the Hawaiian Islands to produce new fisheries (Coles et al., 1997; Johnston and Purkis, 2016).

4.5 Current Management

4.5.1 Protected Species and Ecosystem Monitoring and Management

The following DON programs are currently in place at JBPHH Main Base and Surrounding Areas in an effort to conserve, protect, and provide benefit to ESA- and SOH-listed species and MBTA-protected birds with potential to occur at JBPHH Main Base and Surrounding Areas. The NAVFAC HI Natural Resource staff coordinate with federal and SOH agencies including USFWS, NMFS, the USDA, SOH DLNR, and USACE on natural resources issues pertaining to the federally- and SOH-protected species that occur within JBPHH Main Base and Surrounding Areas, and Pearl Harbor and Nearshore Training Areas.

Endangered Species Act-protected Waterbirds

Pearl Harbor and its shoreline provide habitat for the Hawaiian duck (suspected Hawaiian duck-mallard hybrid, see Section 4.3.3.2, *Fauna*), Hawaiian coot, Hawaiian gallinule, and Hawaiian stilt. The DON uses a variety of management actions to protect ESA-listed Hawaiian waterbirds and to enhance their habitat which are described below.

Memorandum of Understanding

The DON continues to comply with the terms of the MOU between the DON, USFWS, NMFS, and SOH DLNR for the protection, development, and management of fish and wildlife resources at JBPHH. The DON has an agreement for an overlay refuge at Pearl Harbor (Appendix J-9).

Project Reviews and Consultations

The DON conducts project reviews and, as appropriate, conducts consultation with resource agencies to ensure minimal impact to protected species, including Hawaiian waterbirds. An example includes qualitative surveys along the South Hālawa Stream, which started in December 2021 to monitor any physical characteristic (e.g., changes in sediment deposits, turbidity) and if any ESA-listed species are in the area and their behavior. After 4 months of monitoring, there have been three observations of the Hawaiian Stilt transitioning in the area, no evidence of endangered waterbirds nesting in the area, and one Mallard/Hawaiian duck brood.

Bird Surveys and Monitoring

Bird surveys for JBPHH Main Base and Surrounding Areas were conducted between 2014 and 2015 (Hamer Environmental, 2016). RCUH conducts ongoing, bi-weekly monitoring of seven wetlands within the study area to monitor ESA-waterbird usage. The seven wetland areas are: Āhua Reef Wetlands, Fort Kamehameha Beach, Manuwai Canal, Kumumau Canal, Loko Iʻa Pāʻaiau Fishpond, Oxidation Pond, Ordy Pond, Niuliʻi Ponds, and Navy Marine Golf Course. Ordy Pond is on BRAC land and BRAC land is not covered under the jurisdiction of this INRMP. USDA conducts daily wildlife monitoring and BASH control at Hickam Airfield and conducts monthly wildlife surveys to document abundances and distribution of species that occur there.

The 2014–2015 point count survey (Hamer Environmental, 2016) and ongoing RCUH and USDA surveys build upon the information collected for the 2001 and 2011 INRMPs (Bruner, 1999a, 1999b; NAVFAC PAC, 2006b). The survey assists NAVFAC HI Natural Resource staff in their continued efforts to protect and conserve ESA-protected species at JBPHH Main Base and Surrounding Areas. The DON participates in the SOH's biannual waterbird surveys by monitoring and sending in data for core wetland areas.

Habitat Restoration

Restoration efforts at the Āhua Reef Wetland are ongoing. Since 2011, 4 acres (1.6 hectares) of invasive mangrove and pickleweed have been removed from the wetland and 1.8 acres (0.7 hectare) were outplanted with native wetland plants at this site. Between 2008 and 2009, the DON removed approximately 60 acres of mangrove from the shoreline of Pearl Harbor. Mangrove and pickleweed displace native wetland species and cover open water and mudflats necessary for Hawaiian waterbirds to forage. It is anticipated that the removal of these species will result in an overall enhancement of waterbird habitat within the study area. A program to restore waterbird habitat is described in Table 8-7, Row 3.

Inreach and Community Outreach

The DON continues to promote awareness of ESA-listed and other protected species among DON personnel and the community at-large through ongoing educational efforts (e.g., Earth Day, events bulletins), community service programs, and brochures.

Mitigation Measures During Training

The DON continues to prohibit bivouacking within 3,280 feet (1,000 meters) of posted signs marking the presence of rare and/or protected plant and animal species or restoration projects. Training units larger than 30 personnel (platoon size) are allowed to bivouac outside of reusable bivouac sites that are provided with portable or reusable latrines. No open fires, burying or leaving of trash, food preparation, cutting, or clearing of vegetation, or disturbing of vegetation including mosses, grasses, shrubs, bushes, and trees are allowed during bivouacking. The DON continues to prohibit training in areas marked by signs or fences indicating the presence of rare and/or protected species.

Endangered Species Act-protected Seabirds

Per COMNAVREGHIINST 5090.9, JBPHH takes all reasonable actions to reduce potential effects on Hawaiʻi's night-flying seabirds. These actions may include louver light covers and extinguishing lights temporarily when a bird is observed flying around lights at night (COMNAVREGHIINST 5090.9). Additionally, JBPHH maintains an SOP for injured or grounded seabird response (Appendix J-10).

White Tern and Hawaiian Short-eared Owl

JBPHH Main Base and Surrounding Areas and Pearl Harbor and its shoreline provide habitat for the SOH-listed white tern and Hawaiian short-eared owl. The DON has a variety of management actions in place to protect these species and to enhance their habitat. They are the same as many of the management actions described for Hawaiian waterbirds including resource agency coordination, MOUs, SOPs, project reviews and consultations, bird surveys, inreach and community outreach, and mitigation measures during training. Additionally, when large, mature trees at JBPHH Main Base suitable for white tern nesting are trimmed or felled, nesting bird surveys for the species are completed prior to work. If a white tern nest were found, work would cease until the chick has fledged.

Hawaiian Hoary Bat

Hawaiian hoary bat may forage or pup within the study area. When trimming or removal of vegetation greater than 15 feet (5 meters) is needed, it is required to occur outside of the Hawaiian hoary bat pupping season (June–September) (DLNR, 2015b). If vegetation removal is proposed during the pupping season, DON consultation with USFWS is required.

MBTA-protected Bird Species

Numerous MBTA-protected bird species are known to occur within the study area (see Table 4-9). Many of the MBTA-protected bird species are located at the PHNWR Honouliuli and Waiawa Units. As described in Section 1.6.4, *Management of Migratory Birds on DoD Lands*, under the MBTA and EO 13186, DON cannot “take” migratory birds except for military readiness activities. If the DON does take MBTA-protected bird species during military readiness activities, the DON may be required to conduct monitoring and mitigation actions.

As discussed in Section 4.3.1, *Wetlands*, DON has removed approximately 60 acres (24 hectares) of mangrove from the shoreline of Pearl Harbor and has supported the removal of mangrove and reestablishment of native species at PHNWR Waiawa Unit. The removal of the mangrove and the restoration of native wetland species helps conserve and sustain the MBTA-protected shorebirds that frequent Pearl Harbor. The DON intends to remove mangrove from additional shoreline acreage (Table 8-7, Row 3, includes additional mangrove removal at Āhua Reef Wetland, riparian ecosystems, and additional mangrove removal around Pearl Harbor).

Hawaiian Monk Seal and Marine Mammal Management

Managing and protecting Hawaiian monk seal within JBPHH includes the coordination between the DON, NMFS, volunteer groups, and law enforcement. The effectiveness of the arrangement and interaction between all parties involved and the adequacy of the allocated funding is revisited each year as part of the annual JBPHH INRMP review. If current practices are deemed inadequate, then new solutions to protecting seals will be pursued. Hawaiian monk seals are provided protection from harassment and disturbance within many areas of the study area by exclusion of the public. The DON has provided NMFS input regarding the presence of Hawaiian monk seals on the beaches at Pearl Harbor through routine coordination and communication between the DON environmental staff and agency personnel.

As described in the Amended Programmatic Biological Opinion on U.S. Navy Hawaii-Southern California Training and Testing Activities (NMFS, 2020b) and the Hawaii-Southern California Training and Testing Final EIS/Overseas EIS (DON, 2018), mitigation measures are instituted to assure minimal impacts from training activities to marine mammals, including Hawaiian monk seals. These mitigation measures, driven by the MMPA, are detailed in the Incidental Take Authorization for the Hawaii-Southern California Range Complex (NMFS, 2020c), which includes two LOAs – one for training and one for testing. Marine mammal mitigation measures and SOPs at Pearl Harbor and Nearshore Training Areas include:

Personnel Training and Implementation of Standard Operating Procedures

Training of personnel and implementation of activity-specific SOPs are designed to minimize and/or avoid interactions with protected resources including marine mammals and sea turtles (DON, 2018). Navy Training and Operations staff adhere to the DON policies regarding education, inspections of training areas, and other protections at JBPHH Main Base and Nearshore Training Areas (see Figure 4-2) pertaining to marine mammals (including Hawaiian monk seals) and other protected species. NRH maintains an SOP regarding the reporting of monk seal or sea turtle sightings (Appendix J-11).

Inspections of Training Areas and Construction Footprints

Prior to any training or construction activities, training areas and construction footprints are inspected for the presence of marine mammals (including Hawaiian monk seals). If marine mammals are observed during these inspections, training or construction activities are delayed until the marine mammals voluntarily leave the area. If a Hawaiian monk seal is observed in Pearl Harbor, in Nearshore Training Areas (see Figure 4-2), or on property actively used by the DON, the animal is reported to the Port Operations Tower which controls vessel traffic. All vessels are advised of the sighting, advised that the animal is an endangered species, and all vessels are cautioned to stay clear. The Tower also reports to CNRH environmental for data collection purposes or if there are any issues with the animals.

Training Restrictions, Clearance, and Monitoring

Prior to detonation, the DON requires that the area be determined to be free of marine mammals and sea turtles. The training event does not proceed if marine mammals or sea turtles are near the training event. The DON continues to require that the area involved in underwater detonations (during training) be searched for injured animals after the detonation activities are complete.

The DON continues to require that established procedures be followed during amphibious crew inserts. These include having designated lookouts watching for other vessels, obstructions to navigation, and marine mammals including whales, Hawaiian monk seals, and sea turtles. Training coordinators are required to review training overlays that identify the insertion points and any nearby restricted areas. All sensitive biological receptors are avoided during training exercises.

Monitoring Program

The DON developed a marine species monitoring program in support of environmental compliance during at-sea training and testing activities as required under the MMPA of 1972 and the ESA of 1973. The goal of monitoring projects is to provide scientifically sound results to evaluate the goals of the Integrated Comprehensive Monitoring Program, including making progress on its Intermediate Scientific Objectives; these results are provided to NMFS in annual monitoring reports. Monitoring projects in the Hawaiʻi Range Complex are determined by the U.S. Pacific Fleet Environmental Readiness Division. Details on projects, methods, results, and publications can be found at www.navymarinespeciesmonitoring.us.

Nuisance Animal/Predator Control

Many shoreline areas of Pearl Harbor are industrialized and, consequently, are not frequented by domesticated animals such as dogs or cats; however, feral cats have been observed at Iroquois Point and near Honouliuli Wildlife Refuge. To address this problem, the DON funds nuisance animal/predator control (primarily trapping and removal of feral cats) on Iroquois Point Beaches and in areas near the Honouliuli Wildlife Refuge.

There are residential shoreline areas at Pearl Harbor (Pearl City Peninsula, Ford Island, Hospital Point) and Iroquois Point. Residents in the study area and at Iroquois Point are allowed to keep cats and dogs as pets as long as the animals are restricted to the family housing areas. These animals are not allowed on the beaches at Pearl Harbor. Leash laws for residents are enforced by security patrols. These restrictions likely reduce the possibility of introduction of certain diseases to Hawaiian monk seals and waterbirds in the study area. These restrictions provide a benefit to and aid the recovery of the species.

Access Restrictions

At JBPHH Main Base and Surrounding Areas, there is the potential for disturbance of Hawaiian monk seals (human interaction) through shoreline access and fishing activities. Because of security requirements, access to much of the shoreline is limited to DoD card holders, residents, and guests.

Sea Turtles

NAVFAC PAC completed focused sea turtle surveys of Pearl Harbor in 2020 (NAVFAC PAC, 2020f). The survey provided valuable information about the distribution and habitat of green sea turtle within Pearl Harbor that will assist in the protection and conservation of sea turtles within Pearl Harbor.

NRH maintains an SOP with regard to sea turtle observations (see Turtle Monitoring SOP and BMPs for Sea Turtle Basking and Nesting Habitat, Appendix J-11). This SOP instructs the DON personnel in how to respond to situations involving ESA-protected sea turtles. In an order to protect sea turtles from propeller strikes, JBPHH has installed prop guards on all small boats under Naval Station's control (security and facility response team vessels).

The DON continues to promote awareness among the DON personnel of ESA-protected and other protected species through ongoing educational efforts, community service programs, and brochures. Table 8-8 lists several planned projects that would benefit the sea turtles including sea turtle presence/absence surveys, sea turtle standing data, conservation enforcement education for security, and marine species assessment monitoring.

Personnel Training and Implementation of Standard Operating Procedures

Training of personnel and implementation of activity-specific SOPs are designed to minimize and/or avoid interactions with protected resources including sea turtles (DON, 2018). Navy Training and Operations staff adhere to the DON policies regarding education, inspections of training areas, and other protections at JBPHH Main Base and Nearshore Training Areas (see Figure 4-2) pertaining to sea turtles and other protected species. NRH maintains an SOP regarding the reporting of monk seal or sea turtle sightings (Appendix J-11).

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4.5.2 Marine Debris Reduction

The DON does not dispose of plastics at sea. Instead, the DON ships retain all plastics on board, melting and compressing the accumulated materials into disks that are held on the ship until it reaches its next port for land-based recycling or disposal. In addition, the DON members have worked in partnership with other agencies in removing derelict fishing gear in the Northwestern Hawaiian Islands. Furthermore, DON volunteers participate in beach cleanups on Oʻahu and Kauaʻi in a continuing effort to protect marine animals and as participants in the National Marine Debris Monitoring Program.

4.5.3 Restoration of Natural Resource Areas

DoDI 4715.3 directs DoD agencies to manage natural resources through principles of ecosystem management. Ecosystems with large proportions of native species are to be protected, and habitat restoration activities are to focus on these habitats. Areas with moderate to high natural resource value, as shown in Figure 4-3, are to be managed to conserve those values.

4.5.4 Invasive Species Prevention and Control

IS means, with respect to a particular ecosystem, a non-native organism whose introduction causes economic harm, or harm to human, animal, or plant health. IS management generally begins through prevention, and subsequently addresses early detection and monitoring, and finally control and eradication. Financial costs increase as species become established and widespread, so it is most efficient and effective to prevent introductions as much as possible. Current prevention techniques include ensuring clean gear and vessels during interport movements (biosecurity), and good outreach and education practices to discourage the DON personnel and the NEX from importing and/or propagating IS.

IS are mentioned throughout Sections 4.3.3.2, *Fauna* and 4.4.9, *Marine Non-native and Nuisance Species*, and a list of priority IS for the study area is found in Table 4-17.

Biosecurity

The DON recognizes the transfer of IS to archipelago of Hawaiʻi as a real, ongoing, and an increasing problem. A JBPHH Biosecurity Plan was released in 2021 (NAVFAC HI, 2021, Appendix J-12) and describes the biosecurity roles and responsibilities of the installation command, tenant commands, base personnel, base contractors, the DON support commands (NRH, NAVFAC PAC, COMPACFLT, NAVFAC HI, etc.), and regulatory agencies (USFWS, NMFS, SOH DLNR, SOH Department of Agriculture, USDA, etc.). The plan includes guidance, protocol, and procedures to prevent biosecurity incursions and explores a range of additional biosecurity actions that NAVFAC could implement to existing biosecurity procedures already in place. The plan includes sections on pathway assessment, prevention, early detection, ongoing control, and incident response. A novel aspect of the plan is the concept of outward biosecurity that could be integrated with movement of personnel and materials from JBPHH to other DoD locations in Hawaiʻi.

Aquatic Biosecurity follows the standards from the Regional Biosecurity Plan for Micronesia and Hawaiʻi. Although the DON is exempt from the discharge standards now being proposed for commercial vessels by the USCG, EPA, and International Maritime Association, all military vessels do fall under the jurisdiction for Section 312(n) of the CWA, which requires establishment of Uniform National Discharge Standards (UNDS). More specifically, Section 312(n) of the CWA requires the DoD and EPA to determine which discharges from military vessels require control and to set standards for environmental protection. While ballast water was identified previously as a discharge that required control by UNDS (EPA, 1999), no specific guidance or standard has been provided to date for this discharge.

Fuel compensation (comp) water, which is seawater pumped into fuel tanks to compensate for loss in fuel ballast as fuel is consumed, is currently unregulated.

OPNAVINST 5090.1 (DON, 2021d) includes DON-wide requirements for ballast water exchange and treatment to avoid the introduction of unwater aquatic organisms. However, there is no current policy mandating that hulls be cleaned of AIS prior to arrival in Pearl Harbor. The DON has a policy to clean hulls, but it does not specifically address biosecurity concerns. The DON continues to cooperate with SOH DAR to provide early notification of decommissioned vessels, barges, platforms, or other objects stationary for long periods of time that are scheduled to arrive in Hawaiʻi as well as implementation of management activities to reduce risk of AIS transfer. The DON ensures that the cleaning of vessel hulls, ancillary gear, and other surfaces in the water as well as ballast water flushing is budgeted for inactive vessels coming to Hawaiʻi. The DON continues to partner with DAR in addressing AIS issues in Pearl Harbor by providing notification of AIS matters and jointly working on prevention, early detection monitoring, and eradication projects. DAR has the capacity to address such matters with specialized survey equipment including a remote operated vehicle, specialized removal equipment, trained divers, and the nation's only rapid-response team for AIS. The DON continues to raise awareness among active-duty personnel, dependents, and civilian employees of the potential harm AIS can cause to Hawaiʻi's sensitive ecosystems. Furthermore, the DON continues to employ preventative steps to minimize risk of introducing AIS. Examples of preventative steps include sourcing local vessels to the greatest extent possible trying to ensure they are not dumping ballast water in Pearl Harbor. Prior to commencing in-water work, the Navy or contractor shall ensure that all contracted vessel and barges complete an AIS risk assessment that meets the biosecurity standards defined by the Navy and SOH. Prior to mobilizing, ensure all activities and construction equipment, ballast, and vessel hulls do not pose a risk of introducing new invasive species and will not increase abundance of those invasive species already present at the project location.

Introduced terrestrial organisms, such as the brown tree snake (*Boiga irregularis*), insects, rodents, or other organisms, can arrive via cargo and invade Hawaiʻi. Currently, cargo from overseas is inspected by customs and border patrol agents with the assistance of USDA and SOH Department of Agriculture. However, inspections from mainland cargo may not always occur.

The DON requires decontamination (cleaning, including brushing and visual inspection) of all vehicles, equipment, personal gear, shoes, and clothing before personnel may enter a training area at JBPHH Main Base and Surrounding Areas in order to minimize the introduction of invasive terrestrial plant species.

Potentially invasive plant species can also be spread through poor landscaping choices. Table 8-7, Row 28 includes a recommendation to develop Invasive Species Biosecurity SOPs, including the decontamination of gear, IS training for personnel, and NAVFAC HI biologist review of landscaping projects to ensure no IS are used.

Control and Eradication

Once established, introduced organisms can be difficult, if not impossible to eradicate unless ample funding is dedicated and coordination with outside agencies and the public are undertaken. When eradication is not possible, control operations can continue to provide a level of protection for the native species and habitats threatened by the IS. Several IS require control at JBPHH Main Base and Surrounding Areas to protect sensitive species and habitats including coconut rhinoceros beetle, feral cats, mangroves, and pickleweed.

Coconut Rhinoceros Beetle

The DON issued a JBPHH Greenwaste Policy in 2018 (Appendix J-13). All greenwaste cleared or generated on any JBPHH property must remain on JBPHH property to prevent the spread of coconut rhinoceros beetle from JBPHH. If coconut rhinoceros beetle is discovered at any life stage during greenwaste clearing, work must stop, and NAVFAC HI Natural Resources staff must be notified so that they may report the observation to SOH Department of Agriculture. Currently, greenwaste is stored at the air curtain burner at JBPHH Main Base.

Eradication efforts on JBPHH are a collaboration between DON personnel, contractors, and SOH Department of Agriculture. University of Hawaiʻi at Mānoa Pacific Cooperative Studies Unit field biologists support these efforts by assisting with trap-checking and breeding site survey duties when necessary, alerting DON staff to potential breeding sites on base (e.g., standing greenwaste), and occasionally attending Coconut Rhinoceros Beetle working group meetings for awareness of ongoing issues. Additionally, canines are used to track and locate coconut rhinoceros beetle breeding sites. Injections of pesticides into host trees (completed autumn 2021) have greatly reduced the number of trapped beetles at Iroquois Point.

Naio Thrips

In May 2019, the OISC Naio Thrips Working Group determined the best way to bolster control efforts is to remove all naio plants from landscaping or restoration sites in an effort to protect wild populations. Currently, there are no treatments for naio thrips in the wild or in landscaping. Transport of the naio plant between islands is discouraged to help stop the spread of naio thrips to other islands where it has not yet been established (OISC, 2021). On JBPHH, SOPs for infested naio plants is to remove and bag all infested naio plants, and take the infested plants to the air curtain burner on Hickam for disposal.

Going forward, the Navy will refrain from hand pulling naio that are infested with naio thrips. The reason being: 1) The previous state goal was to prevent the spread of naio thrips to wild naio populations by removing naio (infested or non-infested). At this point naio thrips is now widespread and found in wild populations on the island. 2) It has been suggested to let the naio grow and see if the naio has built up a “tolerance” of the thrips. Monitoring for signs of growth and reproduction was recommended to see if the naio could live and flourish, even while being infested with naio thrips.

Feral Cats

Feral cats, even those that are sterilized and fed in feral cat colonies, hunt and prey on multiple species of birds, including endangered waterbirds. DON policy dictates that feral and stray cats not be fed (DoDI 4715.3, Appendix J-5) on DON lands. DON’s current policy (Table 8-7, Rows 1, 12, and 28) includes control of feral cats that prey on waterbirds and transfer diseases to Hawaiian monk seals. Feral cat control helps reduce the amount of toxoplasmosis that might enter the nearshore waters, further protecting critical habitat for the Hawaiian monk seal and Main Hawaiian Islands insular false killer whale.

Mangrove and Pickleweed

The DON has ongoing restoration plans within Pearl Harbor to remove mangrove and pickleweed as described in Sections 4.5.3, *Restoration of Natural Resource Areas*, and 4.5.6, *Wetlands*.

Invasive Marine Species

Control of invasive marine species (e.g., invasive sponge, soft coral, and algae) should be considered the most important priority to sustain and protect the fishery and benthic invertebrate resources of Pearl Harbor. NAVFAC HI will continue monitoring of the coral communities within Pearl Harbor on a periodic basis. Methods to control AIS, such as gorilla ogo, should be explored, possibly through a combination of reduced nitrification, manual control (super sucker), and urchin translocations. NAVFAC HI has requested funds for invasive marine species removal and monitoring.

4.5.5 Natural Resources Studies

DoDI 4715.3 directs DoD agencies to manage natural resources through principles of ecosystem management. Ecosystems with large proportions of native species are to be protected, and habitat restoration activities are to focus on native species’ habitats. Areas with moderate to high resource values, as shown in Figure 4-3, are to be managed to conserve those values.

Update and/or Initiate Fauna Studies at JBPHH Main Base and Surrounding Areas

As discussed in Section 4.5.1, *Protected Species and Ecosystem Monitoring and Management*, bird surveys for JBPHH Main Base and Surrounding Areas were conducted between 2014 and 2015 (Hamer Environmental, 2016). RCUH conducts ongoing, bi-weekly monitoring of seven wetlands within the study area to monitor ESA-waterbird usage. USDA conducts daily wildlife monitoring and BASH control at Hickam Airfield and conducts monthly wildlife surveys to document abundances and distribution of species that occur there. NAVFAC HI participates in biannual waterbird surveys conducted by the state and conducts periodic JBPHH-wide bird survey updates to continue the DON's effort to monitor, conserve, and sustain native bird species at JBPHH.

The DON conducted herpetological surveys and freshwater species surveys at JBPHH in the mid-2000s (NAVFAC PAC, 2006d, 2007b). These surveys provided data to NAVFAC HI Natural Resource staff regarding terrestrial amphibian, reptile, and freshwater aquatic species known to occur at JBPHH Main Base and Surrounding Areas. The Waiawa Stream Aquatic Species Survey (NAVFAC PAC, 2007b) reported observations of an indigenous dragonfly and native fish species, updating the survey to confirm if these species persist in the area would be of value. Focused herpetological surveys at JBPHH where they are a threat to native species (see Chapter 6, *JBPHH Lualualei Annex*) would be valuable to NAVFAC HI Natural Resources staff in managing native species on DON land.

Waiawa Watershed

The Waiawa Stream Aquatic Species Survey (NAVFAC PAC, 2007b) recommended that the portion of Waiawa Stream that contains indigenous dragonfly and native fish species be retained in its natural state. Furthermore, the survey report recommended that no land development be pursued that would alter the quality of the stream or degrade the streamside habitat. The DON continues to maintain the undeveloped nature of Waiawa Wetlands and limits public access to provide a benefit to bird, insect, and aquatic species.

Botanical Survey Updates

The DON updated botanical surveys for JBPHH Main Base and Surrounding Areas in 2015 (AECOM, 2016). The surveys provide needed data and information to allow NAVFAC HI Natural Resource staff to make decisions on how to protect, conserve, and manage vegetation communities and to identify areas of moderate to high natural resource value within the study area (see Figure 4-3). Ideally, botanical surveys will be conducted every 5 years.

An updated wetland inventory is needed for Pearl Harbor and ongoing monitoring and restoration of mangrove and pickleweed wetlands within the study area is recommended for NAVFAC HI to effectively manage wetland areas within JBPHH Main Base and Surrounding Areas.

Marine Biotic Resource Management and Monitoring

The DON has conducted focused marine surveys within Pearl Harbor between 2020 and 2022 (NAVFAC PAC, 2020c,d,f,h, 2021a,b, 2022a,b,c) for the purposes of updating this INRMP and in support of the SIOP. These surveys included surveys of the benthic habitats, community structure, and marine flora and fauna (sea turtle, coral, other non-coral invertebrates, and fish) near the Combined Naval Shipyard, Southern end of Ford Island, Waipiʻo Peninsula, and Victor Wharves. The results of these surveys are discussed in Section 4.4, *General Marine Biotic Environment*.

4.5.6 Wetlands

The JBPHH Natural Resources Manager's goal is to ensure that there is no net loss of wetlands on DON-controlled lands, while simultaneously establishing and/or enhancing native wetland species and reducing alien wetland species. Wetland goals and objectives are to restore wetland habitat while retaining wetland function. Wetland habitats, specifically for shorebirds and waterbirds, such as the endangered Hawaiian stilt, are to be restored through the removal of invasive mangroves and pickleweed. As of 2011, approximately 60 acres (25 hectares) of wetland were cleared of mangroves; however, 102 acres of mangrove (41 hectares) in Pearl Harbor remain. The cleared areas are experiencing mangrove regrowth and need to be regularly maintained. Table 8-7 identifies Currently Funded Projects at JBPHH for invasive plant removal and maintenance. As mentioned in Section 4.5.1, *Protected Species and Ecosystem Monitoring and Management*, the DON is taking an approach to enhance endangered species habitat on DON land, such as wetlands, when the enhancement is not in conflict with the military mission.

Removal of mangroves along the shoreline of Pearl Harbor is an ongoing effort and there are opportunities for partnership with community groups and other government agencies. For example, in 2014, the DON worked with Aliʻi Pauahi Hawaiian Civic Club and ʻAiea community members to complete mangrove removal from the Loko Paʻaiau Fishpond at McGrew Point. Additionally, USFWS Refuges contain two overlay refuges at Pearl Harbor (Honouliuli Unit and Waiawa Unit [Section 4.3.1, *Wetlands*]). The DON may consider working with USFWS to jointly manage additional wetland habitat at Pearl Harbor. A continued mangrove removal program, to include mature tree removal and maintenance through seedling removal, is described in Table 8-7, Row 14.

Wetlands act as filtering agents for streams flowing into Pearl Harbor, and coupled with riparian habitat along streams, buffer against high-flow events and excessive sedimentation. Wetlands at stream mouths in Pearl Harbor, and riparian areas upstream, serve a valuable purpose in maintaining water quality in the harbor. Removing mangroves may increase detrimental sedimentation effects of high-flow events. Native vegetation should be restored along riparian corridors and wetland areas to mitigate against the unintended consequences of mangrove removal. These wetlands and riparian areas often cross jurisdictional boundaries and must be protected via partnerships with local watershed protection groups. The DON's goal is to enhance their relationship with community groups to jointly protect our resources. Regular wetland and stream inventories (e.g., every 5 years) of those areas identified as high value areas and a mangrove restoration framework needs to be developed for implementing this goal. Projects such as these are described in Table 8-7, Rows 3, 9, 10, 13, 14, and 23.

No Net Loss of Wetlands

OPNAVINST 5090.1 requires "no overall net loss" of wetlands (DON, 2021d). The JBPHH Natural Resources Manager's goal is to ensure that there is no net loss of wetlands on DON-controlled lands, while simultaneously establishing and/or enhancing native wetland species and reducing alien wetland species.

NAVFAC HI Natural Resources staff work with the appropriate federal and SOH agencies when mitigation planning is required to reduce the severity or intensity of impacts from a proposed action. Mitigation planning can include: (1) avoiding the impact altogether by not taking certain actions or parts of action or by moving the project location or timing; (2) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the impact over time by monitoring, maintaining, and/or replacing equipment or structures so that future environmental degradation due to equipment or structural failure does not occur during the life of an action; and (5) compensating for the impact by replacing or providing substitute resources or environments.

Update of Pearl Harbor Wetland Inventory

The DON conducted a Pearl Harbor Wetland Inventory in 2007 (NAVFAC PAC, 2007a) that updated information contained in the 1999 Pearl Harbor Wetland Inventory (USACE, 1999). An updated wetland inventory is recommended.

4.5.7 Flood Plains

Section 4.2.6.1, *Surface Water Resources*, provides a description of the flood and tsunami zones at JBPHH Main Base and Surrounding Areas. There are no flood plain program elements associated with the study area. All new construction is reviewed by NAVFAC HI Environmental to ensure compliance with EO 11988, *Flood Plain Management*.

4.5.8 Land Management

Base Planning

Land management at JBPHH Main Base and Surrounding Areas and other DON installations is governed, in part, by DoDI 4715.03, *Natural Resources Conservation Program* (DoDI, 2018) ecosystem management guidelines. JBPHH staff follow a routine procedure to assure coordination among facilities planners, resource managers, and government agencies. The NAVFAC HI Natural Resources staff are the primary point of contact to provide relevant information on issues with potential to affect waterbirds or other protected species, such as sound levels, direct habitat loss due to clearance and construction, proximity to neighboring habitats, and sensitivity of the species to disturbance. The DON continues its policy of reducing point source pollution for JBPHH through identification of pollution sources and their reduction and/or elimination. The DON continues to utilize BMPs during earthwork and construction and storm drain design in order to maintain stabilize soil conditions and provide erosion control. The DON continues to maintain vegetation along shoreline segments in order to stabilize the shoreline and minimize siltation in Pearl Harbor. As of 2011, the DON removed 60 acres (24 hectares) of mangrove (an invasive plant species) from JBPHH Main Base and Surrounding Areas and permitted the removal of mangrove at PHNWR Waiawa Unit in an effort to support native vegetation and habitat at Pearl Harbor. The DON continues its policy of non-point source pollution prevention for JBPHH lands including the identification of non-point sources and their reduction and/or elimination. Table 8-8, Row 15 includes a recommendation to work with state agencies and private landowners to reduce non-point source pollution into the harbor.

Landscape Design

The DON continues to utilize native plants in landscape and enhancement projects throughout JBPHH and does not promote or encourage the use of noxious weed species. In accordance with DoDI 4715.03, native plants will be used to the maximum extent practicable when replacing or rejuvenating existing landscapes (DoDI, 2018). Similarly, SOH law Hawaiʻi Revised Statute 103D-408 requires the State to incorporate indigenous and Polynesian-introduced plants into its landscaping projects whenever and wherever feasible.

PHNWR Honouliuli and Waiawa Units

The DON worked with USFWS for the management of the overlay refuges, to improve vehicular access to PHNWR Waiawa Unit, and supported the USFWS in its development of a public (Betty Nagamine Bliss Memorial) overlook at PHNWR Honouliuli Unit.

Land Management Restrictions During Training

Military training planners work with NAVFAC HI Natural Resources and environmental planning staff prior to training activities. The DON prohibits vehicle traffic off existing roads, the use of rocks from rock piles or walls for training purposes, and establishment of new vehicle tracks during training maneuvers. In addition, during training maneuvers, digging, including entrenchments and foxholes, are prohibited, except in areas specifically designated by the exercise planner. No new placement of barbed wire or concertina wire or fences are allowed near signs marking the presence of sensitive ecological areas during training. No road, trail, or firebreak clearing is allowed during maneuvers without permission. No grading or construction of buildings or other permanent structures is allowed without permission.

Regulatory Coordination and Environmental Documentation – MAC Service Data Unit-1 Training

The DON coordinates with regulatory agencies to prepare environmental documentation as appropriate prior to MAC Service Data Unit-1 training. Coordination is necessary to reduce environmental impacts and to assist with the development of any required mitigation measures.

National Priorities List – Pearl Harbor Sediment Site

As described in Section 4.5.14, *Outdoor Recreation*, the DON completed an RI and addendum for Pearl Harbor to characterize chemical contaminants in sediments and marine life in the harbor and evaluate the potential threat of these chemical contaminants to human life and the environment (NAVFAC PAC, 2018b). A Record of Decision was signed in 2018 placing the Pearl Harbor Sediment site on the National Priorities List. The Record of Decision presents selected remedy for the site chosen by the DON and EPA in accordance with CERCLA as amended by the Superfund Amendments and Reauthorization Act (NAVFAC PAC, 2018b). Remediation at the Pearl Harbor Sediment site is ongoing.

4.5.9 Forestry

The DON continues to protect mature and significant trees and pocket forests at JBPHH Main Base and Surrounding Areas including forested areas along Waiawa and Waimano Streams in the Waiawa Watershed. The most extensive forest resource within JBPHH Main Base and Surrounding Areas is the mangrove forest that composes a thin band around the Pearl Harbor Shoreline. There is no known local commercial potential for mangrove and they are considered an IS that chokes out native plant species and destroys habitat for federally-listed bird species. Mangrove forests are effective in providing shoreline erosion control by trapping of upland sediments; however, the DON has been actively removing mangrove from selected portions of the shoreline at Pearl Harbor in order to improve native habitat and installation security.

Non-native forested areas exist in the interior of Makalapa Crater, Pearl City Peninsula, Red Hill Fuel Annex, and Waiawa Watershed. Forested areas within Waiawa Watershed function primarily to control erosion at riparian areas. Flash flooding within the property adjacent to Waiawa and Waimano Streams causes flooding along the stream banks. The forested areas within Waiawa Watershed prevent excessive soil loss during these periods of high water.

Mature and significant trees and landscapes are located in the developed portions of JBPHH Main Base and Surrounding Areas, including the DON family housing communities. These urban forests provide a range of amenities including enhancement of quality of life, climate control, sense of place, wildlife habitat, and aesthetic value.

Facility managers from NRH must get approval from the JBPHH Executive Officer prior to removing any tree(s) on base. This keeps JBPHH Command informed of tree losses. Prior to proceeding to the Executive Officer for approval, Facility Managers should consult and coordinate with the NAVFAC HI Landscape Architect and NAVFAC HI Historical Architect to determine whether the tree poses any safety issues or has any significant or historical value (to that area) prior to justifying the removal of that tree.

In addition, the DON has guidelines on tree maintenance, removal/replacement, and selection, described in the Navy Tropical Landscape Guide (DON, 2003). Culturally significant and/or historic landscapes, which can include trees, are detailed in the Integrated Cultural Resources Management Plan (CNRH, 2008). The DON project recommendations include BMPs to prevent clearing trees greater than 15 feet (4.6 meters) in height during the bat pupping season (June 1 through September 15) and verification that trees or bushes scheduled for removal do not contain the active nests of migratory birds.

4.5.10 Wildland Fire

The DON continues to maintain security fencing and fire breaks at both Red Hill Fuel Annex and Waiawa Watershed in order to minimize fire hazards at those outlying properties. Wildland fires have not been an issue at JBPHH Main Base and Surrounding Areas. The FFD would respond to any fires at JBPHH Main Base and Surrounding Areas. In case of fire during training exercises, all fires will be reported to the FFD and personnel will stop training and begin to fight the fire. Personnel will continue to fight the fire until released by the fire department.

4.5.11 Use of Geographic Information Systems

JBPHH's natural resources data are being integrated into the DON's enterprise geodatabase and made available to planners and land managers to aid in decision-making. The NAVFAC HI Natural Resources staff ensure that newly acquired or updated natural resources information is integrated into the NAVFAC HI geodatabase on a regular basis.

NAVFAC HI staff continually maintain their GIS database to include the locations of protected flora and fauna species at JBPHH Main Base and Surrounding Areas. This continually updated GIS database will include the ESA-listed bird species (e.g., Hawaiian stilt), MBTA-protected bird species, and vegetation types.

4.5.12 Access Restrictions

JBPHH is a secure military installation, with access limited to military personnel, civilian employees, contractors, and military families. The public is allowed access to JBPHH Main Base for specific purposes (e.g., special events, media coverage, visiting houseguests, etc.) but requires a background check and sponsor. Organized public tours, such as those to the USS Missouri and Pearl Harbor Aviation Museum, are permitted on Ford Island.

For the purposes of security, public safety, and the interests of the military mission, the DON restricts access to the shoreline and waters of Pearl Harbor, including NDSA, and Puʻuloa Underwater Range (see Figure 4-2). This restricted action has created a de facto marine fisheries reserve at Pearl Harbor.

4.5.13 Community Outreach

NRH has implemented an environmental education campaign directed at installation personnel, residents, visitors, and the general public. The objective of the campaign is two-fold: strengthen the centralized repository of natural resources information and continue to efficiently disseminate JBPHH natural resources information to increase awareness among base personnel, installation residents, and the community. Table 8-8, Rows 2, 6, 17, and 29 include increased inreach and community outreach projects. Outreach information typically includes, but is not limited to: Hawaiian hoary bat, green sea turtles, Hawaiian monk seals, white terns, wildlife lighting, feral cat police, invasive species (coconut rhinoceros beetle, brown tree snake, etc.), and avoidance and minimization measures.

4.5.14 Outdoor Recreation

According to the Sikes Act (16 U.S.C. 670a et seq.), outdoor recreation relates to activities that take advantage of the natural resources of an area to provide recreational opportunities for installation personnel. If there is no conflict with the installation mission, access and use by other DoD employees and the general public is recommended. Outdoor recreation activities described in this INRMP do not include the provision or management of recreational facilities generally associated with urban developments such as playgrounds, golf courses, athletic fields, hobby shops, and swimming pools.

Outdoor recreation planning is accomplished within the broader context of natural resources management where land uses are intended to satisfy both the needs for outdoor recreation as well as the preservation of natural resources. Outdoor recreation, as described in this plan, is confined to areas within the installation boundaries over which the DON has management authority.

Operational constraints, including security requirements at the installation, limit the available land suitable for development of outdoor recreation activities. In addition, the size of the on-base resident population is used to justify the demand for outdoor recreation facilities. Recreational opportunities at NAVMAG PH/West Loch Annex, including Waipiʻo Peninsula, are either non-existent or severely limited due to access restrictions.

The waters of Pearl Harbor and much of the surrounding land are largely off-limits for public recreational use. Current DON regulations permit limited fishing and recreational boating by authorized personnel (e.g., military and civilian employees of DoD and their dependents and guests) in designated areas. The majority of harbor waters are restricted due to berthing, ship movements, industrial operations, and/or safety constraints. Hunting is not permitted at JBPHH Main Base and Surrounding Areas. Bathing, water skiing, and recreational swimming are not permitted in Pearl Harbor.

Fishing

Recreational fishing within Pearl Harbor and Iroquois Point is authorized in designated areas only as pole and line fishing on a catch and release basis (Appendix J-14: Joint Base Pearl Harbor-Hickam Instruction [JBPHHINST] 5510.4, January 2022.). Spearfishing, crabbing, or net fishing are not permitted. General public fishing areas are shown in Figure 1 of JBPHHINST in Appendix J-14 and include portions of the shoreline along Middle Loch, East Loch, ʻAiea Bay State Recreation Area, and West Loch Shoreline Park. Military housing resident fishing areas include shorelines along Pearl City Peninsula, McGrew Point, Ford Island, Hospital Point, and Hickam Housing areas. DoD card holders are permitted to fish on the north side of Ford Island and portions of the Hickam Coastline. Kapilina Beach Homes (formerly Iroquois Point Housing) residents and the public may fish within areas of the Iroquois Point Lagoon).

Fishing from privately-owned boats is prohibited within Pearl Harbor. Commanding Officers of ships moored in Pearl Harbor but outside of the Shipyard may authorize crewmembers to fish from their own ship's decks. Fishing is prohibited within the NDSA, the Puʻuloa Underwater Range, and the Barbers Point Underwater Range (see Figure 4-2).

Public fishing from non-DON (e.g., SOH) lands is regulated by SOH DLNR that is responsible for enforcement of fish and game regulations on non-DON lands around the harbor. However, public fishing by unauthorized personnel from DON land occurs regularly and openly in many areas. In addition, a variety of illegal fishing methods are employed including the use of oversize nets, spears, and fish/crab traps. The majority of the illegal methods occur in areas where enforcement is difficult.

Consumptive fishing from DON land at Pearl Harbor is not permitted due to concerns about contaminated fish and shellfish. In 1998, HDOH issued an advisory warning based on the DON's preliminary RI results that humans should not consume fish and shellfish caught in Pearl Harbor (NAVFAC PAC, 2018b), posted warning signs in various locations around the harbor, and published multilingual brochures warning of possible health effects associated with eating fish and shellfish from the harbor.

Rainbow Bay Marina

Located on DON land, Rainbow Bay Marina in East Loch is managed and operated by MWR to provide outdoor recreational services for authorized personnel.

The DON allows recreational boating, sailing, canoeing, and kayaking by authorized personnel in specified locations in Pearl Harbor; however, permits are required. Eligible DoD personnel may launch their own boats from Rainbow Bay Marina under permit from MWR. MWR provides various watercraft activities to authorized patrons from its Rainbow Bay Marina facilities, including sailing, kayaking, canoeing classes, deep-sea fishing (by contractor in areas outside of Pearl Harbor), self-contained underwater breathing apparatus (i.e., SCUBA) diving (by contractor outside of Pearl Harbor), and boat rentals. Windsurfing and related activities are not permitted in Pearl Harbor. The DON permits the Honolulu Canoe Club and the Pearl Harbor Yacht Club to operate their organizations from the Rainbow Bay Marina. These organizations allow participation from both DoD and the general public. The DON has maintained and promoted recreational boating policies at Pearl Harbor for MWR-authorized patrons. JBPHHINST 5510.3 (Appendix J-15) governs the entry and operation of privately-owned local craft in the Pearl Harbor NDSA. This instruction provides regulations on the operation of personal watercraft, kayak operating instructions, kayak operating areas, MWR specific operations, and recreational catch and release fishing in Pearl Harbor.

Pearl Harbor Bike Path

The Pearl Harbor Bike Path follows the historic Oʻahu Railway and Land Company right-of-way around Pearl Harbor (see Figure 4-4). The bike path extends along the Pearl Harbor Shoreline from the Arizona Memorial Visitor Center, is closed at the Admiral's Boat House, resumes south of the boathouse, and extends to Waipahu Depot Road at the northwest corner of Waipiʻo Peninsula and is maintained by the CCH. A portion of the path, from the Arizona Memorial Visitor Center to Waipiʻo Point Access Road, is on DON property. From that point, it turns into a SOH-owned right-of-way. CCH maintains the bike path.

Other Recreational Opportunities

Recreational use by installation personnel is limited to casual bird watching and nature study. No formal programs exist for such activities for base civilian and military personnel. The DON supported USFWS efforts to build the Betty Nagamine Bliss Memorial Overlook at PHNWR Honouliuli Unit in order to provide outdoor recreational activities to JBPHH personnel and the general public. The DON has continued to promote public events at JBPHH Main Base and Surrounding Areas including the Ford Island Fun Run and canoe regattas at Pearl Harbor.

4.5.15 Law Enforcement

Base law enforcement is responsible for patrolling the restricted portions of JBPHH Main Base and Surrounding Areas. The family housing communities that have unrestricted access are patrolled by a security contractor and the Honolulu Police Department. JBPHH military, civilian, and contractor security forces work with the NAVFAC HI Natural Resources Program Manager in reporting any incidents or observations pertaining to Hawaiian monk seals on the beaches. They enforce beach and fishing restrictions and ensure that the public does not disturb monk seals or basking or nesting sea turtles hauled out on beaches. However, for reporting violations of natural resources laws, the DON security forces report any incidents to SOH officials. Fishing regulations are discussed in Section 4.5.14, *Outdoor Recreation*, and Appendix J-15.

4.5.16 Leases and Encroachment Management

4.5.16.1 Agricultural Leases

Under the DON's agricultural outleasing program, Puʻuloa Farms, located at NAVMAG PH/West Loch Annex, leased 1,025 acres (415 hectares). Due to a proposed Hawaiian Electric Company photovoltaic farm, Puʻuloa Farms now occupies approximately 923 acres (374 hectares) (Figure 4-34). The Puʻuloa Farms Lease expiration date was extended to March 31, 2024. For the 5-year period commencing on April 1, 2013, annual payment for rent was $35,700 paid quarterly in advance at a rate of $8,925. For the 5-year period commencing on April 1, 2018, this rate was not changed. Crops planted in 2020 include watermelon, tomatoes, and cucumbers.

Prior to 2005, CNRH outleased two parcels of land at Pearl City Peninsula under two 5-year lease agreements: 19.5 acres (7.9 hectares) to Takano Nakamura Landscaping for $12,000 per year, and 18.2 acres (7.4 hectares) to Gushing Waters for $21,000 per year. The Gushing Waters parcel was vacated in 2005 and is not included in Figure 4-28. The Takano Nakamura Landscaping lease expired in 2007; although, the tenant is currently on hold over status and continues to pay rent that is now $16,000 per year. A succeeding lease is currently underway. There is an adjacent 3-acre (1.2-hectare) agricultural parcel at Pearl City Peninsula; however, that area is not currently being outleased (NAVFAC HI, 2008). Revenue from Agricultural Outlease goes back into the Natural Resources program.

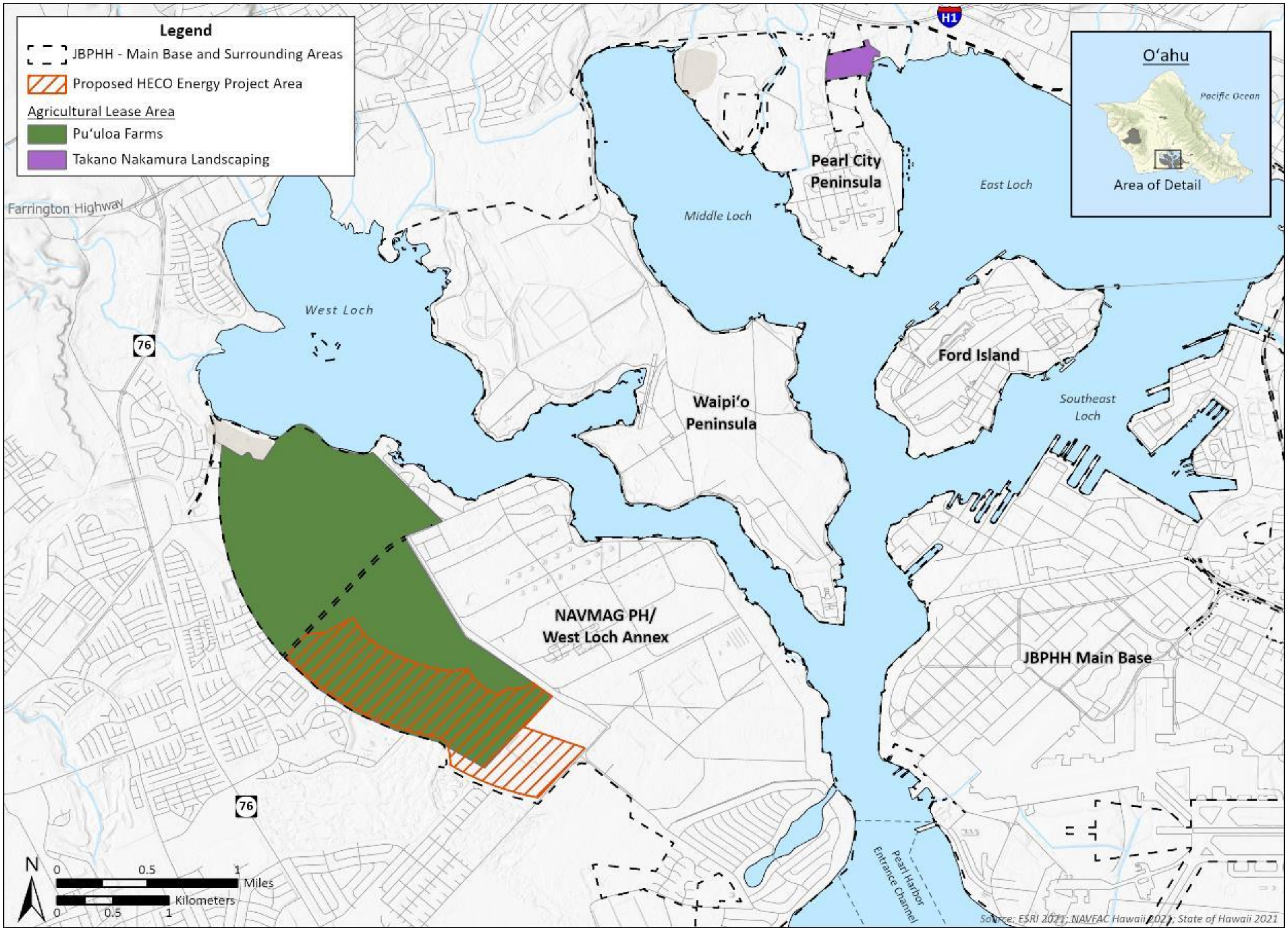

Figure 4-34 Agricultural Leased Areas

Encroachment

In 2021, the DON developed an Encroachment Management Plan to identify potential community development, or changes in local laws/regulations that may affect the DON operating procedures (DON, 2021a). Potential encroachment issues identified in the plan for JBPHH Main Base and Surrounding Areas are listed below.

- Development of the Honolulu Authority for Rapid Transit-Oriented Development is an encroachment concern for JBPHH Main Base as it may introduce new sight lines onto the installation and/or violate AT/FP standoff distances.
- Illegal drone flights frequently occur on base and present surveillance and aircraft safety threats. Additionally, tourist helicopters routinely violate airspace rules over JBPHH, which presents security and safety concerns.
- The threat of SLR is an encroachment concern for JBPHH Main Base. Projected SLR and recurrent flooding could damage base facilities and render some facilities unusable in the long-term. Additionally, JBPHH facilities are highly vulnerable to damage during significant weather events that could interrupt base operations, cause power outages, or damage facilities or assets resulting in long-term impacts on operations and increased costs.
- Significant historic and archaeological resources are present at JBPHH Main Base and Surrounding Areas. As a steward of cultural resources, the DON must comply with federal regulations related to those resources (e.g., National Register of Historic Places [NRHP] and National Historic Landmark [NHL]). The presence of cultural resources increases costs associated with staffing, planning, and mitigation of effects to cultural resources throughout JBPHH (DON, 2021a).
- Long-term homeless encampments are present along the Pearl Harbor Bike Path and the mangroves throughout the Pearl Harbor area. The homeless population and unauthorized civilians have been known to trespass, break in, use drugs, and illegally dump at JBPHH. Unauthorized access at JBPHH is a security concern and may lead to additional costs for repairs (e.g., fencing and/or equipment repairs, illegal dumping removal) and is a safety concern (DON, 2021a).
- Tourists have nearly free access once on Ford Island, exposing the DON to liability and safety/security concerns. Foreign entities may access Ford Island for surveillance or other illicit purposes.
- Pearl Harbor routinely experiences significant runoff and sediment deposits after heavy rains and runoff causes water quality issues which is a concern to human and environmental health.
- Past legislative efforts have attempted to limit activities at the Red Hill Fuel Annex, and future efforts have the potential to arise. Future legislation could directly limit or stop operations at Red Hill Fuel Annex.

4.5.17 Climate Considerations

Chapter 3 provided an overview of the climate risks that may impact JBPHH. Table 4-17 describes specific climate considerations, vulnerabilities, and adaptations for JBPHH Main Base and Surrounding Areas.

Table 4-17 JBPHH Main Base and Surrounding Areas Climate Considerations, Vulnerabilities and Adaptations

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
1) ESA- and SOH-listed Species (See Tables 4-8 and 4-15)	<u>ESA- and SOH-listed Waterbirds</u>: • Hawaiian Duck (*Anas wyvilliana*) • Hawaiian Coot (*Fulica alai*) • Hawaiian Gallinule (*Gallinula chloropus sandvicensis*) • Hawaiian Stilt (*Himantopus mexicanus knudseni*)	*MEDIUM*: Although habitat and food availability will be impacted by climate changes, waterbirds may be able to relocate. <u>*SLR, Severe Storms*</u>*:* Loss of terrestrial habitat because of rising sea levels and associated storm surge is a serious threat to Hawaiian waterbirds. <u>*Warmer Temperatures, Diseases*</u>: Warming temperatures could affect waterbird food supply, available breeding habitat, predation (rat, mongoose, cat, etc.) and increase the risk of avian botulism. Botulism is an important cause of mortality in waterbirds, including some endangered species, and climate change may have consequences on the ecology of wetlands that favor the occurrence of botulism outbreaks (USFWS, 2019a, 2019b, 2019c; USFWS, 2018).	Continue to monitor changes in distribution and numbers, perform habitat restoration, and protect existing birds. Management Actions described in *Section 4.5.1* include: Hawaiian waterbird surveys and monitoring along with habitat restoration. *Table 8-7, Rows 3, 7, 8, 10 thru 14, 16, and 29* provide recommendations for JBPHH Main Base and Surrounding Areas to include minimum monthly waterbird surveys and Pearl Harbor wetland and riparian ecosystem restoration (including Āhua Reef wetlands restoration and in accordance with USFWS 26 Aug 2009 Hickam Biological Opinion [Appendix J-1]) and predator control. Compliance with the Biological Opinion wetland restoration conservation measures occurs with both monthly volunteer service projects and annual contracted projects. Recommendations for the DON projects that could impact waterbirds include BMPs to inform personnel of the presence of ESA waterbirds and conduct nest surveys both prior to project initiation and repeat surveys if nests are found.

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
1) ESA- and SOH-listed Species (See Tables 4-8 and 4-15) (continued)	SOH-listed Birds: • Hawaiian Short-eared Owl (*Asio flammeus sandwichensis*) • White Tern (*Gygis alba*)	MEDIUM: Although habitat and food availability will be impacted, MBTA birds may be able to relocate. *Warmer Temperatures*: Warming temperatures could affect their food supply and available breeding habitat.	Monitor changes in distribution and numbers and protect existing birds. Management Actions described in *Section 4.5.1* include bird surveys. *Table 8-7, Rows 2, 4, and 8* provide recommendations for JBPHH Main Base and Surrounding Areas to include updating flora and fauna surveys to monitor for changes in these species in the study area. Hawaiian short-eared owl and white tern are SOH-listed species on Oʻahu. Twilight pre-construction surveys shall be conducted by a qualified biologist prior to clearing any vegetation. Anytime Hawaiian short-eared owl adults/nests/chicks are found and/or flushed out during clearing operations, contractors must stop work and inform NAVFAC HI Natural Resources Manager of the Hawaiian short-eared owl presence which contributes to population survey data. If nests are found to be present, a buffer zone should be established in which no clearing occurs until nesting ceases.

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
1) ESA- and SOH-listed Species (See Tables 4-8 and 4-15) (continued)	Terrestrial Mammal: • Hawaiian Hoary Bat *(Lasiurus cinereus semotus)*	*MEDIUM:* Although habitat and food availability may be impacted, the Hawaiian hoary bat may be able to relocate. <u>*Warmer Temperatures, Change Precipitation*</u>*:* Hawaiian hoary bat could be threatened by the effects of climate change if less habitat becomes available for foraging, roosting and pupping; however, there is a general lack of knowledge concerning its distribution, abundance, and habitat needs. While prime habitats include native moist and rain forests up to 6,000 feet (1,830 meters), bats also use native xeric and disturbed habitats as well as wet to moist non-native habitats and urban areas (USFWS, 2021). Changing precipitation and rising temperatures could affect the bat's food availability (moths, beetles, crickets, mosquitoes, and termites). In addition, bats tend to move to higher elevations with cooler temperatures during January through April, potentially because the cooler temperatures allow them to achieve a lower metabolic rate while roosting.	Between January and June, trimming of tall mature trees at JBPHH Main Base should only be performed after the tree has been inspected for white tern. Monitor for changes in the distribution and numbers. *Table 8-7, Row 5* provides recommendations for JBPHH Main Base and Surrounding Areas to include Hawaiian hoary bat acoustic surveys. The DON project recommendations include BMPs to prevent clearing trees greater than 15 feet (4.6 meters) in height during the bat pupping season June 1 through September 15.

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
1) ESA- and SOH-listed Species (See Tables 4-8 and 4-15) (continued)	Marine Mammals: • Sei Whale (*Balaenoptera borealis*) • Blue Whale (*Balaenoptera musculus*) • Fin Whale (*Balaenoptera physalus*) • Humpback Whale (*Megaptera novaeangliae*) • Hawaiian Monk Seal (*Neomonachus schauinslandi*) • Sperm Whale (*Physeter macrocephalus*) • Main Hawaiian Islands Insular False Killer Whale DPS (*Pseudorca crassidens*) • Spinner Dolphin (*Stenella longirostris*)	*MEDIUM:* Although habitat and food availability will be impacted, marine mammals may be able to relocate. *Ocean Warming, Acidification, SLR:* Changes in seawater temperature, freshening of seawater, acidification, rises in sea levels, the loss of icy polar habitats and the decline of food sources are just some of the many risks which climate change poses for marine mammals. Some cetacean species may immediately benefit from climate change; however, many studies point to long-term negative impacts for many species. Due to oceanic temperature changes alone, numerous marine habitats will drastically change, which will result in the endemic marine mammal species (i.e., whales, seals) to either quickly adapt or move to more habitable environment. *SLR, Storm Surge:* Loss of terrestrial habitat because of rising sea levels and associated storm surge is a serious threat to Hawaiian monk seals. The majority of the seal haul outs at Pearl Harbor have been at the Iroquois Point-Puʻuloa Beach area which are projected to be impacted by SLR (see Chapter 3).	Monitor for changes in the distribution and numbers. Management Actions described in *Section 4.5.1* include: Marine mammal and sea turtle monitoring. *Table 8-7, Row 23, and Table 8-8, Rows 8, 14, and 33* provide recommendations for JBPHH Main Base and Surrounding Areas to include annual Hawaiian monk seal monitoring, protection program with BMPs, wetland ecosystem restoration, and predator control to reduce cat populations that are vectors to transmit toxoplasmosis. The DON project recommendations include BMPs to halt work when marine mammals or sea turtles are within 50 yards (46 meters) of the work area (depending on the intensity and duration of work).

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
1) ESA- and SOH-listed Species (See Tables 4-8 and 4-15) (continued)	Reptiles: • Loggerhead Turtle (*Caretta caretta*) (North Pacific DPS) • Green Sea Turtle (*Chelonia mydas*) (Central North Pacific DPS) • Leatherback Turtle (*Dermochelys coriacea*) • Hawksbill Turtle (*Eretmochelys imbricata*) • Olive Ridley Turtle (*Lepidochelys olivacea*)	*VERY HIGH:* The effects of climate change are likely to be very high for sea turtles because they use both marine and terrestrial habitats during their life cycles. <u>*SLR*</u>*:* A rise in sea level is likely to reduce the available beach habitat for turtle nesting and basking. Sea turtles' memories are "imprinted" with a magnetic map of the sandy beach where they hatch. As adults, they often return to the same beaches annually to nest; these beaches are under threat from SLR. <u>*Increased Sand Temperatures*</u>*:* An increase in nesting beach temperatures impact many aspects of turtle embryonic development. Hotter nest temperatures have been linked to a decrease in hatchling fitness and increased occurrence of defects. Sea turtles exhibit temperature dependent sex determination and temperature changes could skew gender ratios. <u>*Ocean Warming, Acidification*</u>*:* Rising oceanic temperatures are likely to negatively impact food resources for virtually all marine species. Coral reefs, which are an important food source for sea turtles, are at risk from bleaching and acidification. Warmer ocean temperatures may cause changes in ocean circulation and alter sea turtle movements and possibly shift their range	Monitor for changes in the distribution and numbers. Management Actions described in *Section 4.4.1.1* include: Marine surveys of Pearl Harbor and JBPHH Main Base and Surrounding Areas. *Table 8-7, Row 27, and Table 8-8, Row 24* provide recommendations for JBPHH Main Base and Surrounding Areas to include marine resources and fisheries survey. The DON project recommendations include BMPs to halt work when marine mammals or sea turtles are within 50 yards (46 meters) of the work area (depending on the intensity and duration of work).

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
1) ESA- and SOH-listed Species (See Tables 4-8 and 4-15) (continued)	Fish and EFH: • EFH • Oceanic white-tipped shark • Giant manta ray	and the timing of their reproductive cycles. *Severe Storms:* More severe storms could increase the chance that sea turtle nests will flood and/or wash out. *MEDIUM:* Although habitat and food availability will be impacted, fish may be able to relocate. *Ocean Warming, Acidification, SLR:* Changes in seawater temperature, freshening of seawater, acidification, rises in sea levels, and the decline of food sources are just some of the many risks which climate change poses for fish. Due to oceanic temperature changes alone, numerous marine habitats will drastically change, which will result in the endemic fish species to either quickly adapt or move to more habitable environment.	Monitor for changes in the distribution and numbers. *Table 8-7, Row 27, and Table 8-8, Row 24* provide recommendations for JBPHH Main Base and Surrounding Areas to include marine resources and fisheries survey.
2) Wetlands Management	Wetlands habitats that support diverse flora and fauna assemblages (Concurrently protects above ESA-listed waterbirds and federal CWA-regulated wetland ecosystems)	*HIGH*: The direct impacts of rising temperatures (including ocean acidification), changing precipitation patterns, extreme weather events and SLR may increase chronic flooding, sediment/pollutant runoff, beach/shoreline erosion and high wave impacts. *SLR:* Rising sea levels may lead to inundation and loss of coastal wetlands and contribute to elevated coastal storm surges. In some instances, water inundation may create new wetlands. Collectively these climate changes may have significant impacts on ecologically	Wetlands help to provide the natural infrastructure that supports testing, training, and operational readiness at JBPHH. JBPHH INRMP follows an ecosystem-based management approach and fosters long-term sustainability of ecosystems services. The principles of ecosystem management to foster long-term sustainability of ecosystem services dovetails well with the climate adaptation risk-based management

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2) Wetlands Management (continued)		productive wetlands that support diverse flora and fauna ecosystems.	concepts and is adaptable to complex and changing requirements. Management Actions described in *Section 4.5.1* include Hawaiian waterbird habitat restoration. Goal 2 of the JBPHH INRMP includes recovery of terrestrial ecosystems including wetlands. *Table 8-7, Rows 3, 13, 14, and 29* provide recommendations for JBPHH Main Base and Surrounding Areas to include riparian and wetland restoration actions including climate adaptation. Compliance with the USFWS 26 Aug 2009 Hickam Biological Opinion (Appendix J-1) wetland restoration conservation measures to remove IS and out-plant native flora occurs with both monthly volunteer service projects and annual contracted projects. The DON project recommendations include BMPs to remove invasive red mangroves from wetland areas with minimal disturbance of sediments that could increase water turbidity. Current JBPHH Main Base and Surrounding Areas policy is to stop grass cutting during waterbird nesting season at West Loch Oxidation Pond.

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
3) Migratory Bird Treaty Act (MBTA)	JBPHH Main Base and Surrounding Areas is home to a diversity of MBTA-protected birds (Table 4-9) and bird habitats.	*MEDIUM:* Rising temperatures and changing precipitation patterns may increase the growth of certain bird populations, from longer breeding seasons and changes in habitat and cause shifts in the distribution and abundance of bird species. Warmer temperatures may favor the occurrence of botulism outbreaks in waterfowl and shorebirds that may impact migrating waterfowl and shorebirds (i.e., plovers, turnstones, tattlers, etc.). Severe Storms may increase the number of wedge-tailed shearwater fallouts.	DoD MBTA position is that incidental/unintentional take of migratory birds is still prohibited. While there is no specific INRMP MBTA project, the INRMP programs/projects for wetland restoration and predator control also benefit MBTA birds. JBPHH maintains an SOP for injured and grounded seabird response (Appendix J-10) *Table 8-7, Rows 2, 4, and 8* provide recommendations that includes periodic flora and fauna surveys. Navy project recommendations include BMPs to verify that trees or bushes scheduled for removal do not contain the active nests of migratory birds.
4) Invasive Species (IS)	PRIORITY IS INCLUDE: Plants: • Pickleweed (*Batis maritima*) • Mangrove, Red (*Rhizophora mangle*) Vertebrates: • Feral Cat (*Felis catus*)	*HIGH:* Climate change and IS rank among the largest predicted threats to global ecosystems over the next century. Climate-related impacts often operate through amplifying the impact of existing stressors, such as IS. IS are, by nature, highly flexible, and respond to unusual environments more quickly than do natives. And with the help of climate change, IS also reap the benefits that come with	Management Actions described in *Section 4.5.1* include Hawaiian waterbird habitat restoration. INRMP wetland goals and objectives are to restore wetland habitat while retaining wetland function. *Table 8-7, Rows 1, 9, 11, 12, 14, 19, 25, and 28* provide recommendations for

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
4) Invasive Species (IS) (continued)	• Small Indian Mongoose (*Herpestes javanicus*) • Rodents Invertebrates: • Coconut Rhinoceros Beetle (*Oryctes rhinoceros*) • Naio Thrips (*Klambothrips myopori*) Non-native Marine Species: • Invasive Algae • Snowflake coral (*Carijoa riisei*) • Biofouling such as Orange Keyhole Sponge (*Mycale armata*)	early blooming, shading out competitors and capturing a larger share of nutrients, water, or pollinators. Changing rainfall patterns may increase the spread of IS. Warming air temperatures lead to expanded IS. Extreme climatic events, such as hurricanes, floods, and droughts, can transport IS to new areas and decrease the resistance of habitats to invasions Climate change may increase available food for IS, feral cats, mice, rats, and mongoose. IS can impact marine coastal, freshwater, wetland, and riparian habitats with altered hydrological regimes. Warming ocean water temperatures may result in earlier mixing and phytoplankton blooms that may alter zooplankton development. Changes to timing of zooplankton reproduction and/or abundance could favor certain species over others and may have negative consequences for aquatic ecosystems. Increased water and air temperatures, increased CO_2, altered stratification regimes, increased sea levels, and changes in surface runoff (that affect siltation and eutrophication) may help or hinder AIS (EPA, 2008). Rising temperatures may benefit some IS' range expansion.	JBPHH Main Base and Surrounding Areas to include predator control; Wetland and Riparian Restoration/Management Actions; Climate Adaptation Planning; Invasive Species Biosecurity (Appendix J-12); Reduce/Prevent Release AIS; Marine Species Surveys; and Predator Control. Compliance with the USFWS Aug 26, 2009 Hickam Biological Opinion (Appendix J-1) wetland restoration conservation measures to remove IS and out-plant native flora occurs with both monthly volunteer service projects and annual contracted projects. The DON project recommendations include BMPs to remove invasive red mangroves from wetland areas with minimal disturbance of sediments that could increase water turbidity.

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
5) Bird/Wildlife Aircraft Strike Hazard (BASH)	Airfield Vicinity: • Near Ocean Surface (Pelagic, seabirds, petrels, shearwaters, tropicbirds, etc.) • Drainage Ditches and Standing Water (Waterbirds, waterfowl, shorebirds, herons, stilts, cattle egrets, etc.) • Turf, Tree, and Bush Habitat Birds (Gamebirds, pigeons, doves, owl, passerines, etc.)	*MEDIUM*: Changing rainfall and temperature patterns may affect bird populations and change their distribution around airfields. More rainfall creates standing water that is attractive to waterbirds. Inland inundation may create new wetlands. Increased flooding may also create new ponding areas. Loss existing wetland habitat could cause waterbirds to relocate nearer to airfield. Global warming may increase the growth of certain bird populations, from longer breeding seasons and changes in habitat, placing new pressure on airport wildlife control programs to mitigate the hazard of bird strikes to aircraft. Low atmospheric pressure associated with storm activity may also lead to more bird strikes on land. As climate change causes shifts in the distribution and abundance of bird species, there may be instances where bird hazards can pose increased risks to runways and JBPHH flight operations. Efforts to control bird populations at airports may need to be strengthened (Scott, 2004).	Management Actions described in *Section 4.5.1* includes Bird Surveys and Monitoring. *Table 8-8, Row 1* provides recommendations for JBPHH Main Base and Surrounding Areas to include BASH Support for Hickam Airfield. NAVFAC HI Natural Resources staff attend JBPHH quarterly BASH meetings, share mutual bird field survey data with the USDA BASH Technicians, and provide comments for periodic updates to the written JBPHH BASH Plan.

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
6) Wildland Fire	Wildfire poses a risk to dry ecosystem habitats (i.e., grassland and coastal mesic forest, etc.), personnel, facilities, and other infrastructure.	*LOW:* The rate of warming air temperature has increased in Hawaiʻi in recent decades that increases the risk of wildfires during drought occurrences. Wildland fire risks are low at JBPHH Main Base and Surrounding Areas based on historical records.	The DON continues to maintain security fencing and fire breaks at both Red Hill Fuel Annex and Waiawa Watershed in order to minimize fire hazards at those outlying properties. Wildland fires have not been an issue at JBPHH Main Base and Surrounding Areas *(Section 4.5.10)*. The FFD would respond to any fires at JBPHH Main Base and Surrounding Areas. In case of fire during training exercises, all fires will be reported to the FFD and personnel will stop training and begin to fight the fire. Personnel will continue to fight the fire until released by the fire department. *Table 8-7, Row 21 and Table 8-8, Row 36* provide recommendations for JBPHH Main Base and Surrounding Areas includes coordination with the FFD and Honolulu Fire Department and to establish a wildland fire management plan.

Notes: AIS = Aquatic Invasive Species; BMP = Best Management Practice; CO_2 = carbon dioxide; CWA = Clean Water Act; DoD = Department of Defense; DON = Department of the Navy; EFH = Essential Fish Habitat; EPA = United States Environmental Protection Agency; ESA = Endangered Species Act; FFD = Federal Fire Department; IS = Invasive Species; INRMP = Integrated Natural Resources Management Plan; IS = invasive species; JBPHH = Joint Base Pearl Harbor-Hickam; MBTA = Migratory Bird Treaty Act; NAVFAC HI = Naval Facilities Engineering Systems Command, Hawaii; SLR = Sea Level Rise; SOH = State of Hawaii; USFWS = United States Fish and Wildlife Service.

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5 JBPHH Lualualei Annex

Photograph 5-1: Niuliʻi Ponds Wildlife Refuge (September 2020)

5.1 Current Conditions and Use

5.1.1 Installation Information

JBPHH Lualualei Annex is composed of two separate yet contiguous facilities, NAVMAG PH Lualualei and NRTF Lualualei, jointly referred to as Lualualei Annex (study area) (Figure 5-1). JBPHH Lualualei Annex contains 9,220 acres (3,731 hectares) and is located on the Waiʻanae Coast of Oʻahu. NAVMAG PH Lualualei contains 7,520 acres (3,043 hectares) and is located on the eastern side of Lualualei Valley. NRTF Lualualei contains approximately 1,700 acres (688 hectares) within the Lualualei Valley floor.

5.1.2 General Description, Operations, and Activities

As described in Section 5.1.1, JBPHH Lualualei Annex includes two contiguous facilities; their locations are shown on Figure 5-1.

5.1.2.1 NAVMAG PH Lualualei

NAVMAG PH Lualualei Branch is a munitions magazine complex that includes storage and operational facilities, community and personnel support facilities, and large areas of open space.

5.1.2.2 NRTF Lualualei

NRTF Lualualei is used to transmit state-of-the-art high and low frequency radio signals for the navigation of Navy vessels throughout the Pacific.

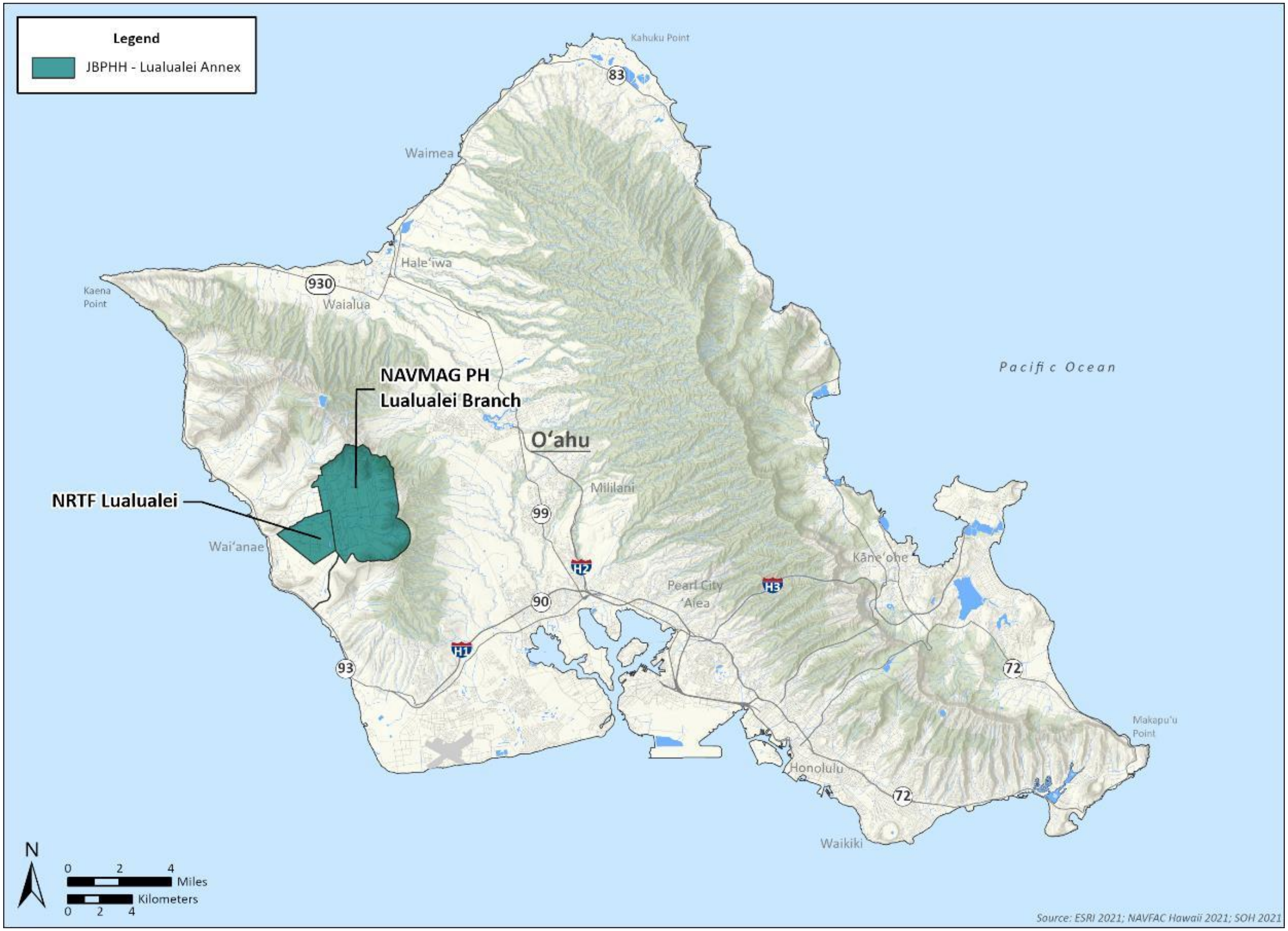

Figure 5-1 JBPHH Lualualei Annex Overview

5.1.3 Abbreviated History and Pre-Military Land Use

Lualualei Valley is the largest coastal valley on the southwestern side of Oʻahu. Native Hawaiians initially occupied the valley with temporary settlements noted from as early as the mid-1400s. During the pre-contact period (before 1778), Hawaiians grew sweet potatoes, yams, and taro within the valley. Establishment of permanent Native Hawaiian habitation sites began in the mid-to-late 1600s and continued through the early 1800s as the population within the valley increased (CNRH, 2006). Waiʻanae District, which includes Lualualei Valley, is tied to many gods and goddesses of Polynesia and the archipelago from its creation. The coastal end of Ulehawa Stream to the south of the NRTF Lualualei is reputed to have been the birthplace of the demi-god Maui (CNRH, 2008).

Sugarcane cultivation began in the Lualualei Valley after the Waiʻanae Sugar Company began operation in the Waiʻanae Valley in 1878. By 1892, 300 acres (121.4 hectares) of sugarcane had been planted in central Lualualei. A railroad, irrigation ditches and flumes, and reservoirs were constructed. "Cane Camp," a plantation housing area, was established adjacent to the railroad tracks by Niuliʻi Reservoir. The Waiʻanae Sugar Company ceased operations in 1946 (NAVFAC PAC, 1998a).

Following the overthrow of the Hawaiian monarchy in 1893, former Crown Lands were offered as homesteads. Development of the first homestead lots in Lualualei began in 1902. Some of the lots were in areas that the Waiʻanae Sugar Company had developed for sugarcane planting in the central Lualualei Valley. By 1912, L. McCandless had leased or purchased most of the first series of homestead lots for use as a cattle ranch. In addition, McCandless had subleased use-rights for some of these areas to the Sandwich Island Honey Company for establishing apiaries. The McCandless Ranch continued to raise cattle in the valley until 1929 (NAVFAC PAC, 1998a).

In the early twentieth century, the U.S. military established an ammunition depot at NAVMAG PH Lualualei and continued to use the area through World War II, the post-war, and the Cold War (CNRH, 2008). Between 1929 and 1931, the DON acquired more than 8,300 acres (3,358.9 hectares) in the Lualualei Valley, most of which was the former McCandless Ranch (CNRH, 2008). In 1933, under provisions of the Hawaiian Homes Commission Act of 1921, the Territorial Governor gave a 1,729-acre (699.7-hectare) lot in Lualualei Valley to the DON (CNRH, 2008).

The primary Cold War activities at NAVMAG PH Lualualei were extensions of the 1930s and World War II functions, including storage and renovation of ordnance (NAVFAC PAC, 1998a). As part of the DON's Shore Establishment Reassignment, Naval Ammunition Depot Oʻahu was disestablished on July 1, 1974.

5.1.4 Land Use and Land Use Constraints

Situated within a broad amphitheater-headed valley on the western side of the Waiʻanae Mountain Range of Oʻahu, Hawaiʻi, most of JBPHH Lualualei Annex is open space and disturbed open space. There are relatively small areas of industrial, administrative, and unoccupied housing. The non-DON-lands surrounding JBPHH Lualualei Annex are rural with some privately-owned small truck farms and residential developments. The nearest urban area is the town of Māʻili, approximately 0.5 mile (0.8 km) to the southwest. Encroachment is a concern for the study area and is discussed further in Section 5.4.15, *Agricultural Leases and Encroachment*.

There are environmental constraints at JBPHH Lualualei Annex. Areas of moderate to high natural resource value include Management Units (MUs), Niuliʻi Ponds Wildlife Refuge, and critical habitat (see Section 5.3.3.2, *Fauna*) that provide habitat for terrestrial ESA-listed and MBTA-protected species (Figure 5-2).

5.1.5 Military Land Use Opportunities

There are opportunities for additional training and operations.

5.1.6 Regional Land Uses

Most of NAVMAG PH Lualualei and all of NRTF Lualualei are within the SOH State Agricultural District, with the upland areas of NAVMAG PH Lualualei extending into the State Conservation District. The northwest corner of NRTF Lualualei touches an Urban District containing the town of Māʻili (SOH LUC, 2021). Both installations are zoned by the CCH as F-1 (Military and Federal Preservation). The upper slopes of NAVMAG PH Lualualei are zoned P-1 (Restricted Preservation District). Areas adjacent to the western edge of NAVMAG PH Lualualei and lands surrounding NRTF Lualualei are either zoned AG-2 (General Agricultural District) or Country District (CCH, 2021).

5.2 General Physical Environment

The discussion of the general physical environment is divided into six subsections (5.2.1 through 5.2.6): physical geography, topography, climate, geology, soils, and hydrology—including surface water resources and hydrogeology (groundwater resources). General island-wide descriptions of these resources are presented in Section 2.2; the following discussion addresses the study area and environs.

5.2.1 Physical Geography

Lualualei Valley is a caldera remnant of the Waiʻanae Volcano and is bound by Waiʻanae Valley to the north, Nānākuli Valley to the south, the Waiʻanae Range on the west, and the Pacific Ocean on the east. It is the largest valley in leeward Oʻahu and is composed of a large, flat valley floor. NAVMAG PH Lualualei occupies most of the inland portion of the valley, and in places, extends to the ridge of the Waiʻanae Range. NRTF Lualualei is located on the western boundary of NAVMAG PH Lualualei. A general discussion of the physical geography of the Hawaiian Islands and Oʻahu is presented in Section 2.2.1.

5.2.2 Topography

JBPHH Lualualei Annex is composed of a large, flat valley floor, which includes several smaller valleys, gently sloping into an alluvial fan. Bound on the west by the 22-mile (35-km) long Waiʻanae Mountain Range, the 6,500-acre (2,631-hectare) Lualualei Valley is located between the Waiʻanae Valley to the north and the Nānākuli Valley to the south. NAVMAG PH Lualualei consists of essentially flat lands at an elevation of 80 feet (25 meters) above MSL along Fence Road, gently sloping in the magazine area, and graduating to steep mountainous slopes in the Waiʻanae Range with a maximum elevation of 3,127 feet (953 meters) (Figure 5-3). NRTF Lualualei ranges in elevation from 10 feet (3.1 meters) above MSL at the western corner to 100 feet (30.5 meters) above MSL on the west side (Figure 5-3). A general discussion of the topography of Oʻahu is presented in Section 2.2.2.

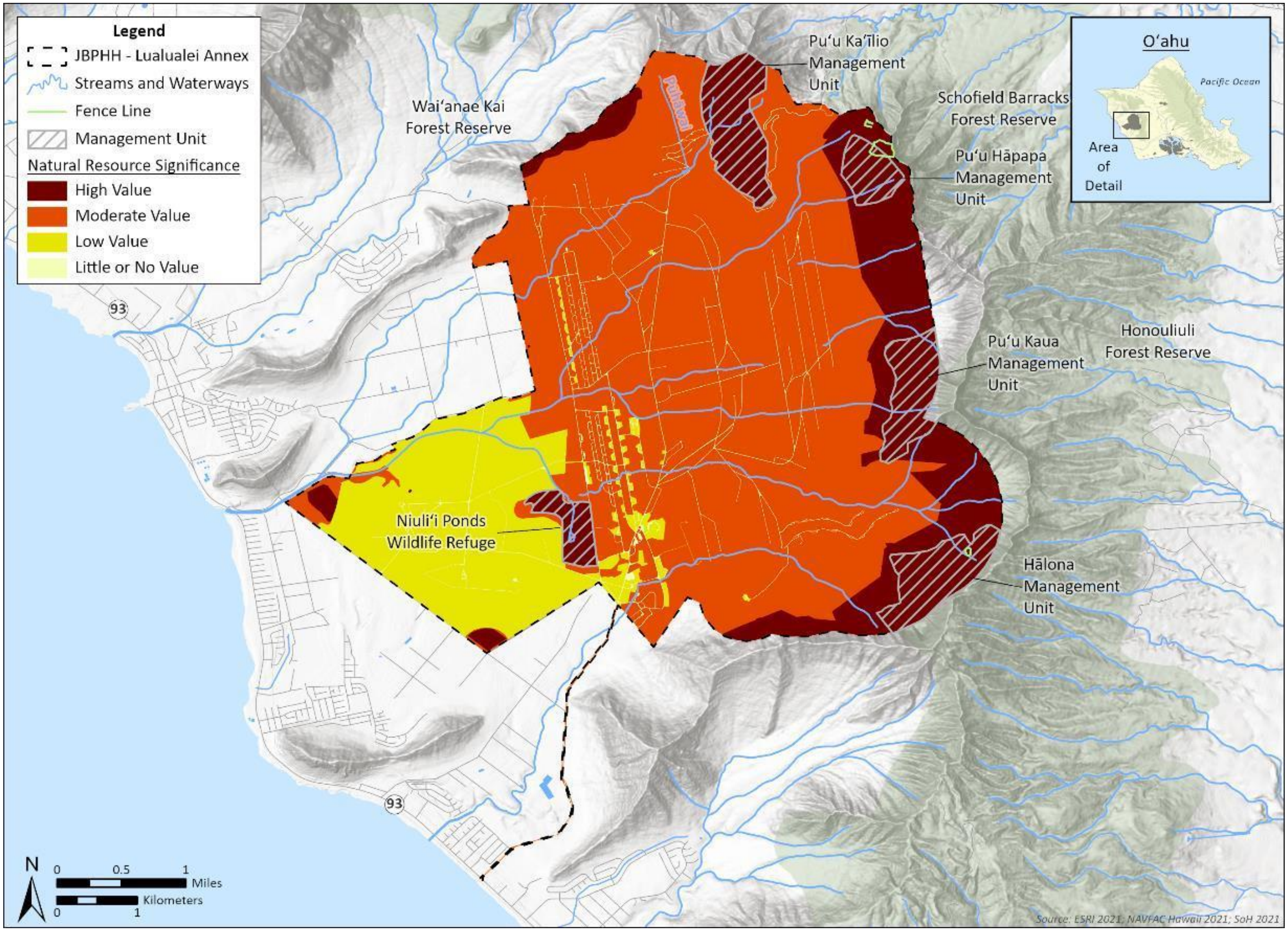

Figure 5-2 JBPHH Lualualei Annex Land Use Constraints

Figure 5-3 JBPHH Lualualei Annex Topography

5.2.3 Climate

A general discussion of the climate for the island of Oʻahu is presented in Section 2.2.3. The climate of Lualualei Valley is warm and dry with an average air temperature of approximately 79°F (26°C) in the summer and approximately 72°F (22°C) in the winter. The highest maximum monthly average is approximately 87.5°F (30.8°C), for the month of August and the lowest minimum monthly average is 63.4°F (17.5°C) for the month of February (NOAA, 2021) (Table 5-1).

Table 5-1 10-Year Monthly Average Air Temperature Ranges near JBPHH Lualualei Annex (2011-2020)

Month	*Waiʻanae Valley (Fahrenheit [Celsius])*		
	Monthly Average	*Monthly Maximum Average*	*Monthly Minimum Average*
January	72.15 (22.31)	80.12 (26.73)	64.18 (17.88)
February	71.16 (21.76)	78.89 (26.06)	63.42 (17.46)
March	71.55 (21.97)	79.14 (26.19)	63.91 (17.73)
April	74.27 (23.48)	81.94 (27.75)	66.55 (19.19)
May	75.12 (23.96)	82.78 (28.21)	67.43 (19.68)
June	77.27 (25.15)	84.72 (29.29)	69.84 (21.02)
July	78.77 (25.98)	86.33 (30.18)	71.20 (21.78)
August	79.75 (26.53)	87.49 (30.83)	71.98 (22.21)
September	79.25 (26.25)	87.17 (30.65)	71.32 (21.84)
October	77.86 (25.48)	85.73 (29.85)	70.00 (21.11)
November	75.64 (24.24)	82.76 (28.20)	68.49 (20.27)
December	73.60 (23.11)	80.59 (26.99)	66.63 (19.24)

Source: NOAA, 2021.

Rainfall at the installation is highly variable due to the many different tropical features and elevations. Average annual rainfall on the summit crest near Kolekole Pass is approximately 46 inches (117 cm) per year and decreases to approximately 22 inches (56 cm) at the Waiʻanae Coast (NOAA, 2021).

5.2.4 Geology

The Lualualei Valley is a caldera remnant of the Waiʻanae Volcano. The valley extends from the summit of Mount Kaʻala at 4,015 feet (1,224 meters) to a wide plain near sea level. Non-lithified alluvial sediments that are largely the result of stream deposition and coralline reef deposits fill Lualualei Valley to approximately 1,214 feet (370 meters) below present sea level (Presley et al., 1997). The high cliffs along the eastern half of the valley are comprised primarily of Waiʻanae basalt lava flows (Stearns and Vaksvik, 1935). The lava flows are separated on the northern and southern ends of the valley by interspersed masses of volcanic breccias, vertical dike complexes, and volcanic tuff. A general discussion of the geology of Oʻahu is presented in Section 2.2.4.

5.2.5 Soils

Table 5-2 provides a summary of the soil types found at JBPHH Lualualei Annex and Figure 5-4 depicts the locations of the soil types. The soils reflect the volcanic geology and erosional history of the region. One of the predominant soil types of the study area are soils of the Lualualei Series which are fine-grained soils predominated by highly plastic clay. These soils have a high shrink-swell potential that can cause cracking of the soils and foundations of structures built upon them (USDA-NRCS, 1972).

Table 5-2 Soils of JBPHH Lualualei Annex

Soil Type	*Location*	*Description*	*Characteristics*
ʻEwa Series: The ʻEwa Series consists of well-drained soils in basins and on alluvial fans. These soils developed in alluvium derived from basic igneous rock.			
ʻEwa stony silty clay, 6 to 12 percent slopes (EwC)	This soil type occurs on alluvial fans and terraces.	In a representative profile, the surface layer is dark reddish-brown silty stony clay about 18 inches (46 cm) thick. The subsoil is about 42 inches (107 cm) thick and is dark reddish-brown and dark-red silty clay loam that has subangular blocky structure. The substratum is coral limestone, sand, or gravelly alluvium. The soil is neutral in the surface layer and subsoil.	Permeability is moderate. Runoff is slow to medium and erosion hazard is slight to moderate. The available water capacity is about 1.3 inches/feet (10.8 cm/meter). This soil is more than 60 inches (152 cm) deep.
ʻEwa Silty clay loam, moderately shallow, 0 to 2 percent slopes (EmA)	This soil type occurs on alluvial fans and terraces.	This soil has a profile like EwC except that the depth to coral limestone is 20 to 50 inches (51 to 127 cm).	Permeability is moderate. Runoff is very slow, and the erosion hazard is mild. The available water capacity is about 1.3 inches/feet (10.8 cm/meter). This soil is more than 60 inches (152 cm) deep.
Haleʻiwa Series: The Haleʻiwa series consists of well-drained soils on fans and in drainageways along the coastal plains. These soils developed in alluvium derived from basic igneous material.			
Haleʻiwa silty clay, 0 to 2 percent slopes (HeA)	This soil type occurs as large areas on alluvial fans or as long narrow areas in drainage ways.	In a representative profile, the surface layer is dark brown silty clay about 17 inches (43 cm) thick. The subsoil and substratum, to a depth of more than 5 feet (2 meters), are dark brown and dark yellowish-brown silty clay that has subangular blocky structure. The soil is neutral to slightly acid.	Permeability is moderate. Runoff is very slow, and the erosion hazard is no more than slight. The available water capacity is about 1.9 inches/feet (15.8 cm/meter).
Haleʻiwa silty clay, 2 to 6 percent slopes (HeB)	This soil type occurs as large areas on alluvial fans or as long narrow areas in drainage ways.	This soil type is similar to HeA.	This soil type is similar to HeA except that runoff is slow, and the erosion hazard is slight.

Soil Type	*Location*	*Description*	*Characteristics*
Lualualei Series: Lualualei Series consists of well-drained soils on the coastal plains, alluvial fans, and on talus slopes. These soils developed in alluvium and colluvium. They are nearly level and gently sloping.			
Lualualei clay, 0 to 2 percent slopes (LuA)	This soil type occurs on alluvial fans.	In a representative profile, the surface layer, about 10 inches (25 cm) thick, is very dark grayish brown, very sticky, and very plastic clay that has prismatic structure. The next layer, 27 to more than 42 inches (69 to 107 cm) thick, is a dark grayish brown, very sticky, and very plastic clay that has prismatic structure. In addition, it has gypsum crystals. The soil is underlain by coral, gravel, sand, or clay at depths below 40 inches (102 cm). It is neutral in the surface layer and medium acid to moderately alkaline in the underlying layers.	This soil cracks widely upon drying. Permeability is slow, runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.4 inches/feet (11.7 cm/meters). The very sticky and very plastic nature of the clay makes cultivation difficult and practical only within a narrow range of moisture content. Because of the high shrink and swell potential, considerable care is necessary when using this soil as a site for buildings or highways.
Lualualei clay, 2 to 6 percent slopes (LuB)	This soil type occurs on alluvial fans.	It is similar to LuA except for the slope.	The soil is similar to LuA except that runoff is slow, and the erosion hazard is slight.
Lualualei stony clay, 0 to 2 percent slopes (LvA)	This soil occurs on alluvial fans adjacent to drainageways.	It is similar to LuA except that there are enough stones to hinder machine cultivation.	This soil is similar to LuA.
Lualualei stony clay, 2 to 6 percent slopes (LvB)	This soil occurs adjacent to drainageways.	It is similar to LuA except that there are enough stones to hinder machine cultivation.	This soil is similar to LuA except that runoff is slow, and the erosion hazard is slight.
Lualualei extremely stony clay, 3 to 35 percent slopes (LPE)	This soil occurs on talus slopes.	This soil is similar to LuA except that there are many stones on the surface and in the profile. It is impractical to cultivate this soil unless the stones are removed.	This soil is similar to LuA except that runoff is medium to rapid, and the erosion hazard is moderate to severe.

Soil Type	*Location*	*Description*	*Characteristics*
Māmala Series: This series consists of shallow, well-drained soils along the coastal plains. These soils formed in alluvium deposited over coral limestone and consolidated calcareous sand.			
Māmala stony silty clay loam, 0 to 12 percent slopes (MnC)	These soils occur on coastal plains.	Neutral to mildly alkaline, dark reddish-brown stony silty clay loam in the surface layer (approximately 8 inches [20 cm] thick). The subsoil is neutral to mildly alkaline, dark reddish-brown silty clay loam (approximately 11 inches [28 cm] thick). The soil is underlain by coral limestone and consolidated calcareous sand at depths of 8 to 20 inches (20 to 51 cm). Stones, mostly coral rock fragments, are common in the surface layer and in profile.	Permeability is moderate. Runoff is very slow to medium, and the erosion hazard is slight to moderate. The available water capacity is 2.2 inches/feet (18 cm/meter) in the surface layer and 1.9 inches/feet (16 cm/meters) in the subsoil.
Pūlehu Series: This series consists of well-drained soils on alluvial fans and stream terraces and in basins. These soils developed in alluvium washed from basic igneous rock.			
Pūlehu clay loam, 0 to 3 percent slopes (PsA)	This soil is found on alluvial fans and stream terraces and in basins.	In a representative profile, the surface layer is dark brown clay about 21 inches (53 cm) thick. This is underlain by dark brown, dark grayish brown, and brown massive loam and silt loam about 39 inches (99 cm) thick. Below this is coarse, gravelly, or sandy alluvium. The soil is neutral in the surface layer and neutral to mildly alkaline below the surface layer.	Permeability is moderate. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.4 inches/feet (11.6 cm/meters) in the surface layer and subsoil.
Pʻlehu stony clay loam, 2 to 6 percent slopes (PuB)	This soil is found on alluvial fans and stream terraces and in basins.	This soil is similar to PsA except that on this soil, there are sufficient stones to hinder tillage but not enough to make intertilled crops impracticable.	This soil is similar to PsA except that runoff is slow, and the erosion hazard is slight to moderate. Workability is difficult because of the stones.
Pʻlehu very stony clay loam, 0 to 12 percent slopes (PvC)	This soil is found on alluvial fans and stream terraces and in basins.	This soil is similar to PsA except that as much as 3 percent of the surface is covered with stones.	This soil is similar to PsA except that runoff is slow to medium, and the erosion hazard is slight to moderate. Workability is difficult because of the stones.

Soil Type	*Location*	*Description*	*Characteristics*
Rockland (rRK)	This soil type includes exposed rock covering 25 to 90 percent of the surface and can be found at Makalapa Crater and Red Hill Fuel Annex.	The rock outcrops and very shallow soils are the main characteristics. The rock outcrops are mainly basalt and andesite.	In many areas, the soil material associated with the rock outcrops is very sticky and very plastic. It also has high shrink-swell potential. Buildings on the steep slopes are susceptible to sliding when the soil is saturated. Foundations and retaining walls are susceptible to cracking.
Stony land (rST)	This soil type occurs in valleys and on side slopes of drainage ways.	It consists of a mass of boulders and stones deposited by water and gravity. Stones and boulders cover 15 to 90 percent of the surface. The soil among the stones consists of silty clay loam. In most places, there is enough soil among the stones to provide a foothold for plants.	No characteristics were reported.
Tropohumults-Dystrandepts Association: Areas mapped as Tropohumults-Dystrandepts association consist of mountainous areas in the Waiʻanae Range. Deep, V-shaped drainage ways and narrow ridges dominate the areas. Most of this association is very steep and inaccessible. It serves mainly as a watershed.			
Tropohumults-Dystrandepts Association (rTP)	Tropohumults occur on narrow ridge tops at the higher elevations. Dystrandepts occur on steep side slopes and narrow ridge tops at the lower elevations. These soils formed mainly in volcanic ash, but partly in colluvium. Histosols occupy small, wet positions near mountain peaks.	The soils in this association consist mainly of Tropohumults and Dystrandepts. Histosols make up a smaller part of the association. Tropohumults are well-drained, strongly acidic to extremely acidic soils. The surface layer consists of reddish-brown silty clay that has strong structure and high bulk density. The subsoil has strong subangular blocky structure; it is underlain by an ironstone pan or by saprolite. A hard crust that has a purplish cast forms on these soils in some places where the vegetation has been depleted.	No characteristics were reported.

Soil Type	*Location*	*Description*	*Characteristics*
Tropohumults-Dystrandepts Association (rTP) (continued)		Dystrandepts are dark-colored, friable soils. In most places, the surface layer is silty clay. The subsoil is generally massive. They are well drained and medium to strongly acidic. Histosols are poorly drained and have accumulations of organic materials as much as 3 feet (1 meter) thick.	

Notes: cm = centimeter(s)
Source: USDA, 1972.

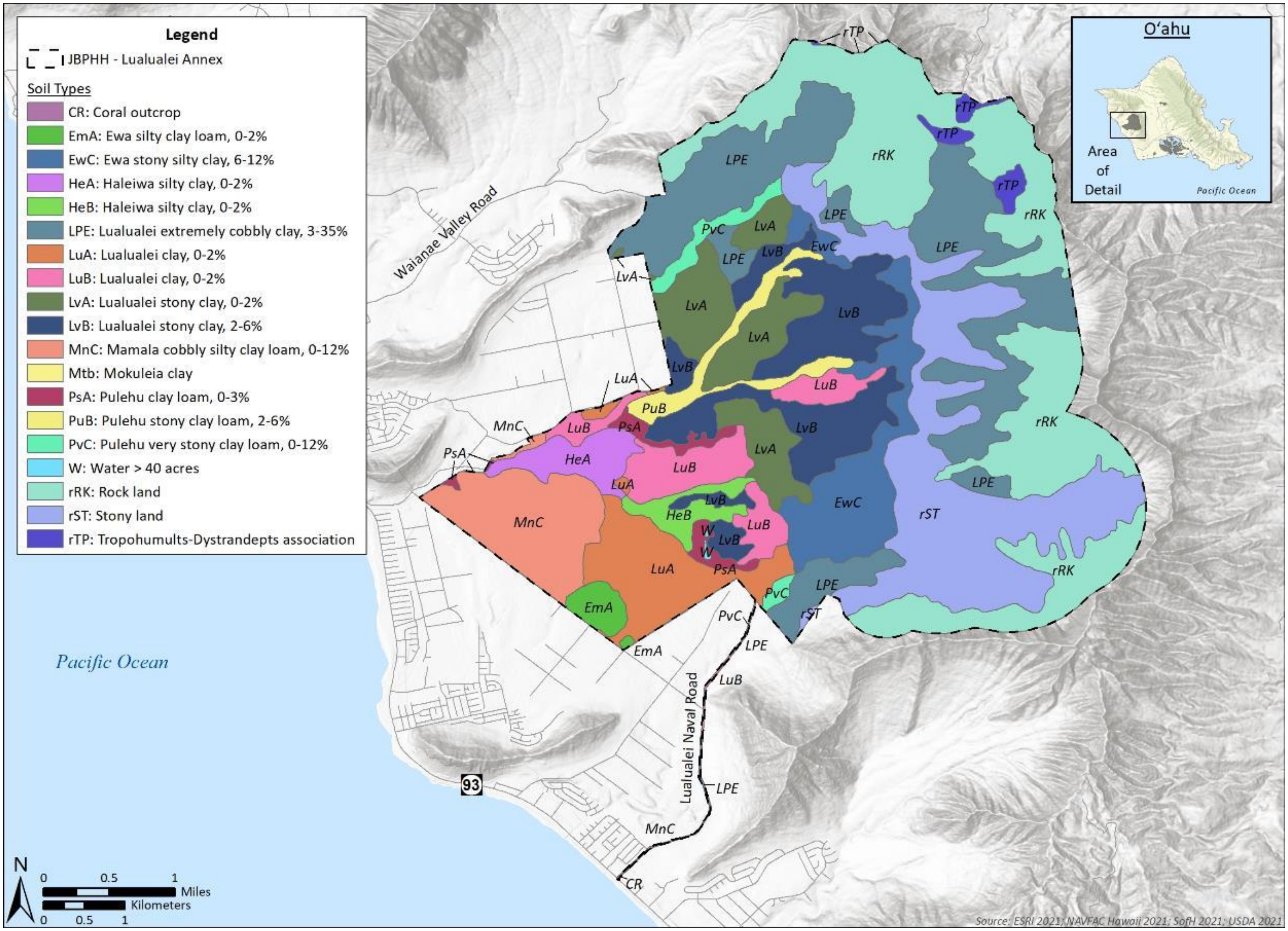

Figure 5-4 JBPHH Lualualei Annex Soils

5.2.6 Hydrology

A general discussion of Oʻahu's hydrology is presented in Section 2.2.5. The discussion of the hydrology of Lualualei Annex is divided into two subsections: surface water and groundwater resources (hydrogeology).

5.2.6.1 Surface Water Resources

There are two watersheds within the boundaries of the study area, the Māʻiliʻili and Ulehawa Watersheds (Figure 5-5) (SOH DAR and Bishop Museum, 2008). There is one perennial stream located in Lualualei, Pūhāwai Stream, which is located on the north-central portion of NAVMAG PH Lualualei (Figure 5-5). There were once streams in all five of the smaller valleys within Lualualei Valley; however, many of these streams have since disappeared or are now intermittent due to water diversions for agriculture and urban use (DON, 2001a). After passing through the study area, all streams empty into the Pacific Ocean.

NAVMAG PH Lualualei lands drain toward the western boundary of the installation adjacent to NRTF Lualualei into a fork of Māʻiliʻili Stream, an intermittent stream emanating from the Waiʻanae Mountain Range. The upper reaches of Māʻiliʻili Stream are typical of many small Hawaiian watersheds with short, straight channels, steep gradients, and narrow stream bottoms, and thus are subject to flash flooding. The fans onto which storm water flow discharges are extremely stony and their black vertisols, once expanded, have low water intake rates. Adjacent to, and south of NRTF Lualualei is Ulehawa Stream which runs through NAVMAG PH Lualualei (DON, 2001a). While there are no natural or permanent freshwater lakes, streams, or wetlands at NRTF Lualualei, there are two former stabilization and oxidation ponds (Niuliʻi Ponds Wildlife Refuge) that support the adjacent NAVMAG PH Lualualei sewerage system, (DON, 2001a). Niuliʻi ponds are filled via a septic tank which separates solids and allows untreated effluent liquid to discharge into Niuliʻi ponds and excess water from NAVMAG PH Lualualei drinking water system. The stabilization and oxidation ponds (Niuliʻi Ponds Wildlife Refuge) are further discussed in Section 5.3.1, *Wetlands*.

5.2.6.2 Hydrogeology

Groundwater resources beneath Lualualei Valley are recharged primarily by rainfall in higher elevations of the valley that then infiltrate the ground surface and percolate downward into the permeable sediments and fractured basalts. Groundwater occurs within the alluvial sediments, the coralline limestone, and in the basaltic lava flows that crop out at higher elevations in the mountainous areas and form the deep bedrock beneath the sediment deposits.

Three different aquifer types occur at Lualualei Valley. At the head of the valley, groundwater occurs in a high-level, unconfined aquifer within dike compartments in the basalt. Further downslope toward the ocean, the site and surrounding area contain groundwater in two recognized regional systems: a deep confined basaltic aquifer (basal aquifer) and a near-surface unconfined caprock aquifer. The near-surface unconfined caprock aquifer is the first groundwater system encountered below the site.

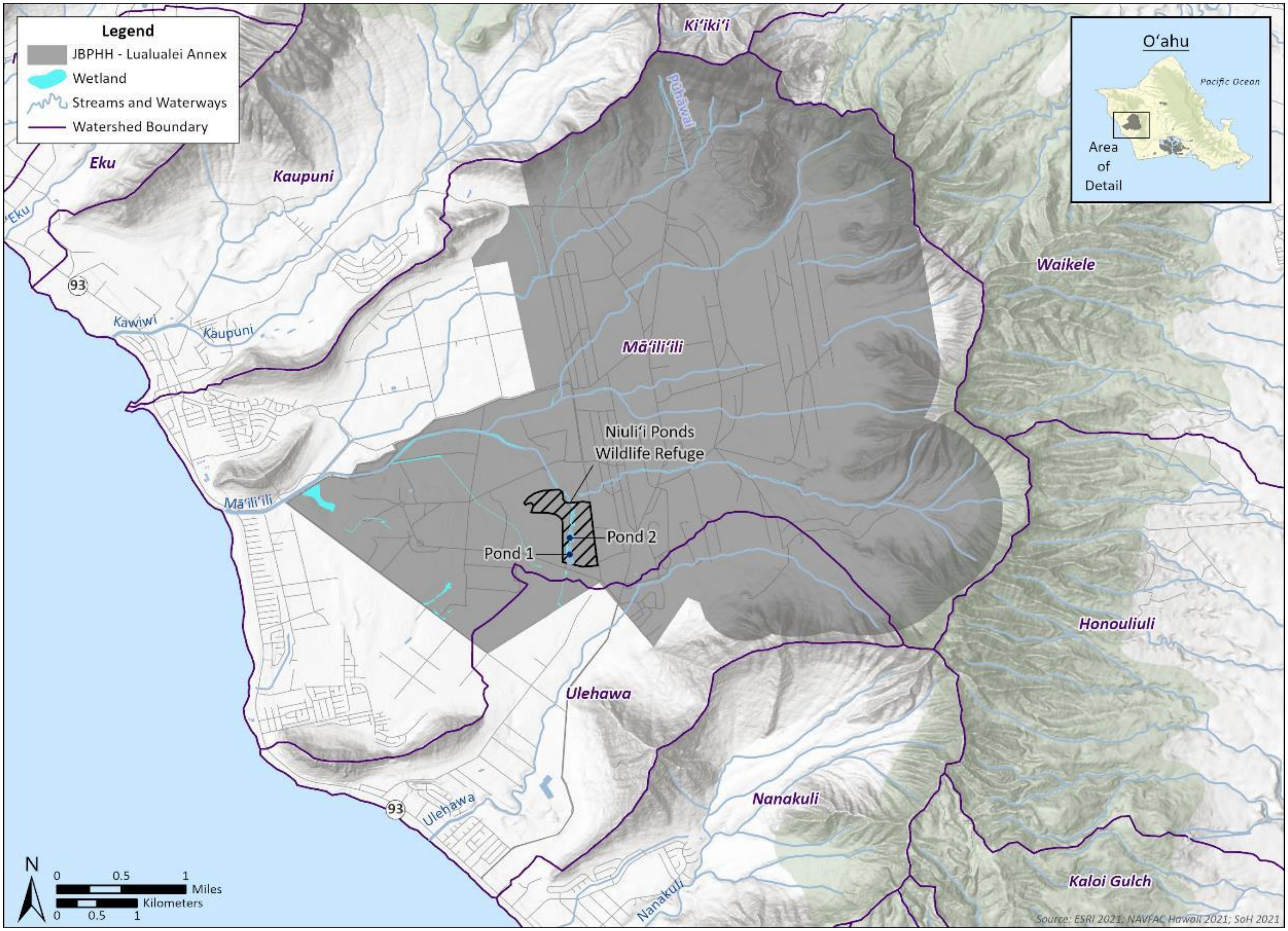

Figure 5-5 JBPHH Lualualei Annex Watersheds and Streams

The study area is located within the Lualualei Aquifer System of the Waiʻanae Aquifer Sector. At higher elevations, the eastern portion of NAVMAG PH Lualualei is underlain by a high-level, unconfined, dike-compartment aquifer that is currently used for drinking water. This aquifer is considered to be fresh with less than 250 milligrams per liter (mg/L) chlorides (Cl^-). It is considered irreplaceable with a high vulnerability to contamination (Mink and Lau, 1990). The installation derives its drinking water from this aquifer, which is fed by Pūhāwai Stream, located at the north end of the installation (see Figure 5-5). The intermittent stream appears to flow from water percolating from dikes just above the base of Puʻu Kūmakaliʻi. A large artificial aqueduct that connects to the base of the mountain is adjacent to Pūhāwai Stream and can be seen from Kolekole Road. Another water source is Pōhākea Spring, located in the southeast portion of the valley in the Hālona Subdistrict. This water source, however, is small in comparison to the Pūhāwai Stream water source, and water flowing from this spring often collects in a small reservoir or dissipates downstream (DON, 2001b).

The majority of the western portion of the installation at lower elevations is largely underlain by a basal, unconfined, dike-compartment aquifer that has potential use. It has moderate salinity (1,000 to 5,000 mg/L Cl^-) and is considered replaceable. It has a high vulnerability to contamination. Two other aquifers (30302116 13311 and 30302122 23323) underlie the very western boundary of the installation. The first aquifer is classified as a basal, unconfined sedimentary aquifer that is currently used but is not used for drinking water nor is it ecologically important. This aquifer has moderate salinity (1,000 to 5,000 mg/L Cl^-), is irreplaceable, and has a high vulnerability to contamination. The second aquifer is a basal, confined, dike aquifer. It has potential use; however, it would not be used for drinking water nor is it ecologically important. The aquifer has moderate salinity, is replaceable, and has a low vulnerability to contamination (Mink and Lau, 1990).

5.3 General Biotic Environment

5.3.1 Wetlands

5.3.1.1 NAVMAG PH Lualualei

The USFWS NWI maps identify three areas of Lualualei Valley as wetlands: Māʻiliʻili Stream, the northern unnamed tributary to Māʻiliʻili Stream, and channeled Ulehawa Stream in the southern part of the Station. Māʻiliʻili Stream and its unnamed northern tributary are classified as riverine system, intermittent subsystem, streambed class, seasonal, non-tidal. The channeled Ulehawa Stream is classified as a riverine system, intermittent subsystem, streambed class, seasonal; non-tidal, excavated (see Figure 5-5) (DON, 2001a).

5.3.1.2 NRTF Lualualei

Wetlands at NRTF Lualualei are limited to a man-made wetland within the Niuliʻi Ponds Wildlife Refuge located on the southeastern corner of the installation, a portion of the intermittent Māʻiliʻili Stream located along the northern boundary of the installation, and the downstream reservoir.

The Niuliʻi Ponds Wildlife Refuge was established in 1972 on an approximately 88-acre (35-hectare) site in the southeastern corner of NRTF Lualualei. The Niuliʻi Ponds consist of 9.6 acres (3.9 hectares) of stabilization and oxidation ponds that were initially dependent on the flow of stormwater runoff and wastewater effluent from the adjacent NAVMAG PH Lualualei, but are no longer dependent on it. The refuge and ponds exist because the stabilization and oxidation ponds developed into a wetland and attracted waterbirds and waterfowl, including four federally-listed endangered birds (i.e., Hawaiian stilt, Hawaiian gallinule, Hawaiian duck, and Hawaiian coot) (Section 5.3.3, *Terrestrial Biology*). In 2005, the DON connected a freshwater line (from an existing waterline) with a manual outlet that connects the pump to Pond 1 (NAVFAC PAC, 2006a). Pond water is kept at a level to cover at least the entire base of Pond 1, with deeper water in the center of the pond maintained to provide foraging habitat for Hawaiian coots.

Niuliʻi is a "supporting wetland," which is defined by the USFWS as a wetland that provides habitat important for smaller waterbird populations or provides habitat needed seasonally by segments of the waterbird populations during a part of their life cycle. As such, the USFWS recommended the following: development and implementation of a management plan, secure water resources and manage water levels, manage vegetation, reduce and control predators, minimize human disturbance to the waterbirds and their habitat, monitor and control avian disease, monitor populations of endangered waterbirds, and remove threat of mallard hybridization (NAVFAC PAC, 2006a). Section 5.4.5 details DON's management plan and activities at Niuliʻi Ponds Wildlife Refuge.

5.3.2 Ecosystems

The classification of the study area's native terrestrial ecosystem includes areas transformed by human activity; lowland dry shrubland and grassland and mesic forest; woodland; and shrubland (Juvik et al., 1998). Forests and woodlands are dominated by trees; and a forest canopy is dense (60 to 100 percent cover), while a woodland canopy is more open (10 to 60 percent). Shrublands are distinguished by multi-branched shrubs over 3.3 feet (1 meter) in height (Juvik et al., 1998).

5.3.3 Terrestrial Biology

5.3.3.1 Flora

The present discussion of vegetation within Lualualei focuses on the terrestrial vegetation at NAVMAG PH Lualualei and NRTF Lualualei. Botanical surveys of these areas were completed in 1998 and 2004 (NAVFAC PAC 1998b; Char, 2004). Lualualei Annex surveys are recommended to occur every 5 years. A list of all naturally occurring (non-landscaped) terrestrial flora species at JBPHH Lualualei Annex is provided in Appendix K-1.

Threatened and Endangered Flora Species and Species of Concern

There are 53 ESA-listed endangered plant species and 9 USFWS designated state species of special concern with potential to occur at NAVMAG PH Lualualei and NRTF Lualualei. Table 5-3 lists the plant species potentially occurring across all DON-owned lands at JBPHH Lualualei Annex; of these species, only *Abutilon menziesii,* puʻukaʻa *(Cyperus trachysanthos*), and ʻihi (*Marsilea villosa)* occur at NRTF Lualualei (CNRH, 2004a,b; Chau, 2012) and the remaining 59 species occur or have the potential to occur at NAVMAG PH Lualualei. Appendix K-2 provides photographs of the plants and brief life histories.

Table 5-3 Federally-listed, Candidate, and Terrestrial Flora Species of Concern with Potential to Occur at JBPHH Lualualei Annex

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status***	*Study Area Occurrence****
*Abutilon menziesii**	Red ʻIlima	Koʻoloaʻula	FE, SE	Confirmed
Abutilon sandwicense	Greenflower Indian Mallow	Koʻolua maʻomaʻo	FE, SE	Confirmed
Alectryon macrococcus var. *macrococcusmicrococcus**	Hawaiʻi Alectryon	ʻAlaʻalahua, Māhoe	FE, SE	Confirmed
*Asplenium dielfalcatum**	Sickle Island Spleenwort	-	FE, SE	Potential
*Asplenium unisorum**	Singlesorus Island Spleenwort	-	FE, SE	Confirmed
Bobea sandwicensis	Hawaiʻi Dogweed	Ahakea	SSC	Potential
Bonamia menziesii	Hawaiʻi Lady's Nightcap	-	FE, SE	Offsite, within 5 miles
*Bonamia menziesii**	Menzies' Nightcap Hawaiʻi Lady's Nightcap	-	FE, SE	Confirmed
Cenchrus agrimonioides var. *agrimonioides*		Kamanomano	FE, SE	Offsite, within 5 miles
*Chrysodracon forbesii**	Forbes' Hala Pepe	Hala Pepe	FE, SE	Confirmed
*Cyanea calycina**	Waiʻanae Range Rollandia	Hāhā	FE, SE	Potential
Cyanea grimesiana ssp. *obatae*	Splitleaf Cyanea	Haha	FE, SE	Offsite, within 5 miles
Cyanea membranacea	Papery Cyanea	Hāhā	SSC	Potential
Cyanea pinnatifida	Sharktail Cyanea	Haha	FE, SE	Offsite, within 5 miles
Cyanea superba ssp. *Superba*	Mt. Kaʻala Cyanea	-	FE, SE	Offsite, within 5 miles
*Cyperus trachysanthos**	Sticky Flatsedge	Puʻukaʻa	FE, SE	Confirmed
Delissea waianaeensis	-	-	FE, SE	Offsite, within 5 miles
Dissochondrus biflorus	False Bristlegrass	-	SSC	Potential
Dracaena forbesii	Waianae Range Hala Pepe	Hala Pepe	FE, SE	Offsite, within 5 miles
Dubautia sherffiana	-	-	SSC	Potential
Euphorbia herbstii	-	-	FE, SE	Offsite, within 5 miles
*Euphorbia kuwaleana**	-	ʻAkoko, Kōkōmālei	FE, SE	Confirmed
Exocarpos gaudichaudii	-	-	SC	Offsite, within 5 miles
Flueggea neowawraea	Mēhamehame	Mēhamehame	FE, SE	Confirmed
Gardenia brighamii	Hawaiian Gardenia	Naʻu	FE, SE	Offsite, within 5 miles
Gardenia mannii	Oahu Gardenia	Nanu	FE, SE	Offsite, within 5 miles
Hesperomannia arbuscula	Maui Island-Aster	-	FE, SE	Offsite, within 5 miles

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status***	*Study Area Occurrence****
Hibiscus brackenridgei mokuleianus	Mokulei Rosemallow	-	FE, SE	Offsite, within 5 miles
Joinvillea ascendens subsp. *Ascendens**	-	ʻOhe	FE, SE	Potential
Kadua parvula	Rockface Star-Violet	-	FE, SE	Confirmed
Labordia kaalae	-	Kāmakahala	SSC	Confirmed
*Lepidium arbuscula**	Waiʻanae Range Pepperwort	ʻĀnaunau, Naunau, Kūnānā	FE, SE	Confirmed
Lipochaeta lobata var. *leptophylla**	Shrubland Nehe	Nehe	FE, SE	Confirmed
*Lobelia niihauensis**	Niʻihau Lobelia	ʻŌhā, Hāhā, ʻ Ōhā wai	FE, SE	Confirmed
*Lobelia yuccoides**	-	Pānaunau	SC	Confirmed
*Marsilea villosa**	Villous Waterclover	ʻIhi ʻihi, ʻIhi lāʻau	FE, SE	Confirmed
*Melanthera tenuis**	Waiʻanae Range Nehe	Nehe	SSC	Confirmed
Melicope (Platydesma) cornuta var. *decurrens**	-	-	FE, SE	Confirmed
Melicope christophersenii	Waiʻanae Range Melicope	Alani	FE, SE	Confirmed
*Melicope pallida**	Pale Melicope	Alani	FE, SE	Offsite, within 5 miles
*Melicope saint-johnii**	St. John's Melicope	Alani	FE, SE	Offsite, within 5 miles
*Neraudia melastomifolia**	Angular-Fruit Maʻoloa	Maʻaloa, ʻOloa	SSC	Confirmed
Neraudia angulata var. *angulataangulata**	Angular-Fruit Maʻoloa	Maʻaloa, ʻOloa	FE, SE	Confirmed
Nototrichium humile	Kaʻala Rockwort	Kuluʻī	FE, SE	Confirmed
Phyllostegia hirsuta	Molokai Phyllostegia	-	FE, SE	Offsite, within 5 miles
Phyllostegia kaalaensis	Kaala Phyllostegia	-	FE, SE	Offsite, within 5 miles
Phyllostegia mollis	Waianae Range Phyllostegia	-	FE, SE	Offsite, within 5 miles
Plantago princeps var. *princeps*	-	Ale	FE, SE	Confirmed
Platydesma cornuta var. *decurrens*	Oahu Pilo Kea	Alani	FE, SE	Offsite, within 5 miles
Pritchardia kaalae		-	FE, SE	Offsite, within 5 miles
Pritchardia martii	-	-	SSC	Confirmed
*Pteralyxia macrocarpa**	-	Kaulu	FE, SESSC	Potential
*Schiedea hookeri**	Hooker's Schiedea, Sprawling Schiedea	-	FE, SE	Confirmed
Schiedea kaalae	Oahu Schiedea	-	FE, SE	Offsite, within 5 miles
Schiedea ligustrina	-	Maʻoliʻoli	SSC	Potential

Scientific Name	***Common Name***	***Hawaiian Name***	***Regulatory Status*****	***Study Area Occurrence******
Schiedea mannii	Ridgetop Schiedea	-	SC	Offsite, within 5 miles
*Schiedea pentandra**	Hairy Schiedea	-	SC	Confirmed
Sicyos lanceoloideus	-	ʻAnunu	SC	Offsite, within 5 miles
*Silene perlmanii**	Cliff Face Catchfly	-	FE, SE	Offsite, within 5 miles
Solanum sandwicense	Hawaiʻi Horsenettle	ʻAiakeakua, Popolo	FE, SE	Offsite, within 5 miles
*Spermolepis hawaiiensis**	Hawaiʻi Scaleseed	-	FE, SE	Confirmed
Stenogyne kanehoana	Oahu Stenogyne	-	FE, SE	Offsite, within 5 miles
Strongylodon ruber	Hawaiʻi Jadevine	-	SC	Offsite, within 5 miles
Tetramolopium filiforme var. *filiforme*	Ridgetop Tetramolopium	-	FE, SE	Confirmed
Tetramolopium lepidotum subsp. *Lepidotum**	Waiʻanae Range Tetramolopium	-	FE, SE	Potential
*Urera kaalae**	-	Ōpuhe	FE, SE	Offsite, within 5 miles
Viola chamissoniana subsp. *chamissoniana*	Molokaʻi White Hibiscus-	ʻOlopū, Pāmakani	FE, SE	Confirmed
Zanthoxylum dipetolum var. depetalum	-	Kawaʻu	FE, SE	Offsite, within 5 miles

Notes: *Denotes DLNR High Priority Taxa. **Definitions provided in Appendix I.***Definitions of Study Area Occurrence are provided in Appendix K-3.
Candidate = candidate for listing; FE = federally-listed endangered; FT = federally-listed threatened; SE = state-listed endangered; SC = species of concern; SOH = State of Hawaiʻi; ST = state-listed threatened; - = not available

Designated Critical Habitat at Lualualei

In their Final Rule, USFWS designated critical habitat for 22 species adjacent to and within the study area (USFWS, 2012). However, DON lands within Lualualei Valley received an exemption from critical habitat designation under Section 4(a)(3)(B)(i) of the ESA because of the benefits provided to these species from the 2011 INRMP's implementation. These benefits included an assessment of conservation needs of the listed species, a statement of goals and priorities, a detailed description of the actions to address the stabilization needs of these species and included a monitoring and adaptive management plan. DON actions include management and stabilization of ESA-listed flora species, IS removal, ungulate fencing installation, black-stem borer research, native habitat management, and management of protected species (CNRH, 2012). As a result, USFWS exempted all portions of flora critical habitat occurring on DON property (USFWS, 2012). The implementation of this INRMP continues those species' benefits and management programs (Table 8-7, Rows 2, 16, 17, and 18).

Vegetation Communities of NAVMAG PH Lualualei

The entire NAVMAG PH Lualualei was surveyed intensively in 2004 (CNRH, 2004a). Biologists with Hawaiʻi Natural Heritage Program (HNHP) classified nine vegetation types at NAVMAG PH Lualualei.

1. Cook Island Pine
2. Mixed Trees
3. Christmas Berry Dominant
4. Transitional Koa Haole and Christmas Berry
5. Koa Haole Dominant
6. Kiawe Dominant
7. Mixed Shrub and Grass
8. Grass Dominant and Kiawe
9. Urban or Built-up Land

High-level GIS data of the vegetation community boundaries defined in the 2004 surveys were not available.

Approximately 365 species of vascular plants and ferns inhabit NAVMAG PH Lualualei (CNRH, 2004a). Much of the native vegetation within the study area has been altered by human activities, namely by cattle grazing. For this reason, most of the native flora is limited to higher elevations where it was too steep for cattle. However, the Lualualei Valley historically supports some the largest and most important forests of endemic species including lonomea and hame (*Antidesma pulvinatum*) (NAVFAC PAC, 1998b). Thirty-seven species of native plants had been recorded at NAVMAG PH and NRTF Lualualei; some of these, such as pāpala kēpau (*Pisonia brunoniana*) and ʻaʻaliʻi form the dominant vegetation (NAVFAC PAC, 1998b). In a past survey, a small population of the native coastal sandalwood or ʻiliahi aloʻe was observed east of the end of Dent Street, as well as on a small ridge above 59th Street. Both populations were intermixed with non-native vegetation. ʻIliahi aloʻe was not extensively harvested during the sandalwood trade of the early 1800s, yet, due to displacement by IS like koa haole and kiawe, coastal sandalwood has become increasingly rare (NAVFAC PAC, 1998b).

Nearly half of the approximately 365 species at NAVMAG PH Lualualei are non-natives. Purposeful introductions of non-native species by Polynesians prior to European contact ("Polynesian introductions") include kukui (*Aleurites moluccana*), ti (*Cordyline fruticosa*), taro (*Colocasia esculenta*), and ʻape (*Alocasia macrorrhizos*). In addition, the government of Hawaiʻi purposefully introduced several species of trees in 1902 to reforest eroded landscapes. These species included *Eucalyptus* spp., Cook Island pine (*Araucaria columnaris*), ironwood (*Casuarina equisetifolia*), fig trees, logwood (*Haematoxylum campechianum*), and *Peltophorum pterocarpum.* Other common non-native species on the installation are mimosa (*Albizia* sp.) and silk oak, although these were not intentional introductions (NAVFAC PAC, 1998b). Groves of mature non-native trees that were planted during the installation's initial development line administrative and housing areas. These include monkeypod trees along the historic streets, and shade trees and Norfolk Island pines (*Araucaria heterophylla*) in lawn areas around the buildings and houses (NAVFAC PAC, 1998b).

Threat from wildland fires is increasing for many species, and unfortunately, the ongoing spread of invasive Guinea grass and molasses grass further contributes to the threat of fire. Other prevalent IS include huehue haole (*Passiflora suberosa*), Christmas berry, kiawe, koa haole, and prickly pear (*Opuntia ficus-indica*) (NAVFAC PAC, 1998b). Control and prevention of IS is covered in the JBPHH Biosecurity Plan (NAVFAC HI, 2021; Appendix J-12).

Vegetation Communities of NRTF Lualualei

A total of 92 vascular plants have been identified at NRTF Lualualei (CNRH, 2004b). Of these, 5 are endemic, 7 are indigenous, and 80 are non-native (introduced intentionally or accidentally by humans after European contact) (CNRH, 2004b). Vegetated areas at the installation include both developed and undeveloped land.

Developed Areas

About 90 percent of the 1,700-acre (687-hectare) area comprising NRTF Lualualei is flat land covered by non-native, landscaped (primarily buffelgrass) grasses and herbs.

The large stretch of grasses and lack of shading vegetation of the antenna fields as well as the large, landscaped trees in the historic housing community are the defining characteristics of developed portions of NRTF Lualualei (DON, 2008). Large banyan (*Ficus* spp.), monkeypod, African tuliptree (*Spathodea campanulata*), mango (*Mangifera indica*), Norfolk Island pine, and coconut palm trees line the streets and are scattered around the homes in housing areas (DON, 2008).

Undeveloped Areas

Small, wooded areas comprised of non-native species (primarily kiawe) grow at the north and south corners of NRTF Lualualei (NAVFAC PAC, 2009). Two principal vegetation types dominate the undeveloped portions of NRTF Lualualei: buffelgrass-kiawe and koa haole-kiawe scrub. The buffelgrass-kiawe covers approximately 60 acres (24 hectares) and consists of widely scattered kiawe trees in a matrix of buffelgrass and weedy annual species. The koa haole-kiawe scrub covers roughly 110 acres (44.5 hectares) and encompasses Niuliʻi Ponds Wildlife Refuge (NAVFAC PAC, 2009).

The Niuliʻi Pond Complex forms a wildlife refuge located on the western side of the valley. This area is comprised mainly of non-native species with aggressively invasive California grass (*Urochloa mutica*), koa haole and kiawe dominating (NAVFAC PAC, 2009). The kiawe trees are widely separated with koa haole forming a shrub layer between the trees. A mixture of grass, weedy annual, and smaller shrub species are found beneath the koa haole/kiawe canopy (NAVFAC PAC, 2009). California grass also covers the floor and banks of the ponds with koa haole and kiawe encircling the shores. Other species present in the area include mauʻu lei (*Chloris barbata*), kamole (*Ludwigia octovalvis*), cattails (*Typha latifolia*), and the natives ʻaeʻae, maʻo, pāʻū o hiʻiaka, and ʻilima (CNRH, 2004b; NAVFAC PAC, 1998b).

Hawaiian cotton or maʻo is found scattered throughout NRTF Lualualei, including a large population near the ʻihi ʻihi colonies. Maʻo is not considered endangered or threatened by the USFWS or the State as the species occurs in lowland areas on all islands; however, its numbers are lower than they once were (NAVFAC PAC, 2009).

5.3.3.2 Fauna

The following is a discussion of terrestrial fauna with the potential to occur at Lualualei. The discussion focuses on threatened and endangered species and other wildlife such as amphibians and reptiles, birds, terrestrial mammals, and invertebrates within the study area. A list of terrestrial fauna species known to occur or with potential to occur within the study area is included in Appendix K-4.

Threatened and Endangered Fauna Species and Species of Concern

Numerous threatened and endangered fauna species occur or have the potential to occur at Lualualei and are listed in Table 5-4. Critical habitat has also been designated within the study area for the endangered Oʻahu ʻelepaio (Figure 5-6). These species and their occurrences within the study area are described below.

Endangered Species Act-listed Avifauna

Waterbirds: Four species of ESA-listed endangered waterbirds occur at Niuliʻi Ponds Wildlife Refuge: Hawaiian stilt, Hawaiian coot, Hawaiian gallinule, and Hawaiian duck. Hawaiian stilt is commonly observed at Niuliʻi Ponds and during the 2020 nesting season, field biologists observed two nests (RCUH, 2020). Hawaiian coot is also commonly observed at Niuliʻi Ponds. During the 2020 nesting season, field biologists recorded six Hawaiian coot nests (RCUH, 2020). By the third quarter of 2021, field biologists had observed or deduced that approximately 13 Hawaiian coot nesting attempts had occurred over the 2021 breeding season. Water levels at Pond 1 are maintained to provide foraging habitat for Hawaiian coot and Hawaiian gallinule (RCUH, 2020). Hawaiian gallinule has not been observed since field biologists began bi-weekly avian surveys of Niuliʻi Ponds in 2017. The 2006 INRMP survey (NAVFAC PAC, 2006b) reported Hawaiian gallinules at Niuliʻi Ponds Wildlife Refuge and noted their preference for dense vegetation to forage in water depths less than 3.3 feet (1 meter). Hawaiian ducks, most likely Hawaiian duck-mallard hybrids, are regularly observed at Niuliʻi Ponds Wildlife Refuge (RCUH, 2020). The Hawaiian duck is a federally-listed endangered, endemic waterbird. The species is not observed in high numbers nor been observed to nest in the area. These species are further described in Section 4.3.3.2, *Fauna*.

Table 5-4 Federally-listed, SOH-listed, and Terrestrial Fauna Species of Concern with Potential to Occur at JBPHH Lualualei Annex

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence***
Bird Species				
Anas wyvilliana	Hawaiian Duck	Koloa maoli	FE, SE	Potential
Asio flammeus sandwichensis	Hawaiian Short-eared Owl	Pueo	SE	Confirmed
Chasiempis ibidis	Oʻahu ʻElepaio	Oʻahu ʻElepaio	FE, SE, CH	Potential
Chlorodrepanis flava	Oʻahu Amakihi	O'ahu Amakihi	SC	Potential
Drepanis coccinea	Scarlet Honeycreeper	ʻIʻiwi	FT, SE (Oʻahu, Molokaʻi, and Lānaʻi populations)	Potential
Fulica alai	Hawaiian Coot	ʻAlae keʻokeʻo	FE, SE	Confirmed
Gallinula chloropus sandvicensis	Hawaiian Gallinule	ʻAlae ʻula	FE, SE	Potential
Himantopus mexicanus knudseni	Hawaiian Stilt	Aeʻo	FE, SE	Confirmed
Himatione sanguinea	ʻApapane	ʻApapane	SC	Potential
Oceanodroma castro	Band-rumped Storm Petrel	ʻAkēʻakē	FE, SE	Offsite, within 5 miles
Pterodroma sandwichensis	Hawaiian Petrel	ʻUaʻu	FE, SE	Offsite, within 5 miles
Bird Species (continued)				
Puffinus newelli	Newell's Shearwater	ʻAʻo	FT, ST	Offsite, within 5 miles
Terrestrial Mammal Species				
Lasiurus cinereus semotus	Hawaiian Hoary Bat	ʻŌpeʻapeʻa	FE, SE	Confirmed
Terrestrial Mollusks				
Achatinella mustelina	Oʻahu Tree Snail	Kāhuli	FE	Potential
Amastra cylindrica	-	-	SC	Potential
Arthropod Species				
Drosophila montgomeryi	Hawaiian Picture-wing Flies	-	FE	Potential
Hylaeus anthracinus	Hawaiian Yellow-faced Bees	Nalo Meli Maoli	FE	Potential
Megalagrion xanthomelas	Orangeblack Hawaiian Damselfly	-	FE	Potential

Notes: *Definitions provided in Appendix I. **Definitions of Study Area Occurrence are provided in Appendix K-3. Candidate = candidate for listing; CH = critical habitat; FE = federally-listed endangered; FT = federally-listed threatened; SE = state-listed endangered; SC = species of concern; SOH = State of Hawaiʻi; ST = state-listed threatened; - = not available.

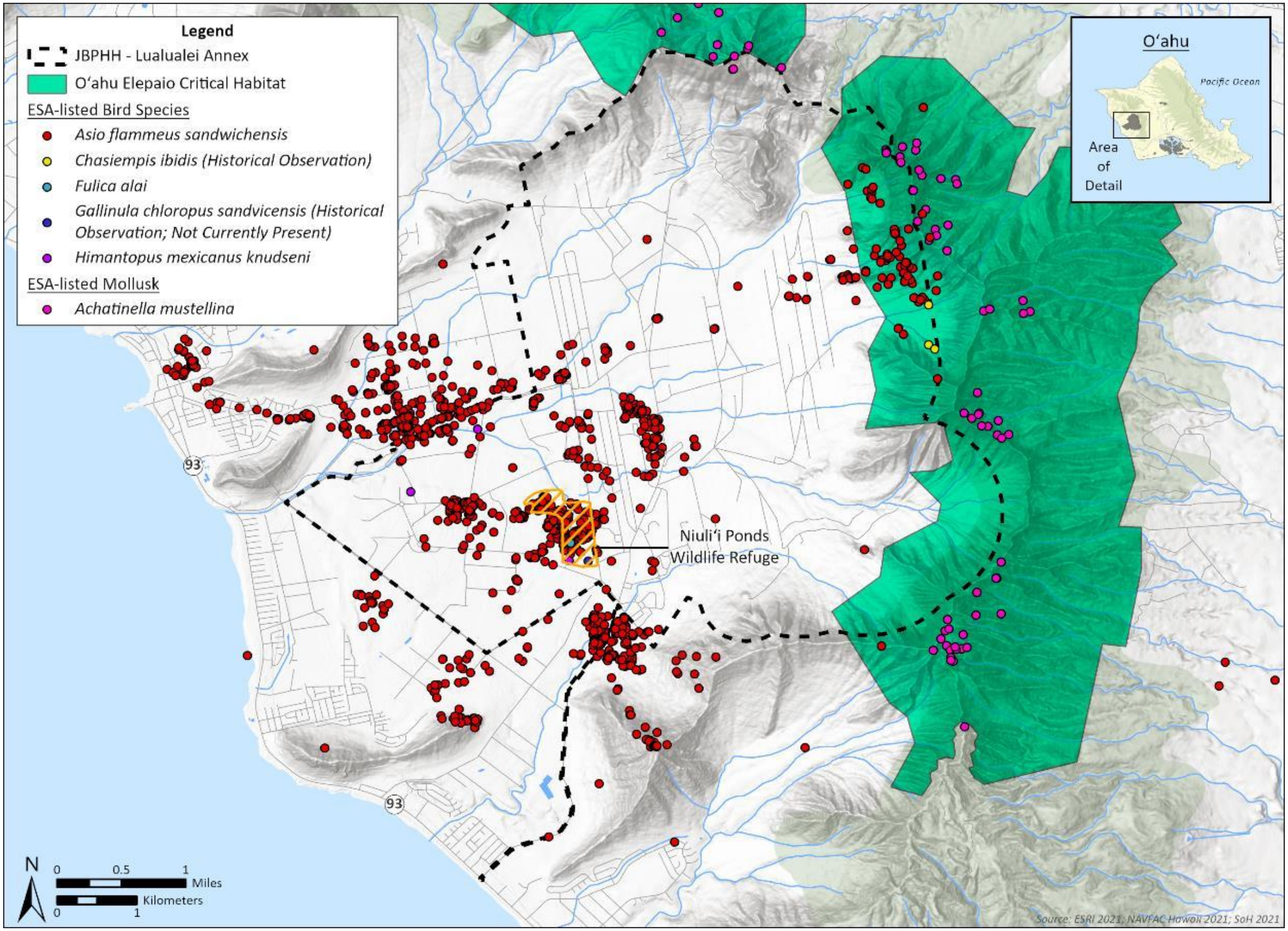

Figure 5-6 Critical Habitat and General Observations of ESA-listed Fauna Species at JBPHH Lualualei Annex

Oʻahu ʻElepaio: The Oʻahu ʻelepaio (Photo 5-2) is a federally endangered, endemic, monarch flycatcher. Historically found in a variety of forest types at all elevations on the island, Oʻahu ʻelepaio are now only found in mid-elevation forests in portions of the Koʻolau and Waiʻanae Mountain Ranges. In the Waiʻanae Mountains, typical Oʻahu ʻelepaio habitat is composed of mixed mesic forest with a well-developed understory and tall canopy at elevations ranging from 1,625 to 2,775 feet (550 to 850 meters) (DLNR, 2015a).

Photo 5-2: Oʻahu ʻelepaio

Oʻahu ʻelepaio have adapted relatively well to disturbed forests dominated by introduced plants; however, the species remains vulnerable to mosquito-borne avian diseases (predominantly avian pox [*Poxvirus avium*] and avian malaria [*Plasmodium relictum*]) and predation of eggs, nestlings, and incubating females by introduced mammals, particularly black rats. Steep population declines and dramatic reductions in range (only 4 percent of the presumed historic range is currently occupied) led to the Oʻahu ʻelepaio being listed as endangered by the USFWS in 2000. In 2012, the estimated population size for the Oʻahu ʻelepaio was 1,261 birds with 477 breeding pairs and 307 single males, demonstrating the species' very strong male-biased sex-ratio (VanderWerf and Talpas, 2017).

The final rule relating to Critical Habitat for the Oʻahu ʻelepaio was published on December 10, 2001 (66 Federal Register 63751). Within the rule, five distinct units were designated as Critical Habitat for the Oʻahu ʻelepaio totaling 65,879 acres (26,661 hectares). Portions of Units 1 and 2, Northern Waiʻanae Mountains and Southern Waiʻanae Mountains, respectively, totaling 1,695 acres (686 hectares), are located within NAVMAG PH Lualualei (see Figure 5-6).

Oʻahu ʻelepaio formerly occurred within mid-elevation areas of Lualualei Valley but none were observed during surveys in 2015, 2018, or 2019 (Sundance-EA Associates Joint Venture, 2019). During a focused survey in 2019, five individuals (two pairs, one male) were observed adjacent to NAVMAG PH within the Lualualei State Forest Reserve, Honouliuli Forest Reserve, and on state land near the Nānākuli Forest Reserve (see Figure 5-6). The closest observation was 656 feet (200 meters) from the NAVMAG PH Lualualei boundary in the Lualualei State Forest Reserve (Sundance-EA Associates Joint Venture, 2019).

It is likely that a combination of factors, including habitat loss, competition from non-native birds, mosquito-borne avian disease, and predation from introduced mammalian predators, particularly rats, have led to the extirpation of this species at NAVMAG PH Lualualei.

ʻIʻiwi*:* The ʻiʻiwi (Photo 5-3) is an endemic Hawaiian honeycreeper federally-listed as threatened and state-listed as endangered on the island of Oʻahu. Both male and females are vermilion red, with a black tail and wings, and a long, decurved pink bill (DLNR, 2015b). Primarily nectivorous, the ʻiʻiwi forages on the nectar of a variety of native and non-native flowers. While its decurved bill is well adapted for feeding on nectar of the lobeliod plants, the primary food source for ʻiʻiwi is nectar of the ʻōhiʻa (*Metrosideros* spp.) flower (Fancy and Ralph, 1998). The ʻiʻiwi can fly long distances in search of flowering ʻōhiʻa trees and are

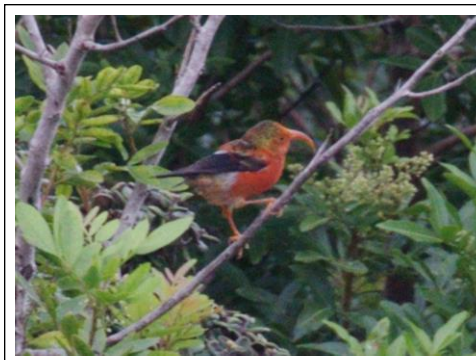

Photo 5-3: ʻIʻiwi

important ʻōhiʻa pollinators. They are found within mesic wet forests dominated by ʻōhiʻa and koa (DLNR, 2015b).

On Oʻahu, ʻiʻiwi persist in higher and cooler elevation forests (82 Federal Register 43873) with population estimates for the island ranging from 50 birds (DLNR, 2015b) to a few individuals (82 Federal Register 43873). At Lualualei, ʻiʻiwi have been repeatedly observed within forested areas adjacent to the facility's upper elevation fence line (eBird, 2021). At Puʻu Palikea, for example, juvenile ʻiʻiwi were seen and photographed in both 2008 and 2009, and an adult ʻiʻiwi was observed in the area in 2013. Such observations highlight the importance of the facility's forested ridgeline for this species. In 2019, a focused survey for ʻiʻiwi in NAVMAG PH Lualualei was conducted but the species was not detected (Sundance-EA Associates Joint Venture, 2019). However, another study in 2019 detected ʻiʻiwi calls at Puʻu Palikea during acoustic surveys for endangered seabirds (Young et al., 2019).

Much like other endemic Hawaiian forest birds, ʻiʻiwi remain vulnerable to habitat loss and modification and predation of eggs, nestlings, and adults by rats and feral and free-ranging cats. The ʻiʻiwi low annual survival is thought to be directly related to mosquito-borne avian disease such as avian pox and avian malaria to which ʻiʻiwi is highly susceptible to (Fancy and Ralph, 1998).

Endangered Species Act-listed Seabirds**:** The ESA-listed band-rumped storm petrel, Hawaiian petrel, and Newell's shearwater are not known to inhabit Lualualei but have potential to fly over the study area from suitable nesting habitat in the Waiʻanae Mountains to the ocean. A 2019 auditory survey confirmed presence of Hawaiian petrel and Newell's shearwater at Mount Kaʻala, approximately 2 miles (3 km) north of NAVMAG PH Lualualei (Young et al., 2019). These species are particularly vulnerable to fallout – when fledglings or occasional migrating adult birds are disoriented by artificial light and become grounded. Due to the occasional flyovers and groundings, they have the potential to occur in the study area. These species are further described in Section 4.3.3.2, *Fauna*.

Endangered Species Act-listed Terrestrial Mammal Species

Hawaiian Hoary Bat**:** In 2014, the USGS, Pacific Islands Ecosystems Research Center used acoustic monitoring to determine the presence or absence of the Hawaiian hoary bat in both Lualualei Valley and the Red Hill Fuel Annex (Bonaccorso et al., 2014). Hawaiian hoary bat presence was noted to be rare within Lualualei Valley with no bats detected at any of the three established stations on the Valley floor; the higher-elevation Kolekole Pass site, however, recorded the highest number of individual bat detection nights of the entire survey (Bonaccorso et al., 2014).

In 2019, USGS and University of Hawaiʻi biologists conducted acoustic monitoring for Hawaiian hoary bat at U.S. Army lands including Schofield Barracks West Range, along the ridgeline just north of NAVMAG PH Lualualei. The survey reported bats are present there year-round and foraged throughout the night, as opposed to the other survey locations that reported seasonal presence and foraging observations mostly occurring in the early hours of the night (Bonaccorso et al., 2019).

Suitable Hawaiian hoary bat foraging and roosting habitat is present throughout the study area. Because the Hawaiian hoary bat is solitary and has been known to forage, roost, and pup in a variety of habitats, this species may be present within the study area where suitable roosting (woody vegetation greater than 15 feet [4.6 meters] in height [DLNR, 2015c]) and foraging habitat is present. Hawaiian hoary bat is further described in Section 4.3.3.2, *Fauna*.

Endangered Species Act-listed Mollusks


Photo 5-4: Oʻahu tree snail

Oʻahu Tree Snail: Oʻahu tree snail (Photo 5-4) is a federally-listed, highly endangered, endemic snail recorded from both the Puʻu Hāpapa area (see Figure 5-6), south of Kolekole Pass, and Puʻu Kūmakaliʻi area, north of Kolekole Pass within NAVMAG PH Lualualei (CNRH, 2004a). The species occurs primarily within native trees in the mesic forests on the high ridges of the eastern border of Lualualei Valley.

Oʻahu tree snails are slow growing with a growth rate of about 2 mm/year. They have low motility, are late maturing (4 to 5 years old), and have a low reproductive rate with 1 to 4 live snails born annually to mature adults (Rohrer et al., 2016). The average life span for Oʻahu tree snails is purported to be about 11 years of age (USFWS, 1993). Major threats to Oʻahu tree snails and other rare tree snail populations include predation by a variety of species including introduced black rats, the predatory rosy wolfsnail (*Euglandina rosea*), and the Jackson's chameleon. Habitat loss and degradation and historical collection by humans also have had a negative impact on the species.

Commonly nocturnal, Oʻahu tree snails are often observed sealed to the leaves, branches, or trunks of trees during the day. At night, the snails feed by rasping thin layers of algae, fungus, and lichen on the surface of the leaves and branches of their host plants (CNRH, 2004a). Genetic analysis of Oʻahu tree snails has indicated that there are six Evolutionary Significant Units (ESUs) across the Waiʻanae Mountain range. An ESU is composed of a population or set of populations with a distinct, long-term evolutionary history isolated from other populations in terms of contemporary gene flow (Rohrer et al., 2016; CNRH, 2004a). The Oʻahu tree snail colonies remaining on NAVMAG PH Lualualei lands are located within a single ESU considered the least endangered of the six ESUs established (CNRH, 2004a).

Surveys undertaken within NAVMAG PH Lualualei indicate that there are no Oʻahu tree snails at intermediate to low levels within the valley (CNRH, 2004a). Use of a 2,000-foot (610-meter) elevation contour for identifying potential Oʻahu tree snail habitat is now established practice by the Oʻahu Army Natural Resources Program (OANRP) due to the limited number of Oʻahu tree snail populations found below such elevation (Rohrer et al., 2016). Surveys have been conducted throughout Puʻu Kūmakaliʻi by the OANRP since 2009, including DON lands within Pūhāwai Gulch. In 2009, 11 Oʻahu tree snails were observed, 1 individual was observed in 2017, and no Oʻahu tree snails were observed in 2018 (OANRP, 2017; Pacific International Center for High Technology Research [PICHTR], 2020). If Oʻahu tree snail is found again at Pūhāwai Gulch, OANRP proposes to translocate those individuals into a managed snail enclosure on U.S. Army lands to ensure their safety from predation (OANRP, 2017).

Endangered Species Act-listed Arthropods

Several ESA-listed endangered arthropod species have potential to occur at JBPHH Lualualei Annex: Hawaiian picture-wing flies (*Drosophila montgomeryi*; and other *Drosophila* spp.), Hawaiian yellow-faced bees (*Hylaeus anthracinus* and other spp.), and orangeblack Hawaiian damselfly. These species and the results of arthropod surveys within the study area are discussed below.

Hawaiian picture-wings are relatively large flies with elaborate markings on clear wings, the patterns on which vary among species (Center for Biological Diversity, 2021). Hawaiian picture-wing flies are found in native vegetation communities where some species have become highly specialized. Hawaiian picture-wing flies occur in mesic forest within the Waiʻanae Mountains and their primary host plant is ōpuhe (*Urera kaalae*) (17 Federal Register 26835).

Hawaiian yellow-faced bees roughly resemble small wasps and are known for their yellow-to-white facial markings (81 Federal Register 67786). Hawaiian yellow-faced bees can occur in a wide array of habitats including coastal strand and high-elevation wet, mesic forests. They are solitary and nest in hollow stems, holes in trees, under bark, in crevices, or in burrows in the soil (DLNR, 2021). Of the seven ESA-listed endangered Hawaiian yellow-faced bees, six occur on Oʻahu.

The first complete survey of JBPHH Lualualei Annex for terrestrial arthropods was conducted by Bishop Museum in 1997. Since then, the Bishop Museum has conducted arthropod surveys in Hālona Valley every year between 2015 and 2020 (Evenhuis et al., 2021). Neither Hawaiian picture-wing flies or Hawaiian yellow-faced bees have been observed during the terrestrial arthropod surveys. However, it is unlikely all potentially suitable habitat has been surveyed due to the rough terrain, small population sizes, rareness, and patchiness of remaining suitable habitat within NAVMAG PH Lualualei.

The orangeblack Hawaiian damselfly was once Hawaiʻi's most abundant damselfly species likely because of its ability to use a variety of aquatic habitats for breeding sites (81 Federal Register 67786). Hālona Valley and Pūhāwai Stream (see Figure 5-5) were surveyed for Hawaiian damselflies in 2006. Although no native Hawaiian damselflies were detected at Pūhāwai Stream, the upper reaches of the stream were found to be free of poeciliid fish, one of the primary predators of *Megalagrion* species (NAVFAC PAC, 2006c). The upper portions of Pūhāwai Stream are therefore considered ideal habitat for *Megalagrion* species.

State of Hawaiʻi-listed Species

Hawaiian Short-eared Owl: The Hawaiian short-eared owl (Photo 5-5) is commonly observed within NAVMAG PH Lualualei as well as in other areas of JBPHH. Focused surveys for Hawaiian short-eared owls on JBPHH properties were initiated by NAVFAC HI field biologists in December 2016. Beginning in 2018, a cooperative agreement with the University of Hawaiʻi was established to further study the breeding phenology and daily activity patterns of Hawaiian short-eared owls at JBPHH. As a result, field biologists conduct monthly surveys for Hawaiian short-eared owl at predetermined survey areas within NAVMAG PH Lualualei where suitable habitat and regular observations occur. Hawaiian short-eared owls have been observed hunting, resting, displaying courtship behaviors, and nesting within the study area (RCUH, 2020). By the third quarter of 2021, field biologists had recorded five nesting attempts and 10 chicks fledged for the 2021 breeding season within NAVMAG PH Lualualei (RCUH, 2021). This species is further described in Section 4.3.3.2, *Fauna*.


Photo 5-5: Hawaiian Short-eared Owl

USFWS Designated Species of Concern, Forest Birds

Oʻahu ʻAmakihi: The Oʻahu ʻamakihi (*Chlorodrepanis flava*) (Photo 5-6) is a small, olive green, native honeycreeper considered a species of conservation concern by the USFWS (USFWS, 2008). Endemic to the island of Oʻahu, the Oʻahu ʻamakihi is found in a variety of habitats from wet forests in the Koʻolau Mountains to dry forests in the Waiʻanae Mountains (DLNR, 2015d). Generalized foragers, Oʻahu ʻamakihi are known to consume the nectar of a variety of both native and non-native plants, fruit juice and pulp, as well as a diverse assortment of insects and other arthropods (DLNR, 2015d).

Photo 5-6: Oʻahu ʻamakihi

While Oʻahu ʻamakihi were considered locally common and widespread in the late 1990s (Lindsey et al., 1998), there is currently little to no information available on the species' population size or present range. Likewise, many of the Oʻahu ʻAmakihi's life history characteristics remain unknown (DLNR, 2015d). In the Waiʻanae Mountains, the Oʻahu ʻamakihi is considered relatively uncommon and is mostly found above 1,640 feet (500 meters) elevation. Confirmed citizen and scientist observations of Oʻahu ʻamakihi report observations in high elevations and along ridgelines of the Waiʻanea mountains as recent as 2021 and 2020 (eBird, 2021). However, the 2019 survey of upper NAVMAG PH Lualualei did not result in any observations (Sundance-EA Associates Joint Venture, 2019).

Much like other endemic Hawaiian forest birds, Oʻahu ʻamakihi are vulnerable to habitat loss and predation of eggs, nestlings, and adults by black rats, Polynesian rats (*Rattus exulans*), and feral and free-ranging cats. Additionally, mosquito-transmitted diseases such as avian pox and avian malaria are known sources of mortality (Lindsey et al., 1998). One of the few remaining species of honeycreepers with a wide elevational distribution, the Oʻahu ʻamakihi shows a low malarial prevalence and is common in some suburban yards and parks particularly those in Mānoa Valley (Lindsey et al.,1998). Research on the species indicates that Oʻahu ʻamakihi may be evolving resistance to avian malaria (Shehata et al., 2001; Krend, 2011) allowing the species to survive in lower elevation areas where mosquito-transmitted disease is prevalent.

ʻApapane: The ʻapapane (*Himantione sanguinea*) (Photo 5-7) is an endemic honeycreeper considered a species of conservation concern by the USFWS (USFWS, 2008). Measuring roughly 5 inches (13 cm) in height, the feathers of the small crimson ʻapapane were once widely used to adorn the capes, helmets, and feather lei of native Hawaiian nobility. Primarily nectivorous, ʻapapane are most often found in mesic and wet native forests dominated by ʻōhiʻa (*Metrosideros polymorpha*) and koa trees (Fancy and Ralph, 1998).

Photo 5-7: ʻApapane

While large numbers of ʻapapane survive on several of the Main Hawaiian Islands, only a small relict population is thought to remain on Oʻahu. Historically, the species was found in forested areas across the island of Oʻahu. Today, ʻapapane occur primarily in the Koʻolau Mountains and are less common in the Waiʻanae Mountains above 1,950 feet (600 meters) (DLNR, 2015e). Relying heavily on the nectar of ʻōhiʻa blossoms, ʻapapane are observed along the upper ridgeline above NAVMAG PH Lualualei (eBird, 2021) where ʻōhiʻa stands are present. However, the species was not observed during the 2019 surveys conducted by Sundance-EA Associates.

Much like other endemic Hawaiian forest birds, ʻapapane remain vulnerable to habitat loss and modification and predation of eggs, nestlings, and adults by rats and feral and free-ranging cats. Of Hawaii's native forest birds, they have the highest rates of mosquito-transmitted diseases such as avian pox and avian malaria. Because they forage over large areas, they may have increased exposure to the diseases (Fancy and Ralph, 1998; Krend, 2011; DLNR, 2015e). ʻApapane breed in mid-elevation forests which may suggest some resistance to the mosquito-transmitted diseases (DLNR, 2015e).

Other Wildlife

Terrestrial Amphibian and Reptile Species

Amphibian and reptile surveys were conducted at NAVMAG PH in 2006 (NAVFAC PAC, 2006d). The non-native wrinkled frog (*Glandirana rugosa*) was common throughout the stream up to Pūhāwai Falls. The non-native, introduced house gecko and mourning gecko were observed during the surveys. Although not observed during the surveys, invasive, non-native cane toad, American bullfrog, Jackson's chameleon, and Anolis species are ubiquitous on the island of Oʻahu and likely to occur throughout the study area.

Avifauna

Several ESA-listed bird species are present (three species) or have potential to occur (seven species) within the study area and are discussed in the threatened and endangered fauna species section above. Two MBTA-protected bird species, white-tailed tropicbird (*Phaethon lepturus*) and Pacific golden plover (*Pluvialis fulva*), are present within the study area and discussed below. The remaining avifauna, and most abundant, at JBPHH Lualualei Annex are non-native species. The most frequently observed avifauna during the 2016 bird survey of lower JBPHH Lualualei Annex included scaly-breasted munia (*Lonchura punctulata*), house sparrow (*Passer domesticus*), common myna, and common waxbill (Hamer Environmental, 2016). A complete list of avifauna present at Lualualei is provide in Appendix K-4.

MBTA-protected white-tailed tropicbirds are often observed soaring above the cliffs at Lualualei Valley (eBird, 2021). Cliffs are important habitat for this bird where they lay eggs in rock crevices or burrows in the cliff face. White-tailed tropicbirds may be nesting in the cliffs of Lualualei Valley, but this has not been confirmed. This species is further described in Table 4-9.

MBTA-protected Pacific golden plover is observed throughout the study area, particularly in areas of managed grass. This species is ubiquitous from September through May throughout the Hawaiian Islands and is further described in Table 4-9.

Terrestrial Mollusks

DON-owned lands in the upper elevations of the Waiʻanae Mountains surrounding NAVMAG PH Lualualei contain native snails including the endangered Oʻahu tree snail, discussed in the threatened and endangered fauna species section above. Six other endemic snails have been observed within NAVMAG PH Lualualei: the extremely rare snail *Amastra cylindrica*, *Succinea caduca*, *Tornatellides* sp., *Leptachatina* sp., *Lymnaeidae* sp., and *Philonesia* sp. During a 2017 snail survey that included portions of DON land at NAVMAG PH Lualualei, no snails were observed (OANRP, 2017). Currently, it is believed that *Amastra cylindrica* has the potential to occur on DON lands at Lualualei (D. Sischo, personal communication, 2020).

Terrestrial Arthropods

NAVMAG PH contains more arthropod species endemic to Hawaiʻi than any other property owned by the DON. The first complete survey of Lualualei for terrestrial arthropods was conducted by Bishop Museum in 1997. Since then, the Bishop Museum has conducted arthropod surveys in Hālona Valley every year between 2015 and 2020 (Evenhuis et al., 2021) (Note that management units are named after the valleys in which they occur. Accordingly, the Hālona Management Unit occurs in the Hālona Valley). The results from the 1997 survey also indicated that Hālona Valley supports the greatest number of native insects when compared to other areas surveyed within NAVMAG PH Lualualei and subsequent surveys were focused there. Of specific interest at Hālona Valley is *Rynchogonus welchii*, a rare weevil that has never been collected anywhere else in the world and has not been found alive since 1976 (NAVFAC PAC, 2007).

Although the annual terrestrial arthropod surveys of Hālona Valley between 2015 and 2020 have not found target threatened and endangered species or the rare *Rynchogonus welchii*, each survey has resulted in numerous new records for Hālona Valley and Lualualei Valley (Evenhuis et al., 2021). Notable new observations from 2020 include a new endemic species of flightless dolichopodid and a new state record of a non-native parasitic wasp (*Trathala annulicornis*). Other significant finds from 2020 include three endemic species of psocopterans (bark lice). Continual findings of native species in Hālona Valley indicates the area may be a repository for possible relict endemics (Evenhuis et al., 2021). Invasive and nuisance arthropod species observed during the terrestrial arthropod surveys are discussed in the invasive and nuisance species section below.

Terrestrial Mammals

The only mammals observed within the study area are alien species, including mongoose, feral cats, feral dogs, feral pigs, and several species of introduced rodents (NAVFAC PAC, 1998b, 2006c; RCUH, 2020).

In the 1990s, several goat (*Capra hircus aegagrus)* populations occurred within the study area, primarily on open ridges. The goats were eradicated in 2001 and no new populations have established in the southern part of the range.

Because of the mobility of goats, an informal partnership among the DON, U.S. Army, Nature Conservancy, and DLNR has been in effect since 1995 to address the issue of goats crossing jurisdictional boundaries. This partnership is necessary for access to adjacent lands in the attempt to eradicate goats in and near the study area. This informal partnership ensures that the landowners have a common goal which is important to ensure that the goats do not reestablish at the installation or the southern Waiʻanae Mountain Range at some later time after they have been eradicated. In the past, the DON has conducted monthly ground hunts with supplemental air operations to control and eradicate feral goats on the installation (DON, 2001a).

Invasive and Nuisance Species

Invertebrates: Yellow crazy ants (*Anoplolepis gracilipes*) are found in Hālona Valley and believed by Navy biologists to be in other areas as well; however, this has not yet been well-documented. Presence in Hālona Valley as of approximately 2016 was believed to be nearer to the mouth of (not all the way back into) the valley. In normal, non-drought conditions, this species is the dominant invertebrate seen in leaf litter and on tree trunks (Evenhuis et al., 2021). Yellow crazy ants and the prevalent Australian cockroach (*Periplaneta australasiae*) may pose severe threats to the native ground-dwelling fauna. Additionally, yellow crazy ants have been known to severely injure or even kill ground-dwelling seabirds (USFWS, 2021); they pose a threat to any vertebrate or invertebrate nesting where they occur.

Invasive mollusks and arthropods are known to occur in JBPHH Lualualei Annex. A management goal of NAVFAC HI at NAVMAG PH Lualualei and NRTF Lualualei is to monitor, assess, and control invasive invertebrates and arthropods that threaten ESA-listed plants and the Oʻahu tree snail (Waiʻanae Mountains Watershed Partnership, 2021). IS of management priority include the rosy wolfsnail (*Euglandina rosea*), garlic snail (*Oxychilus alliarius*), black twig borer, Chinese rose beetle (*Adoretus sinicus*), and two-spotted leafhopper (*Sophonia rufofascia*).

Vertebrates: All terrestrial mammals known to occur within the study area are considered nuisance species. Feral cats are responsible for transmitting toxoplasmosis which can infect and kill ESA-listed waterbirds. Feral cats, mongoose, and rats predate ESA-listed and MBTA-protected birds present within the study area. Rats additionally predate on ESA-listed plants and tree snails, and Jackson's chameleons also pose a predatory threat to tree snails. Feral dogs are a safety hazard to DON staff. Ungulates (e.g., pigs and goats) destabilize hillsides causing erosion, uproot federally protected plants, and spread the seeds of invasive plants.

5.3.3.3 Management Units

There are four MUs located on the steep slopes and ridges of Lualualei Valley (see Figure 5-2). These were selected based on the concentration of native and ESA-listed taxa. The four areas are listed below in order of priority: Puʻu Hāpapa Management Area, Hālona Valley Management Area, Puʻu Kaua Management Area, and Puʻu Kaʻīlio Management Area. The following descriptions were acquired from the Lualualei Ecosystem Management Plan (NAVFAC PAC, 1998b), the NAVMAG PH INRMP (DON, 2001a), and the Lualualei Botanical Projects Report (NAVFAC PAC, 2006e).

Puʻu Hāpapa Management Area

At 30 acres (12 hectares), Puʻu Hāpapa Management Area (see Figure 5-2) is the smallest of the MUs. Puʻu Hāpapa contains eight federally-listed endangered plants and/or federal species of concern including *Abutilon sandwicense*, māhoe*, Bonamia menzisii,* mēhamehame*, Lipochaeta lobata* var. *leptophylla, Melanthera tenuis, Lobelia niihauensis,* kuluʻī (*Nototrichium humile*) and *Schiedea hookeri* (DON, 2001a). The area contains one of two DON-installed fenced enclosures designed to protect rare plant communities by excluding feral ungulates. The 2006 Lualualei Botanical Projects Report (NAVFAC PAC, 2006e) reported that the Puʻu Hāpapa enclosure contains a rare lama forest that provides habitat for three endangered plant species (i.e., mēhamehame*,* kuluʻī*,* and *A. sandwichense*) and one species of concern, hala pepe *(Chrysodracon forbesii)*. Two federally-listed endangered plant species, *Bonamia menziesii* and *Lipochaeta lobata* var. *leptophylla,* had previously been identified at the enclosure but were not observed in 2006 (NAVFAC PAC, 2006e).

Puʻu Hāpapa MU consists of three distinct portions each with its own habitat and vegetation. The lower unit occurs from 1,600 to 1,800 feet (487 to 548 meters) and contains approximately 90 percent native species, comprising the most untouched native forest in NAVMAG PH Lualualei (NAVFAC PAC, 1998b). Some of the species observed in the lower unit include ʻūlei, *Schiedea ligustrina*, *Hibiscus arnottianus*, maile lau liʻi (*Alyxia stellata*), huehue (*Cocculus orbiculatus*), ʻawikiwiki (*Canavalia galeata*), halapepe, hoʻawa (*Pittosporum* sp.), alaheʻe, *Abutilon sandwicense*, *Bonamia menziesii*, and mēhamehame (DON, 2001a). The middle unit consists of a cliff face approximately 100 feet (30 meters) high, which provides habitat to cliff dwelling species such as *Lobelia niihauensis* and ahinahina (*Artemisia australis)* (NAVFAC PAC, 1998b). The upper portion of Puʻu Hāpapa is 50 to 60 percent native and contains a broad range of species including pāpala kēpau (*Pisonia* sp.), kōpiko (*Psychotria hathewayi* var. *hathewayi* and *P. mariniana*), māmaki (*Pipturus albidus*), lama, ʻōhiʻa lehua (*Metrosideros polymorpha*), koa, kōlea lau nui (*Myrsine lessertiana*),alani (*Melicope clusiifolia* and *M. peduncularis*), ʻieʻie (*Freycinetia arborea*), kalia (*Elaeocarpus bifidus*), alaʻa (*Pouteria sandwicensis*), aʻiaʻi (*Streblus pendulinus*), poʻola (*Claoxylon sandwicense*), *Hibiscus arnottianus*, ʻohe mauka (*Polyscias oahuensis*), and aʻe (*Zanthoxylum oahuense*), as well as understory plants like ʻōhelo (*Vaccinium dentatum*), sedges (*Carex meyenii* and *C. wahuensis)*, *Hedyotis schlechtendahliana*, various ferns such as ʻamaʻu (*Sadleria cyatheoides*), and an abundance of maile lau liʻi (NAVFAC PAC, 1998b).

Hālona Valley Management Area

The Hālona Valley MU (see Figure 5-2) is composed of 280 acres (113.3 hectares) and covers the north facing slopes of the cliffs below Palikea (NAVFAC PAC, 1998b). Most of this MU is covered by Christmas berry forest, but forest patches as large as 1 acre (0.4 hectare) are found that can be vegetated with 60 to 70 percent native species. Hālona Valley also has an enclosure which was constructed to protect a small forest of native trees from destruction by feral ungulates. Native flora within the enclosure includes a population of federally-listed endangered *Abutilon sandwicense*, as well as a rare lama and lonomea forest on one of the ridges (DON, 2001a; NAVFAC PAC, 2006b). The rare lama and lonomea native forest remnant supports native insects, including a rare weevil (*Rhyncogonus welchi*) (the weevil is found outside of the fenced area), and a moth (*Thyrocopa* sp.) that are specific to lonomea (NAVFAC PAC, 1998b). These plant communities contain a high density of endangered species including *Abutilon sandwicense*, *Bonamia menziesii*, mēhamehame, kuluʻī, and nehe. Hālona Valley also provides habitat for the following federally-listed endangered plant species: *Hedyotis parvula, Lobelia niihauensis,* maʻaloa (*Neraudia angulate* var. *angulata),* and *Viola chamissoniana* subsp. *chamissoniana* (NAVFAC PAC, 2006b).

Puʻu Kaua Management Area

The Puʻu Kaua MU (see Figure 5-2) comprises 125 acres (50.6 hectares) mainly on the steep vertical cliffs of Puʻu Kaua (NAVFAC PAC, 1998b). This MU contains the smallest number of native species at less than 10 percent. The valley floor below the cliffs are largely non-native forests with kukui and koa haole dominating. Most of the native flora in the area occur on the steep cliff faces: lama, maile lau liʻi, halapepe (*Pleomele forbseii*), and a few of the endangered *Lobelia niihauensis,* maʻaloa*,* and kuluʻī. Aside from those just mentioned, the area also provides habitat for the following federally-listed endangered plant species: mēhamehame*,* ʻānaunau *(Lepidium arbuscula),* nehe, and *Schiedea hookeri* (DON, 2001a).

Puʻu Kaʻīlio Management Area

The Puʻu Kaʻīlio MU (see Figure 5-2) contains approximately 247 acres (100 hectares) (DON, 2001a). Certain parts of the MU are almost exclusively non-native vegetation (more than 90 percent) such as prickly pear, koa haole, Christmas berry, and silk oak (NAVFAC PAC, 1998b). The steep cliff faces along Kolekole Road support native species ahinahina, ʻākulikuli, moa (*Psilotum nudum*), ʻakoko, and ʻaʻaliʻi. There is a small area on the south facing slopes of the peak that contain a small ʻōhiʻa forest and a few areas that are dominated by ʻa'ali'i (NAVFAC PAC, 1998b). The north facing cliffs of Puʻu Kaʻīlio support populations of the federally-listed endangered plant species *Euphorbia kuwaleana* and *Lobelia niihauensis* (DON, 2001a).

5.4 Current Management

5.4.1 Protected Species and Ecosystem Monitoring and Management Actions

The following DON programs are currently in place at JBPHH Lualualei Annex in an effort to conserve, protect, and provide benefit to ESA- and SOH-listed species and MBTA-protected birds with potential to occur at Lualualei. The NAVFAC HI Natural Resource staff coordinate with federal and SOH agencies including USFWS, NMFS, USDA, SOH DLNR, OANRP, and USACE on natural resources issues pertaining to the federally and SOH-protected species that occur within the study area.

5.4.1.1 Endangered Species Act-protected Waterbirds

Niuliʻi Ponds Wildlife Refuge provides habitat for four federally-listed endangered Hawaiian waterbirds (Hawaiian stilt, Hawaiian gallinule, Hawaiian coot, and Hawaiian duck) at JBPHH Lualualei Annex. Currently, Niuli'i' Pond is surveyed bi-weekly by field biologists who survey for ESA-listed and MBTA-protected birds and conduct nest monitoring, when present.

The DON funds predator control efforts at Niuliʻi Ponds to help conserve the four federally-listed endangered bird species that occur and have potential to occur there. Section 8.2.3 provides recommendations for the continued management of the refuge, predator control, and survey updates.

5.4.1.2 Endangered Species Act-protected and Species of Concern Forest Birds

The 2019 focused survey for Oʻahu ʻelepaio and ʻiʻiwi resulted in no observations of the target species or USFWS designated species of concern (i.e., Oʻahu amakihi, ʻapapane) within DON lands at Lualualei. It is likely that a combination of factors, including habitat loss, competition from non-native birds, mosquito-borne avian disease, and predation from introduced mammalian predators has contributed to the decline of this species at NAVMAG PH Lualualei. Surveys for these species are recommended every 3–5 years within suitable habitat at NAVMAG PH Lualualei since there is potential for any of these species to return to the study area (see Table 8-7, Row 2 and Table 8-8, Row 7). If a pair of Oʻahu ʻelepaio are observed within NAVMAG PH Lualualei, rodent control in and around their territory should be implemented during the breeding season to protect any nesting attempts (Sundance-EA Associates Joint Venture, 2019).

5.4.1.3 State of Hawaii-listed Hawaiian Short-eared Owl

DON lands at JBPHH Lualualei Annex provide suitable foraging and nesting habitat for the Hawaiian short-eared owl. The DON has a variety of management actions in place to protect this species and to enhance their habitat. They are the same as many of the management actions described for Hawaiian waterbirds including resource agency coordination, MOUs, SOPs, project reviews and consultations, bird surveys, inreach and community outreach, and mitigation measures during training (see Table 8-7, Row 2). Field biologists conduct monthly surveys for Hawaiian short-eared owl within the study area and when present, conduct nest monitoring and banding.

5.4.1.4 Endangered Species Act-listed Hawaiian Hoary Bat

Hawaiian hoary bat may forage or pup within the study area. To avoid impacts to Hawaiian hoary bat, trimming of vegetation over 15 feet (4.6 meters) in height is avoided whenever possible during the pupping season (June 1–September 15). When trimming vegetation over 15 feet (4.6 meters) is unavoidable, consultation with USFWS is required.

5.4.1.5 Endangered Species Act-listed Oʻahu Tree Snail

Surveys of Oʻahu tree snails are conducted every 3–5 years wherever suitable habitat is found. Surveys in Lualualei Valley found that there are no Oʻahu tree snail remaining in the intermediate and low elevations. Oʻahu tree snail is only found in higher elevations of the Waiʻanae Mountains. Two of those locations fall within the boundaries of NAVMAG PH Lualualei: Puʻu Hāpapa (Mikilua Gulch) and Puʻu Kūmakaliʻi (Pūhāwai) (Waiʻanae Mountains Watershed Partnership, 2021). The most recent survey (2018) for Oʻahu tree snail within DON lands at JBPHH Lualualei Annex resulted in no observations (PICHTR, 2020). If Oʻahu tree snails are found on DON lands of JBPHH Lualualei Annex, OANRP recommends they be translocated to established snail enclosures (OANRP, 2017).

Currently, OANRP manages eight populations of Oʻahu tree snail. Of the four established snail enclosures in the Waiʻanae Mountains, OANRP manages the Kahanahāiki and Puʻu Hāpapa enclosures. Cooperative maintenance of the Puʻu Palikea enclosure is shared between Snail Extinction Prevention Program (SEPP) and OANRP. The Pahole enclosure is managed exclusively by SEPP. Populations within all enclosures are stable or increasing. DON is committed to continuing their partnership with OANRP to ensure the continued survival of Oʻahu tree snail in the Waiʻanae Mountains and is included in Table 8-7, Row 8.

5.4.1.6 Endangered Species Act-listed Arthropods

In 2006, NAVFAC PAC biologists conducted arthropod surveys at Hālona Valley and surveyed for endemic Hawaiian damselflies at Pūhāwai Falls (NAVFAC PAC, 2006b) and the Bishop Museum has been conducting annual arthropod surveys in Hālona Valley since 2015. Although no ESA-listed arthropods have been observed to date, each survey results in new arthropod records, including native species. Given the suitable habitat within the study area, there is potential for the ESA-listed arthropods discussed in Section 5.3.3, *Terrestrial Biology*, to occur within DON lands at JBPHH Lualualei Annex. Surveys for these species are conducted every 3–5 years where there is suitable habitat. Therefore, a discussion of management actions is warranted and recommendations are made in Table 8-7, Row 2 and Table 8-8, Row 3.

5.4.1.7 Federally-listed, Candidate, and Terrestrial Flora Species of Concern at Lualualei Annex

The goals in Table 5-5 are the current DON management actions to support the growth and survival of ESA-listed and native plant species throughout Lualualei Annex. These goals were initially laid out in an addendum added to the 2011 JBPHH INRMP (Appendix K-5).

Table 5-5 Monitoring and Adaptive Management Goals for JBPHH Lualualei Annex

	Goal	***Status***
1	Survey documenting numbers and locations of plant species. Create and implement a Plant and Snail Management Plan.	Ongoing
2	Identification of an additional population of *Marsilea villosa* in the Radio Transmitting Facility	Complete
3	Development of a *Marsilea villosa* management plan based on recommendation strategies outlined in a dissertation, partly funded by the DON	Ongoing
4	Expansion of funding for a fencing plan and fence construction for ungulate control with specified timeline	Ongoing
5	Completion of aerial surveys for feral goats, with plans for their removal beginning in 2013	Ongoing
6	Non-native plant removal within exclosures at Hālona and Mikiula management areas	Ongoing
7	Allocation of funding for research on Black Twig Borer control methods	Ongoing
8	Commitment to prioritize the production of a wildfire management plan	Ongoing
9	Commitment to address outplanting needs for threatened and endangered species to augment and stabilize populations with U.S. Navy property at Lualualei Annex	Ongoing

Note: DON = Department of the Navy

Survey documenting numbers and locations of plant species. Create and implement a Plant and Snail Management Plan: NAVFAC HI Natural Resources staff contracts biologists to regularly monitor and document numbers and location of threatened and endangered plant species, which are reported to USFWS quarterly. The contracted biologists also conduct rodent control, using Good Nature A24 traps near threatened and endangered plant populations. Goals for each species include resurveying and attaining current status, ensuring ex-situ collections for long-term seed storage at Lyon Arboretum, and growing some of the propagules at DOFAW facility for outplanting in adjacent lands for recovery and stabilization actions for each species.

Genetic and seed storage: DON has partnered with DLNR on their Plant Extinction Prevention Program that has an Endangered Species Recovery Permit to help opportunistically collect plant material (cuttings and seeds) from federally-listed plant species. DON provides base access and personnel for field days. Any plant materials collected are then transferred to Lyon Arboretum or to other researchers for use in propagations, outplanting, research, and genetic storage. Ideally, all flora species listed in Table 5-3 will be represented in seed storage collections.

Conservation mapping: The DON conducted conservation mapping at JBPHH Lualualei Annex in order to expand its database on potentially protected species at the installation.

Currently, NAVFAC HI is developing a Plant and Snail Management Plan for JBPHH Lualualei Annex (see Table 8-7, Row 18), which includes management objectives for threatened and endangered species. The plan will include the following objectives for protected species:

1. maintaining and stabilizing existing populations,
2. controlling threats (i.e., ungulate control, invasive flora management, ex situ actions, and mapping),
3. creating a native-dominated environment in areas containing rare plant species, and
4. monitoring results of management actions.

Identification of an additional population of Marsilea villosa in the Radio Transmitting Facility: The Lualualei population is made up of five subpopulations, four of which are located in the NRTF and one in NAVMAG PH. Individual plants of *Marsilea villosa* are difficult to count which is why estimates are used below.

NRTF Subpopulations:

- Southeast Corner (MARVIL-LLL-1): approximately 10–100 individuals located in the south-southeast section of the open field and covers approximately 3,832 square feet (356 square meters).
- Southwest Corner (MARVIL-LLL-2): approximately 100–1,000 individuals located in the southwestern corner in a depression area alongside the road covers approximately 29,536 square feet (2,744 sq m).
- Cattle population (MARVIL-LLL-3): approximately 10–100 individuals located in the northwest corner of the flood plain of Maʻiliʻili Stream. The extent of this population was discovered in 2011, which covers approximately 5 acres (2 hectares) of previously leased cattle grazing area.
- Middle Field (MARVIL-LLL-5): There are three 108 X 323 square feet (10 X 30 square meters) locations southeast from MARVIL-LLL-3 in the antenna field. These were discovered in 2011.

NAVMAG Subpopulation:

- Costa Site (MARVIL-LLL-4): approximately 100–1,000 individuals located in NAVMAG PH just outside the border of NRTF which covers less than approximately 100 square feet (9.3 square meters).

Development of a Marsilea villosa management plan based on recommendation strategies outlined in a dissertation, partly funded by the DON: Currently, NAVFAC HI is developing a *Marsilea villosa* management plan. The plan will incorporate management actions advised in the dissertation ‘Conservation of the endangered Hawaiian Fern ‘ihi’ihilauakea (*Marsilea villosa*): A synthesis of experimental restoration, community ecology and population genetics’ by Marian Chau. It will also include the following:

1. Map showing distribution
2. Description of plant
3. Description of habitat

4. Population history
5. Current population status
6. Reasons for decline
7. Management History
8. Conservation measures
9. Needed stabilization actions
10. Table with monitoring schedule

Expansion of funding for a fencing plan and fence construction for ungulate control with specified timeline: Fenced enclosures have been constructed within MUs to exclude feral ungulates and protect native plants and native vegetation communities. Fences are being built as determined by the Ungulate Fencing and Management Plan (Young, 2013). Ongoing feral pig trapping is conducted by Waiʻanae Mountains Watershed Partnership (WMWP) and RCUH in the lower portion of Hālona Valley in order to reduce damage to rare species and their habitat in unfenced areas.

Completion of aerial surveys for feral goats, with plans for their removal beginning in 2013:The DLNR had been performing aerial goat eradication in the Waianae Mountains including on Navy Land. However, they have had to indefinitely postpone future efforts until they can complete a Formal Goat Management Plan – a request that they are obligated to complete after the local hunting community raised objections to DLNR's current efforts.

Currently, WMWP is conducting aerial surveys for goats biannually and their observations are reported to DLNR who is able to increase their trapping efforts across the Lualualei border where the terrain is safer for on the ground goat control.

Non-native plant removal within exclosures at Hālona and Mikiula management areas: NAVFAC HI Natural Resources staff contracts biologists to control invasive weeds in higher-elevation MUs and around threatened and endangered populations in order to support growth and survival of ESA-listed and native plants. Weed control is especially critical in the spaces immediately surrounding the plants to limit interference competition.

Allocation of funding for research on Black Twig Borer control methods: A Cooperative Ecosystem Studies Unit (CESU) Agreement is in place with Dr. Cheng's Lab at University of Hawaii and NAVFAC HI to advance the understanding of Black Twig Borer (*Xylosandrus compactus*) control methods in a forest setting. Ideally, the outcome of the study will allow for management of infestations around threatened and endangered species. However, the initial trials are taking place away from threatened and endangered. There are two specific objectives in this project:

1. To evaluate low-risk insecticides against Black Twig Borer in a field trial.
2. To evaluate entomopathogenic fungi strains against Black Twig Borer in a field trial.

Commitment to prioritize the production of a wildfire management plan: The Center for Environmental Management of Military Lands wrote the Wildland Fire Management Plan for Lualualei which was completed in September 2021. Implementation of the plan is executed by the Lualualei Wildland Fire Working Group which holds an annual meeting and has two subcommittees for (1) roadside/vegetation management and (2) inter-departmental drills.

Commitment to address outplanting needs for threatened and endangered species to augment and stabilize populations with U.S. Navy property at Lualualei Annex: Permission to outplant ESA species that currently exist in Lualualei in fenced-in management units is still pending. The Navy Natural Resource team is working with Plant Extinction Prevention Program for *Genetic collections and seed storage.*

5.4.1.8 Use of Native Plants in Landscape and Enhancement Projects

The DON continues to utilize native plants in landscape and enhancement projects at JBPHH Lualualei Annex.

5.4.1.9 Grass Maintenance in Antenna Fields

The DON continues to provide maintenance of grasses in antenna fields to support the military mission in the presence of *Marsilea villosa* and *Cyperus trachysanthos*. When Hawaiian short-eared owl nest are present, this maintenance is paused and a buffer is created. Maintenance is resumed only after the owlets fledge. Per informal USFWS consultations completed for mowing activities in the presence of *Marsilea villosa* (completed in 2002) and *Cyperus trachysanthos* (completed in 2004) (both in Appendix N), the following management actions are required for grass maintenance in the presence of *Marsilea villosa* and *Cyperus trachysanthos*:

General Management actions required for Cyperus trachysanthos:

- Install warning signs and barriers to delineate plant habitat occurrence(s).
- Brief the maintenance personnel on the location of listed plants and prohibited activities.
- Suspend mowing when there is mud in the depression where the plants have been observed.
- Monitor the plants for seed fall (at least 50 percent).
- Resume mowing when the mud hole is not present and after at least 50 percent of the seeds have fallen.
- Set mower blade height to 8 inches to keep blade from mowing the base of the *Cyperus* plants on uneven terrain.

General Management actions required for Marsilea villosa:

- Install warning signs and barriers to delineate plant habitat occurrence(s).
- Brief the maintenance personnel on the location of listed plants and prohibited activities.
- Set mower blade height to 3 inches that allows the mower to cut the invasive grasses, while leaving the *Marsilea villosa* uncut.
- Mowing shall occur during the late summer when the plants have completely dried and are dormant for the season, as well as in the spring or early summer when the plant is emergent.

5.4.2 Invasive Species Prevention and Control

5.4.2.1 Ungulates

The DON continues to monitor and control feral ungulates in the upper portions of Lualualei Valley. This includes maintaining barrier fencing at the Hālona and Puʻu Hāpapa enclosures (Section 5.4.1.7, *Federally-listed, Candidate, and Terrestrial Flora Species of Concern at Lualualei Annex*) in order to protect native plant habitats and monitor the impact of feral ungulates on native plant habitat. In addition, the NAVFAC HI Natural Resources staff continues to control invasive plant species in protected areas.

5.4.2.2 Mammals

As discussed in Section 5.4.1, *Protected Species and Ecosystem Monitoring and Management Actions*, NAVFAC HI provides mammalian predator control at Niuliʻi Ponds Wildlife Refuge.

5.4.2.3 Invertebrates

Invasive mollusks and arthropods are known to occur in JBPHH Lualualei Annex. A primary management goal of the plant and snail management plan for NAVMAG PH Lualualei and NRTF Lualualei is to monitor, assess, and control invasive invertebrates and arthropods that threaten ESA-listed plants and Oʻahu tree snail (Waiʻanae Mountains Watershed Partnership, 2021). IS of top interest for management include the rosy wolfsnail, garlic snail, black twig borer, Chinese rose beetle, and two-spotted leafhopper.

Yellow crazy ants and Australian cockroach are found in Hālona Valley (Evenhuis et al., 2021). Future projects aiming to monitor and control these species are included in Table 8-7, Row 2 and Table 8-8, Row 3.

5.4.2.4 Flora

Discussion of invasive flora species removal is provided in Section 5.4.1.7, *Federally-listed, Candidate, and Terrestrial Flora Species of Concern at Lualualei Annex*. In order to ensure invasive species are not introduced or spread to sensitive areas, field teams clean their gear and vehicles before going to different sites. Additionally, work areas are routinely surveyed for incipients in work areas to note any new pioneers.

5.4.3 Restoration of Natural Resource Areas

DoDI 4715.3 directs DoD agencies to manage natural resources through principles of ecosystem management. Ecosystems with large proportions of native species are to be protected, and habitat restoration activities are to focus on these habitats. Areas with moderate to high natural resource value, as shown in Figure 5-2, are to be managed to conserve those values. The Lualualei Protected Species Management Project (currently under contract) includes actions to plant common native species around the endangered species to improve the nearby habitat and create firebreaks. Table 5-6 highlights the goals of the Protected Species Management Plan.

Table 5-6 Goals of Protected Species Management Plan

Goal		*Status*
1	Survey documenting numbers and locations of plant species	Ongoing
2	Identification of an additional population of *Marsilea villosa* in the Radio Transmitting Facility	Complete
3	Development of a *M. villosa* management plan based on recommendation strategies outlined in a dissertation, partly funded by the Navy	Ongoing
4	Expansion of funding for a fencing plan and fence construction for ungulate control with specified timeline	Ongoing
5	Completion of aerial surveys for feral goats, with plans for their removal beginning in 2013	Ongoing
6	Non-native plant removal within exclosures at Halona and Mikiula management areas	Ongoing
7	Allocation of funding for research on Black Twig Borer control methods	Ongoing
8	Commitment to prioritize the production of a wildfire management plan	Ongoing
9	Commitment to address outplanting needs for threatened and endangered species to augment and stabilize populations with U.S. Navy property at Lualualei	Ongoing

5.4.4 Natural Resource Studies

The DON updated botanical surveys, including ESA-protected species, at JBPHH Lualualei Annex between 2003 and 2006 (Section 5.3, *General Biotic Environment*). NAVFAC HI Natural Resources staff used the results of these surveys to develop a prioritized list of species for monitoring and recovery actions (Section 8.2.3, *Funding and Prioritization of INRMP Projects*). The most recent flora surveys at JBPHH Lualualei Annex include the following:

- The Hawaiʻi Natural Heritage Program conducted botanical surveys at NAVMAG PH in 2004 (CNRH, 2004a).
- NAVFAC PAC conducted an ESA-listed plant survey of NRTF Lualualei in 2011 (NAVFAC HI, 2011).
- A management plan specific to Marsilea villosa was created as a result of dissertation research completed at Lualualei in 2012 (Chau, 2012).
- Arthropod surveys were conducted in 2021 by the Bishop Museum that included a checklist of observed plant species (Evenhuis et al., 2021).

The DON conducted general fauna surveys for the study area in 2006 (NAVFAC PAC, 2006b). NAVFAC HI Natural Resources staff used the results of these surveys to develop a prioritized list of species for monitoring and recovery actions (Section 8.2.3, *Funding and Prioritization of INRMP Projects*). Ongoing fauna surveys within the study area include:

- RCUH conducts bi-weekly waterbird surveys at Niuliʻi Ponds Wildlife Refuge to monitor ESA-listed bird species and MBTA-protected birds (RCUH, 2021).
- RCUH conducts monthly Hawaiian short-eared owls surveys and monitoring at JBPHH Lualualei Annex (RCUH, 2021).
- The Bishop Museum conducts annual arthropod surveys in Hālona Valley (Evenhuis et al., 2021).
- Every 3–5 years snail surveys are conducted in cooperation with OANRP; the most recent was conducted in 2018 (PICHTR, 2020).

- Focused Oʻahu ʻelepaio and ʻiʻiwi surveys conducted in 2019 (Sundance-ES Associates Joint Venture, 2019).

5.4.5 Wetlands

The JBPHH Natural Resources Manager's goal is to ensure that there is no net loss of wetlands on DON-controlled lands, while simultaneously establishing and/or enhancing native wetland species and reducing alien wetland species. Niuliʻi Ponds Wildlife Refuge is managed by DON with the overarching purpose of increasing endangered Hawaiian bird populations. Specifically, populations of Hawaiian stilts, Hawaiian gallinules, and Hawaiian coots. There are four management measures at Niuliʻi Ponds Wildlife Refuge that DON implements to attempt to increase the ESA-listed waterbird populations (NAVFAC PAC, 2009).

1. Maintaining continuous water supply and levels at the ponds to provide suitable nesting habitat for the three target species
2. Restore and maintain native vegetation
3. Band the ESA-listed birds that frequent the ponds
4. Provide outreach in the form of educational signs for the refuge entrance

In 2005, the DON connected a freshwater line (from an existing waterline) with a manual outlet that connects the pump to Pond 1 (NAVFAC PAC, 2006e). Pond water is kept to a level to cover at least the entire base of Pond 1, with deeper water in the center of the pond maintained at a deeper level to provide foraging habitat for Hawaiian coots.

In late June 2019, the pipe that provides the water to the ponds burst. The ponds dried up, vegetation regrew, and no waterbirds were observed using the area while dried. On February 3, 2020, the water source was restored, standing water returned to the ponds, and waterbirds were again observed (NAVFAC PAC, 2006e). Field biologists conduct ongoing bird surveys at Niuliʻi Ponds bi-weekly to monitor ESA-listed bird species and other resident and migratory bird species that use the ponds as habitat.

NAVFAC HI biologists continue to manage vegetation to maximize nesting success, brood survival, food availability, and recruitment of waterbirds at the ponds. Fencing at the ponds was installed in the 1990s, predator control began in 1994, and cattle egret control began in 2001. Human disturbance of the waterbirds using the ponds is minimized by the exclusion fencing/gate and posted signs. Furthermore, entry is limited to authorized personnel. NAVFAC HI biologists monitor for avian disease at the ponds and groundskeepers notify biologists or natural resources personnel of noticeable and different occurrences regarding any birdlife. The DON minimizes contamination of waterbird habitat by toxic substances through the implementation of an Integrated Pest Management Plan (DON, 2003) to control pesticide use on the base. Additionally, the refuge is not located near areas where pesticides or other toxicants or pollutants are used. Field biologists monitor all populations of endangered waterbirds at the ponds on a semi-regular basis using standardized surveys (RCUH, 2021).

5.4.6 Flood Plains

The majority of Lualualei is located in an area of undetermined but possible flood hazard (Zone D). A small portion of Māʻiliʻili Channel and Māʻiliʻili Stream located on the northwest side of NRTF Lualualei is designated as a special flood hazard area which is prone to inundation during a 100-year flood (FEMA, 2015). The Māʻiliʻili and Māʻili Streams (see Figure 5-5) have a common flood plain in the coastal zone below the 25 feet (8 meters) notch. Extensive flooding occurs downgradient from NRTF Lualualei when coastal sand berms form across the channel mouths.

5.4.7 Land Management

Ongoing land management programs at Lualualei are similar to those discussed in Section 4.5.8. They include base planning, reduction of point source pollution, utilization of BMPs during earthwork and construction and storm drain design, and non-point source pollution prevention for JBPHH. In addition, at the study area, the DON continues maintenance, management, and enhancement of areas with natural resource value and management of grasses and vegetation in antenna fields at NRTF Lualualei.

Environmental reviews of all facilities and operations projects are conducted to ensure compliance with land management best practices, such as directing impacts of activities away from sensitive habitats and siting new facilities in already developed areas, when appropriate. The DON continues to preserve, protect, and enhance wetlands at JBPHH Lualualei Annex (Section 5.4.5). The DON continues to promote soil stability and control soil erosion in enclosure areas.

5.4.8 Forestry

There are no significant commercial forestry resources at JBPHH Lualualei Annex. The forestry plantings within the installation occupy an area too small to warrant a timber management program for commercial production on a long-term, sustainable-yield basis. In addition, the forests are confined to wetter areas at the foot of the Waiʻanae Mountain Range. Slopes in these areas are generally greater than 20 percent. These forestry plantings function primarily to adhere soil to the plants in order to prevent erosion. Native snails and insects are associated with these mixed forest areas.

Plots of forestry plantings and mixed forests of native and introduced forestry tree species can be found on the slopes below Kolekole Pass, Pōhākea Pass, and Puʻu Hāpapa. Forestry plantings include eucalyptus (*Eucalyptus* spp.), Australian red cedar (*Toona ciliata*), silk oak, logwood (*Haematoxylon campechianum*), ironwood, Cooke pine, and Norfolk pine. There are numerous pockets (less than 5 acres [2 hectares]) of native forests at higher elevations within NAVMAG PH Lualualei. Native species occasionally found on the steep slopes and occurring among the forestry plantings include wiliwili, alaheʻe, lonomea, olopū, hao, and sandalwood.

5.4.9 Wildland Fire

Wildfire poses a significant threat to the natural resources, cultural sites, and infrastructure within the study area (NAVFAC HI, 2020). In accordance with OPNAVINST 5090.1 (DON, 2021b), NAVFAC HI developed a Wildland Fire Management Plan (WFMP) for NAVMAG PH Lualualei and NRTF Lualualei (NAVFAC HI, 2020). The WFMP lays out specific guidance, procedures, and protocols for the prevention and suppression of wildfires on the developed and undeveloped DON lands of JBPHH Lualualei Annex. The Joint Base Commander has overall responsibility for fire prevention and protection requirements and delegates oversight of the wildland fire management program to the WFMP assigned to NAVFAC HI environmental staff. Other key staff responsible for wildland fire management under the WFMP include NAVFAC Environmental Planners, Public Works Department Chief, FFD Fire Chief, and JBPHH West Loch Security Chief (NAVFAC HI, 2020)

5.4.10 Use of Geographic Information Systems

As discussed in Section 4.5.11, JBPHH's natural resources data is being integrated into the DON's enterprise geodatabase and made available to planners and land managers to aid in decision-making. The NAVFAC HI Natural Resources staff ensure that newly acquired or updated natural resources information is integrated into the NAVFAC HI Georeadiness Enterprise Database on a regular basis.

NAVFAC HI staff continually maintain their GIS database to include the locations of protected flora and fauna species at JBPHH Lualualei Annex. This continually updated GIS database will include the ESA-listed flora and fauna species, MBTA-protected bird species, and vegetation types.

5.4.11 Access Restrictions

JBPHH Lualualei Annex is a restricted area due the presence of ordnance and munitions and related health and safety concerns and, therefore, access to areas with significant natural resources, including protected species, is limited to authorized personnel. These restrictions provide a measure of protection to these species and their habitats.

5.4.12 Community Outreach

The study area is a restricted area due the presence of ordnance and munitions and related health and safety concerns. Community outreach activities are not permitted.

5.4.13 Outdoor Recreation

The study area is a restricted area due the presence of ordnance and munitions and related health and safety concerns. Recreation opportunities may exist but need to be balanced with those safety concerns.

The Lualualei Ungulate Fencing Project protects rare ecosystems through weed suppression, creating fenced enclosures, and managing feral ungulates in areas near endangered plants. Due to the expertise needed to identify and care for the endangered plants outside of fenced units, JBPHH Lualualei Annex will remain off-limits to recreational hunting programs.

5.4.14 Law Enforcement

The study area is a restricted area policed by the JBPHH Base police.

5.4.15 Leases and Encroachment

5.4.15.1 Agricultural Leases

Due to installation restrictions, there are no agricultural outleases at the JBPHH Lualualei Annex.

5.4.15.2 Encroachment

The DON continues to monitor surrounding property development in order to limit encroachment to ensure the continued military mission and protect natural resources. In 2021, the DON developed an Encroachment Management Plan to identify potential community development, or changes in local laws/regulations that may affect the DON operating procedures (DON, 2021a). Potential encroachment issues identified in the plan for JBPHH Main Base and Surrounding Areas are listed below (DON, 2021a).

- Lands near JBPHH Lualualei Annex and along Lualualei Naval Access Road are proposed for future development and increases the pressure for DON to transfer ownership of the road to the CCH.

- Significant historic and archaeological resources are present at JBPHH Lualualei Annex. As a steward of cultural resources, the DON must comply with federal regulations related to those resources (e.g., NRHP and NHL). The presence of cultural resources increases costs associated with staffing, planning, and mitigation of effects to cultural resources throughout JBPHH.
- Illegal dumping of trash and large items occurs along Lualualei Road and other roads surrounding the study area. Cleanup of the dump sites can be expensive and time consuming for DON. The primary concern is determining jurisdiction and which agencies are responsible for cleanup of illegally dumped items.
- Illegal trespassing, primarily by pig hunters, occurs frequently at JBPHH Lualualei Annex. The trespassers often cut fences which could be of particular concern if it occurs in ungulate exclusion fenced areas to protect ESA-listed species.

5.4.16 Climate Considerations

Chapter 3 provided an overview of climate risks that may impact JBPHH. Table 5-7 describes specific climate considerations, vulnerabilities, and adaptations for JBPHH Lualualei Annex.

Table 5-7 JBPHH Lualualei Annex Climate Considerations, Vulnerabilities, and Adaptations

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
1) ESA- and SOH-listed Species (see Tables 5-3 and 5-4)	ESA- and SOH-listed Waterbirds: • Hawaiian Duck (*Anas wyvilliana*) • Hawaiian Coot (*Fulica alai*) • Hawaiian Gallinule (*Gallinula chloropus sandvicensis*) • Hawaiian Stilt (*Himantopus mexicanus knudseni*)	*MEDIUM*: Although habitat and food availability will be impacted by climate change, waterbirds may be able to relocate to other suitable habitat on Oʻahu. *SLR, Severe Storms:* Waterbirds nest at inland man-made Niuliʻi Ponds and oxidation pond areas and are less vulnerable to sea rise and storm surge than coastal sites. *Warmer Temperatures, Diseases*: Warming temperatures could affect waterbird food supply, available breeding habitat, predation (rat, mongoose, cat, etc.) and increase the risk of avian botulism. Botulism is an important cause of mortality in waterbirds, including some endangered species, and climate change may have consequences on the ecology of wetlands that favor the occurrence of botulism outbreaks (USFWS, 2019a, 2019b, 2019c; USFWS, 2018).	Continue to monitor changes in distribution and numbers, perform habitat restoration, and protect existing birds. *Table 8-7, Rows 2 and 4* for Lualualei: Continued waterbird surveys and monitoring along with Niuliʻi Ponds restoration.
	ESA-listed and USFWS designated Species of Concern, Forest birds: • Oʻahu ʻElepaio (*Chasiempis ibidis*) • ʻIʻiwi (*Drepanis coccinea*) • Oʻahu Amakihi (*Chlorodrepanis flava*) • ʻApapane (*Himatione sanguinea*)	*HIGH*: Forest birds are unable to relocate to other suitable habitat on Oʻahu because their elevational extent has already been maximized. Their habitat, food availability, and disease exposure will be impacted by climate change. *Warmer Temperatures and Diseases*: Warming temperatures could affect food supply, available breeding and foraging habitat, and predation risk (rat, mongoose, cat, etc.). Warmer temperatures will allow the expansion	*Table 8-7, Row 2 and Table 8-8, Row 7* for Lualualei include recurring forest bird surveys to monitor for presence or expansion of forest birds back into DON lands at Lualualei.

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
1) ESA- and SOH-listed Species (see Tables 5-3 and 5-4) (continued)	SOH-listed Birds: • Hawaiian Short-eared Owl (*Asio flammeus sandwichensis*)	of mosquitoes into higher elevations, increasing the exposure of native forest birds to avian malaria and avian pox. Increase the risk of mosquito-borne avian malaria and avian pox as mosquitoes expand to higher elevations. MEDIUM: Although habitat and food availability will be impacted, Hawaiian short-eared owl may be able to relocate to other suitable habitat on Oʻahu. *Warmer Temperatures*: Warming temperatures could affect their food supply and available breeding habitat.	Continue to monitor changes in distribution and numbers and protect existing birds. Management Actions described in *Section 5.4.1* include bird surveys. *Table 8-7, Row 2* provides recommendations for JBPHH Main Base and Surrounding Areas to include updating flora and fauna surveys to monitor for changes in these species in the study area. Hawaiian short-eared owl is a SOH-listed species on Oʻahu. Twilight pre-construction surveys shall be conducted by a qualified biologist prior to clearing any vegetation. Anytime Hawaiian short-eared owl adults/nests/chicks are found and/or flushed out during clearing operations, contractors must stop work and inform NAVFAC HI Natural Resources Manager of the Hawaiian short-eared owl presence which contributes to population survey data. If nests are found to be present, a buffer zone should be established in which no clearing occurs until nesting ceases.

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
1) ESA- and SOH-listed Species (see Tables 5-3 and 5-4) (continued)	Terrestrial Mammal: • Hawaiian Hoary Bat *(Lasiurus cinereus semotus)*	*MEDIUM:* Although habitat and food availability may be impacted, the Hawaiian hoary bat is known to forage over large distances and may be able to find more suitable habitat outside of the study area. *Warmer Temperatures, Change Precipitation:* Hawaiian hoary bat could be threatened by the effects of climate change if less habitat becomes available for foraging, roosting, and pupping; however, there is a general lack of knowledge concerning its distribution, abundance, and habitat needs. While prime habitats include native moist and rain forests up to 6,000 feet (1,830 meters), bats also use native xeric and disturbed habitats as well as wet to moist non-native habitats and urban areas (Bonaccorso, 2010). Changing precipitation and rising temperatures could affect the bat's food availability (moths, beetles, crickets, mosquitoes, and termites). In addition, bats tend to move to higher elevations with cooler temperatures during January through April, potentially because the cooler temperatures allow them to achieve a lower metabolic rate while roosting.	Monitor for changes in the distribution and numbers. *Table 8-7, Row 5* for JBPHH Main Base and Surrounding Areas include Hawaiian hoary bat acoustic surveys. The DON project recommendations include BMPs to prevent clearing trees greater than 15 feet (4.6 meters) in height during the bat pupping season 1 June through 15 September.

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
1) ESA- and SOH-listed Species (see Tables 5-3 and 5-4) (continued)	<u>Mollusk Species:</u> • Oʻahu Tree Snail *(Achatinella mustelina)* • *Amastra cylindrica*	*HIGH:* Tree snails evolved in microclimates with very specific amounts of sunlight, precipitation, plant communities, and soil conditions and may not be to exist outside of those narrow microclimate confines. Declines are mostly attributed to invasive predators, including rats *(Rattus rattus)* and other rodents, Jackson's chameleon *(Trioceros jacksonii),* and rosy wolfsnail *(Euglandina rosea)*. Virtually all recent native snail species population declines and extirpations correspond to the appearance of the previously undocumented predatory rosy wolfsnail. Additional pressures to the tree snails come from predatory flatworms and pathogens. Climate change may increase the range of IS detrimental to the tree snail. <u>Warmer Temperatures</u>: Warmer temperatures may allow predatory snails to reach higher-elevation native tree snail habitats and expand the range of predators and pathogens. <u>Changing Precipitation</u>: Tree snails depend on low clouds for moisture and are vulnerable to changes in temperature or precipitation. <u>Severe Storms</u>: Stronger and more frequent hurricanes could also wipe out entire populations or species with very restricted population ranges.	Management Actions described in *Section 5.4.1* include: predator control, protected species monitoring, *Table 8-7, Rows 2 and 18* for Lualualei include endangered snail management, flora and fauna mapping, and predator control, and access restrictions.

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
1) ESA- and SOH-listed Species (see Tables 5-3 and 5-4) (continued)	Arthropods: • Hawaiian Yellow-faced Bees (*Hylaeus* spp.) • Hawaiian Picture-Wing Fly (*Drosophila* spp.*)* • Orangeblack Hawaiian Damselfly (*Megalagrion xanthomelas)*	*High:* Suitable habitat and food availability will be impacted, particularly for specialists that have restricted population ranges. *Severe Storms:* Lualualei is located inland and less vulnerable to SLR and storm surge, however, severe storm events have potential to destroy the few remaining patches of suitable habitat for some endangered arthropods. Wetland inundation may adversely impact mature vegetation also used by some Hawaiian yellow-faced bee species to nest.	The presence of Hawaiian picture-wing flies, Hawaiian yellow-faced bees, and orangeblack Hawaiian damselfly at the Lualualei are unconfirmed. *Table 8-7, Row 2 and Table 8-8, Row 3* includes periodic updating of flora and fauna surveys, threatened and endangered arthropod surveys and management, and coastal restoration to out-plant native pollinator flora.
2) Wetlands	Wetlands that support diverse flora and fauna assemblages (*Concurrently protects the above ESA-listed waterbirds and federal Clean Water Act regulated wetland ecosystems*) include Niuliʻi Ponds Wildlife Refuge.	*LOW:* The direct impacts of rising temperatures, changing precipitation patterns and extreme weather events may increase chronic flooding, and sediment/pollutant runoff. However, because Niuliʻi Ponds Wildlife Refuge is man-made, DON has mechanisms for controlling water levels there. *Rising sea levels* may lead water inundation and create new wetlands.	JBPHH INRMP follows an ecosystem-based management approach and fosters long-term sustainability of ecosystems services. The principles of ecosystem management to foster long-term sustainability of ecosystem services dovetails well with the climate adaptation risk-based management concepts and is adaptable to complex and changing requirements. Management Actions described in Section 5.4.5 describes no net loss of wetlands on DON-controlled lands, while simultaneously establishing and/or enhancing native wetland species and reducing alien wetland species. NAVFAC HI implemented a management plan for

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
2) Wetlands (continued)			the Niuliʻi Ponds Wildlife Refuge (Appendix K-6) and continues to maintain wetland habitat at the Niuliʻi Ponds Wildlife Refuge in order to preserve, protect, and enhance wetlands and protected bird species that inhabit them. *Table 8-7, Row 29* for Lualualei includes restoration at Niuliʻi Ponds as waterbird habitat.
3) Migratory Bird Treaty Act (MBTA)	Lualualei is home to a diversity of MBTA-protected birds and bird habitats.	*MEDIUM: <u>Rising temperatures and changing precipitation patterns</u>* may increase the growth of certain bird populations, from longer breeding seasons and changes in habitat and cause shifts in the distribution and abundance of bird species. Warmer temperatures may favor the occurrence of botulism outbreaks in waterfowl and shorebirds (i.e., plovers) that use Niuliʻi Pond Wildlife Refuge. *<u>Severe Storms</u>* may increase the number of seabird fallouts.	JBPHH INRMP management actions are to protect MBTA-protected birds. The DoD MBTA position is that incidental/unintentional take of migratory birds is still prohibited. While there is no specific INRMP MBTA project, the INRMP programs/projects for wetland restoration and predator control also benefit MBTA birds. *Table 8-7, Row 2* for Lualualei includes periodic flora and fauna surveys. DON project recommendations include BMPs to verify that trees or bushes scheduled for removal do not contain the active nests of migratory birds.

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
4) Invasive Species (IS)	PRIORITY SPECIES INCLUDE: Vertebrates: • Feral Cat (*Felis catus*) • Mongoose (*Herpestes javanicus*) • Ungulates • Rodents Invertebrates: • Black Twig Borer (*Xylosandrus compactus*) • Naio Thrip (*Klambothrips myopori*) • Yellow Crazy Ant (*Anoplolepis gracilipes*)	*HIGH:* Climate change and IS rank among the largest predicted threats to global ecosystems over the next century. Climate-related impacts often operate through amplifying the impact of existing stressors, such as IS. IS are, by nature, highly flexible, and respond to unusual environments more quickly than do natives. With the help of climate change, IS also reap the benefits that come with early blooming, shading out competitors and capturing a larger share of nutrients, water, or pollinators. Changing rainfall patterns may increase the spread of IS. Warming air temperatures lead to expanded IS. Extreme climatic events, such as hurricanes, floods, and droughts, can transport IS to new areas and decrease the resistance of habitats to invasions. Climate change may increase available food for IS pigs, feral cats, mice, rats, and mongoose.	Management Actions described in Section 5.4 include Predator Control, invasive species prevention and control, and no net loss of wetlands. INRMP wetland goals and objectives are to restore wetland habitat while retaining wetland function. *Table 8-7, Rows 1, 2, and 16* for Lualualei includes climate adaptation planning, predator control, control invasive plants, early detections via roadside flora surveys, flora and fauna mapping, protect rare/protected species during training, fencing/signage to protect rare/protected species, hunting ungulates, exclude feral ungulates, invasive vegetation removal, and restore/manage Niuliʻi Ponds.
5) Bird/Wildlife Aircraft Strike Hazard (BASH)	*Not Applicable:* There are no airfields at the Lualualei site.	*Not Applicable*	*Not applicable*
6) Wildland Fire	Wildfire poses a risk to dry ecosystem habitats (i.e., grassland and coastal mesic forest, etc.), personnel, facilities, and other infrastructure.	*HIGH:* The rate of warming air temperature has increased in Hawaiʻi in recent decades, which increases the risk of wildfires during drought occurrences. A wildland fire occurred at Lualualei in 2015. The disturbed land on the	Many alien grasses such as buffelgrass are dry and extremely flammable. In addition, koa haole and Christmas berry form dense forests where dry debris and dead material provide fuel for fires. The

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
6) Wildland Fire (continued)		leeward coast of the Waiʻanae Mountain Range is dangerously prone to brush fires.	DON currently maintains grasses and vegetation within the developed portions of the study area. Management Actions described in Section 5.4.9 include agreement for the FFD at Lualualei to coordinate with the Oʻahu Wildland Fire Council to ensure that fuel breaks, water sources, fire prevention measures, and fire suppression staffing are adequate to minimize the potential for wildland fire impacts to listed species. *Table 8-7, Row 21* for Lualualei includes emergency firefighting by personnel during training exercises, coordination with the FFD and Honolulu Fire Department and to establish a WFMP and to develop a framework for swift and effective response in the event of a wildfire.

Notes: BASH = Bird/Wildlife Aircraft Strike Hazard; DON = Department of the Navy; ESA = Endangered Species Act; FFD = Federal Fire Department; IS = Invasive Species; INRMP = Integrated Natural Resources Management Plan; IS = invasive species; JBPHH = Joint Base Pearl Harbor-Hickam; MBTA = Migratory Bird Treaty Act; NAVFAC HI = Naval Facilities Engineering Systems Command, Hawaii; SLR = Sea Level Rise; SOH = State of Hawaii; USFWS = United States Fish and Wildlife Service; WFMP = Wildland Fire Management Plan.

6 JBPHH Wahiawa Annex

6.1 Current Conditions and Use

6.1.1 Installation Information

This chapter covers the JBPHH Wahiawa Annex which includes NCTAMS PAC Wahiawa, Camp Stover Housing Community, and Opana (study area). NCTAMS PAC Wahiawa is the DON's computer and telecommunications area master station located on approximately 700 acres (283 hectares) north of the town of Wahiawā within the central (Schofield) plateau region of Oʻahu, Hawaiʻi (Figure 6-1). Camp Stover Housing Community, located approximately 3.25 miles (5.2 km) southwest of NCTAMS PAC Wahiawa, is composed of 35 acres (14 hectares) at Wheeler Army Airfield in Central Oʻahu (Figure 6-1). Opana is located approximately 11 miles (18 km) north of NCTAMS PAC Wahiawa, is composed of 4 acres (2 hectares), and is situated off an unnamed road approximately 1.3 miles (2 km) south of Kamehameha Highway in Kahuku, Oʻahu.

6.1.1.1 General Description, Operations, and Activities

Naval Computer and Telecommunications Area Master Station, Pacific, Wahiawa

NCTAMS PAC Wahiawa includes operations, open space, and family housing and community support facilities.

Camp Stover Housing Community

Camp Stover Housing Community is located on Wheeler Army Airfield.

Opana

Opana is located within the U.S. Army Kahuku Training Area and includes a U.S. State Department telecommunications station utilized by the Naval Research Laboratory. The Naval Research Laboratory conducts research and development of communications techniques and timing distribution techniques, as well as the effects of the atmosphere on these techniques, in support of DoD missions and direct support to service members. The telecommunications station also serves as a relay for the Department of State's Diplomatic Telecommunications Service (DON, 2021).

6.1.1.2 Abbreviated History and Pre-Military Land Use

The Wahiawā District was formed in 1913 by the Territorial Government by combining the upper portion of Kamananui ahupuaʻa with the Waiʻanae Uka ahupuaʻa. It was known as the home of chiefs. The central plateau of Oʻahu was once forested with sandalwood and other plant species that were depleted by logging in the early 19th century. The plateau also supported both dry land yam and sweet potato cultivation on the ridges and taro cultivation in loʻi (irrigated terraces) constructed in gulches. Agricultural terraces are reported to have been located along the Poamoho, Helemano, and Kaukonahua Streams as well as on the broad interfluves above the gulches. Residential sites are reported on level lands in interfluvial plateaus (CNRH, 2008).

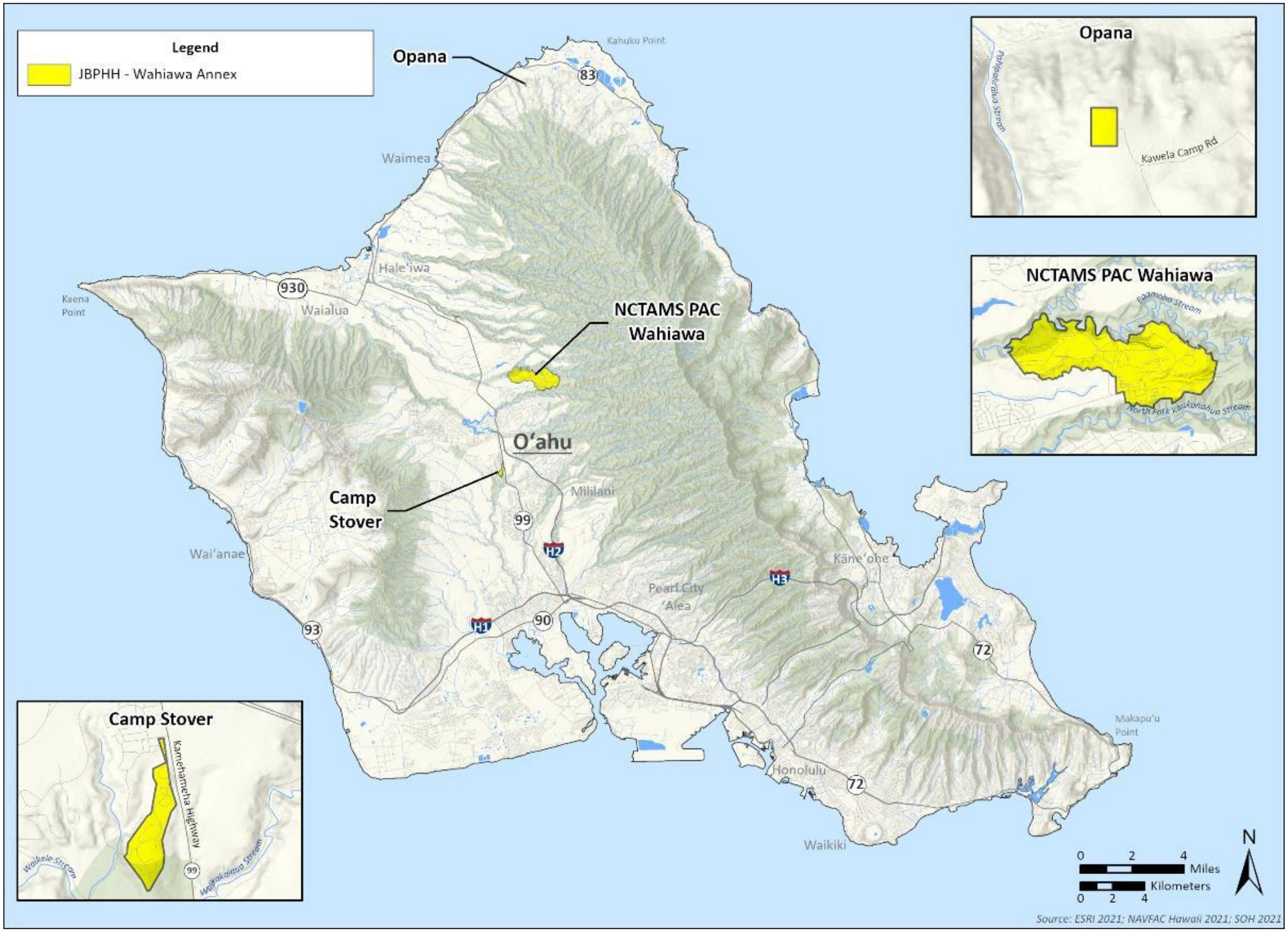

Figure 6-1 JBPHH Wahiawa Annex Study Area

Commercial agriculture transformed the physical and the cultural landscape of the central plateau. By the 1830s, the land was nearly treeless, with scattered ti plants and small groves of koa. After the Great Mahele in 1848, the entire ahupuaʻa of Kamananui was designated “Government Land.” Homesteads were initiated in the late 1890s, but soon afterward, James B. Dole began converting the plateau to pineapple cultivation.

Naval Computer and Telecommunications Area Master Station, Pacific, Wahiawa

The area now known as NCTAMS PAC Wahiawa was used for pineapple cultivation until it was acquired by DON for development of a radio transmitter facility in 1940 (CNRH, 2008). With the arrival of the major COMPACFLT units at Pearl Harbor in 1939, DON required a new receiver and control station. The chosen location in Wahiawā, some 20 miles (32.2 km) north of Pearl Harbor, was selected and purchased by DON for approximately $1,000,000. The NCTAMS PAC Wahiawa site was amassed from three parcels of land acquired through different condemnation proceedings beginning in 1940 and ending in 1946 (CNRH, 2008).

Construction of the installation began in 1940; its construction and the relocation of functions from Wailupe to Wahiawā were completed in December 1941.

In 1941, Contractors Pacific Naval Bases built housing for the Commanding Officer, junior officers, chief petty officers, and enlisted married men at the then named “Naval Radio Station.” C.W Dickey, the well-known local architect, designed these quarters as well as the barracks and mess hall (CNRH, 2008).

For a short period after World War II until 1956, the installation was used as a receiver site and the central point of communications was moved to Pearl Harbor. However, due to insufficient space and the need for expansion of facilities and consolidation of staff, the central point was relocated to the Wahiawā site in 1956. Over the years, requirements for rapid communications from the DON to fleet operational commanders changed. As a result, by 1959, various systems, circuits, and networks were activated at NCTAMS PAC Wahiawa and the stations at Haʻikū and Heʻeia were no longer needed. Additional family housing was constructed at NCTAMS PAC Wahiawa in 1965.

In 1967, the communications stations on Oʻahu underwent a consolidation to become Naval Communications Station (NAVCOMSTA) Honolulu. In 1976, the name was changed to Naval Communications Area Master Station, Eastern Pacific (NCTAMS EASTPAC) and then again in 1997 to NCTAMS PAC.

Camp Stover Housing Community

The family housing units at Camp Stover were originally built in 1973 and units have been revitalized in recent years. DON acquired the land in 1949 (NAVFAC PAC, 2006).

Opana

ʻŌpana, the name of the ridge on which the site is located, was once the site of “a small spring watered terrace area named Ka-wela (the heat), which is also the name of the bay below” (Handy and Handy, 1972 in CNRH, 2008). Prior to European contact, the well-irrigated valleys of Kahuku were cultivated in taro (CNRH, 2008). The Kahuku area was later used for cattle ranching, then sugar and pineapple plantations.

The Opana Radar Site was the first operational use of radar by the U.S. during wartime and is a NHL (DON, 2021). At the onset of World War II, the U.S. military began experimenting with radar and established an Aircraft Warning Service that used radar for the defense of U.S. territory (National Park

Service [NPS], 2021). On Thanksgiving Day in 1941, a mobile radar unit was moved for testing at Opana Radar Site due to its elevation and unobstructed view of the Pacific Ocean (NPS, 2021).

On December 7, 1941, the Opana Radar Site was manned by two privates who detected approaching aircraft at 07:02 a.m. They reported their observation to the temporary information center at Fort Shafter (NPS, 2021). The information center staff had gone to breakfast and Lieutenant Kermit Tyler received the report. Tyler reasoned that the activity was a flight of U.S. Army B-17 bombers scheduled to arrive from California and told the privates, “not to worry about it” (NPS, 2021; Butowsky, 1992). The privates continued to plot the incoming planes until 7:40 a.m. when contact was lost due to background interference (Butowsky, 1992). The privates secured the site and headed down the road to Kawailoa for breakfast (NPS, 2021). The Imperial Japanese Navy Air Service, which the privates had detected, began the attack on Pearl Harbor at 07:53 a.m.

The Opana Radar Site illustrated the immediate value of radar in warfare. The site became a NHL in 1994 and the modern DON telecommunications station, Opana, occupies the top of the ʻŌpana Hill adjacent to the landmark.

6.1.1.3 Land Use and Land Use Constraints

Naval Computer and Telecommunications Area Master Station, Pacific, Wahiawa

Environmental land use constraints at NCTAMS PAC Wahiawa are defined by the presence of Helemano silty clay (HLMG) soil (30 to 90 percent slopes) (see Section 6.2.5, *Soils*, Figure 6-3), which is characterized by severe to very severe erosion hazard; and steep topography in the bordering gulches (north fork of Kaukonahua Stream to the south and Poamoho Stream to the north). NCTAMS PAC Wahiawa is further divided by a small gully that separates the operations and community area on the south from the antenna fields on the north.

Camp Stover Housing Community

The only natural resources land use constraints identified at Camp Stover are the steep topography and the severe to very severe erosion hazard associated with HLMG soils in the gulch bordering the housing community (see Section 6.2.5, *Soils*, Figure 6-3). No military mission land use constraints or encroachment issues are identified for the housing community.

Opana

The only natural resources land use constraint identified at Opana are steep topography in the southeastern portions of the site. There are no military mission land use constraints at Opana, although encroachment has been identified as a potential issue for the site in the near to long term (DON, 2021).

6.1.1.4 Military Land Use Opportunities

There are no military mission training land use opportunities within the study area. Regional Land Uses

Naval Computer and Telecommunications Area Master Station, Pacific, Wahiawa

The location of NCTAMS PAC Wahiawa was carefully chosen from engineering studies as best suited to support the mission, tasks, and functions of the command. The station is bordered on the north and south by deep gulches that are unsuitable for development and which serve as effective natural buffer zones. The downslope (west) side is agricultural land (tree farm and fallow pineapple fields) and upslope (east) lies the Koʻolau Mountain Range/SOH Forest Reserve; both uses are considered desirable as a buffer zone for the receiving antennas. Future industrial or urban development of the agricultural land or forest reserve would constitute an incompatible use.

NCTAMS PAC Wahiawa lands, and most of the surrounding lands in Central Oʻahu, are in the State Agricultural District. The lands above the installation (Koʻolau Mountain Range and SOH forest reserve) lie within the State Conservation District (CCH, 2021).

Land adjacent to NCTAMS PAC Wahiawa is largely devoted to agriculture. Whitmore Village, a plantation town (2020 population: 4,887), lies 1 mile (1.6 km) west of the installation. The nearest urban center is the town of Wahiawā (2020 population: 18,658), located 3 miles (4.8 km) southwest of the facility. NCTAMS PAC Wahiawa is zoned by the CCH as F-1 (Military and Federal Preservation) and is bordered by P-1 zoning (Restricted Preservation District) on its upland (eastern) boundary and AG-1 zoning (Restricted Agricultural District) to the north, west, and south (CCH, 2021).

Camp Stover Housing Community

The Camp Stover Housing Community sits within the State Urban District. It is surrounded on the north and west by Urban District lands (including Wheeler Army Airfield), and the south and east by lands within the State Agricultural District. It is within and bordered by F-1 zoning (Military and Federal Preservation) with AG-1 zoning (Restricted Agricultural District) to the south and east (CCH, 2008).

Opana

Opana is surrounded by the U.S. Army Kahuku Training Area and is zoned by the CCH as F-1 (Military and Federal Preservation). Future industrial or urban development would be incompatible with current training and military uses.

6.2 General Physical Environment

The discussion of the general physical environment is divided into six subsections (6.2.1 through 6.2.6): physical geography, topography, climate, geology, soils, and hydrology – including surface water resources and hydrogeology (groundwater resources). General island-wide descriptions of these resources are presented in Section 2.2; the following discussion addresses the study area and environs.

6.2.1 Physical Geography

A general discussion of the physical geography of the Hawaiian Islands and Oʻahu is presented in Section 2.2.1. NCTAMS PAC Wahiawa and Camp Stover Housing Community are located on an upland, central plateau known as the Schofield Plateau and consists of gently sloping land and steep-sided ravines. The Schofield Plateau is deeply dissected by major streams draining from the Koʻolau Mountain Range.

The gulches bordering NCTAMS PAC Wahiawa include the north fork of Kaukonahua Stream to the south, and Poamoho Stream to the north. NCTAMS PAC Wahiawa is further divided by a small gully that separates the operations and community area on the south from the antenna fields on the north. An unnamed gulch that contributes to the Waikele Stream is located to the west of the Camp Stover Housing Community.

Opana is located in the foothills of the Koʻolau Range. The Pahipahiʻālua Gulch and Pahipahiʻālua Stream are located approximately 0.25 mile (0.40 km) west of Opana.

6.2.2 Topography

A general discussion of Oʻahu's topography is presented in Section 2.2.2. Land occupied by NCTAMS PAC Wahiawa slopes gently east to west from an elevation of approximately 1,300 feet (396 meters) above MSL to an elevation of 1,000 feet (305 meters) above MSL (Figure 6-2). The slope of the plain averages 3 percent. As the foothills of the Koʻolau Range are encountered a short distance east of the station, the terrain at the station is generally suitable for development except for the steep-sided Poamoho Gulch that traverses the site (DON, 2001).

Camp Stover Housing Community slopes gently to moderately to the south from an elevation of approximately 780 feet (238 meters) above MSL to an elevation of 720 feet (220 meters) above MSL (Figure 6-2).

Opana facilities are situated on a leveled area, otherwise the site slopes moderately to the west from an elevation of approximately 520 feet (159 meters) above MSL to an elevation of 490 feet (149 meters) above MSL (Figure 6-2).

6.2.3 Climate

A general discussion of the climate for the island of Oʻahu is presented in Section 2.2.3. The monthly average temperature at NCTAMS PAC Wahiawa ranges from 68.0°F (20.0°C) in winter to 75.5°F (24.1°C) in summer. The highest maximum monthly average is 82.0°F (27.8°C) for the month of August and lowest minimum monthly average is 60.3°F (15.7°C) for the month of January (NOAA, 2021) (Table 6-1). The temperature range at Camp Stover Housing Community is similar to that of NCTAMS PAC Wahiawa.

Table 6-1 10-Year Monthly Average Air Temperature Ranges near NCTAMS PAC Wahiawa (2011–2020)

Month	*Upper Wahiawa Station Air Temperature (°Fahrenheit [°Celsius])*		
	Monthly Average	*Monthly Maximum Average*	*Monthly Minimum Average*
January	68.06 (20.03)	75.80 (24.33)	60.32 (15.73)
February	68.06 (20.03)	75.31 (24.06)	60.79 (15.99)
March	68.04 (20.02)	75.32 (24.07)	60.79 (15.98)
April	70.29 (21.27)	77.64 (25.36)	62.91 (17.17)
May	71.28 (21.82)	78.85 (26.03)	63.73 (17.63)
June	73.22 (22.90)	80.49 (26.94)	65.94 (18.86)
July	74.90 (23.83)	82.00 (27.78)	67.80 (19.89)
August	75.52 (24.18)	80.03 (28.35)	68.03 (20.02)
September	75.16 (23.98)	82.81 (28.23)	67.48 (19.71)
October	73.98 (23.32)	81.58 (27.54)	66.36 (19.09)
November	71.64 (22.02)	78.72 (25.96)	64.58 (18.10)
December	69.51 (20.84)	76.49 (24.72)	62.56 (16.98)

Source: NOAA, 2021.

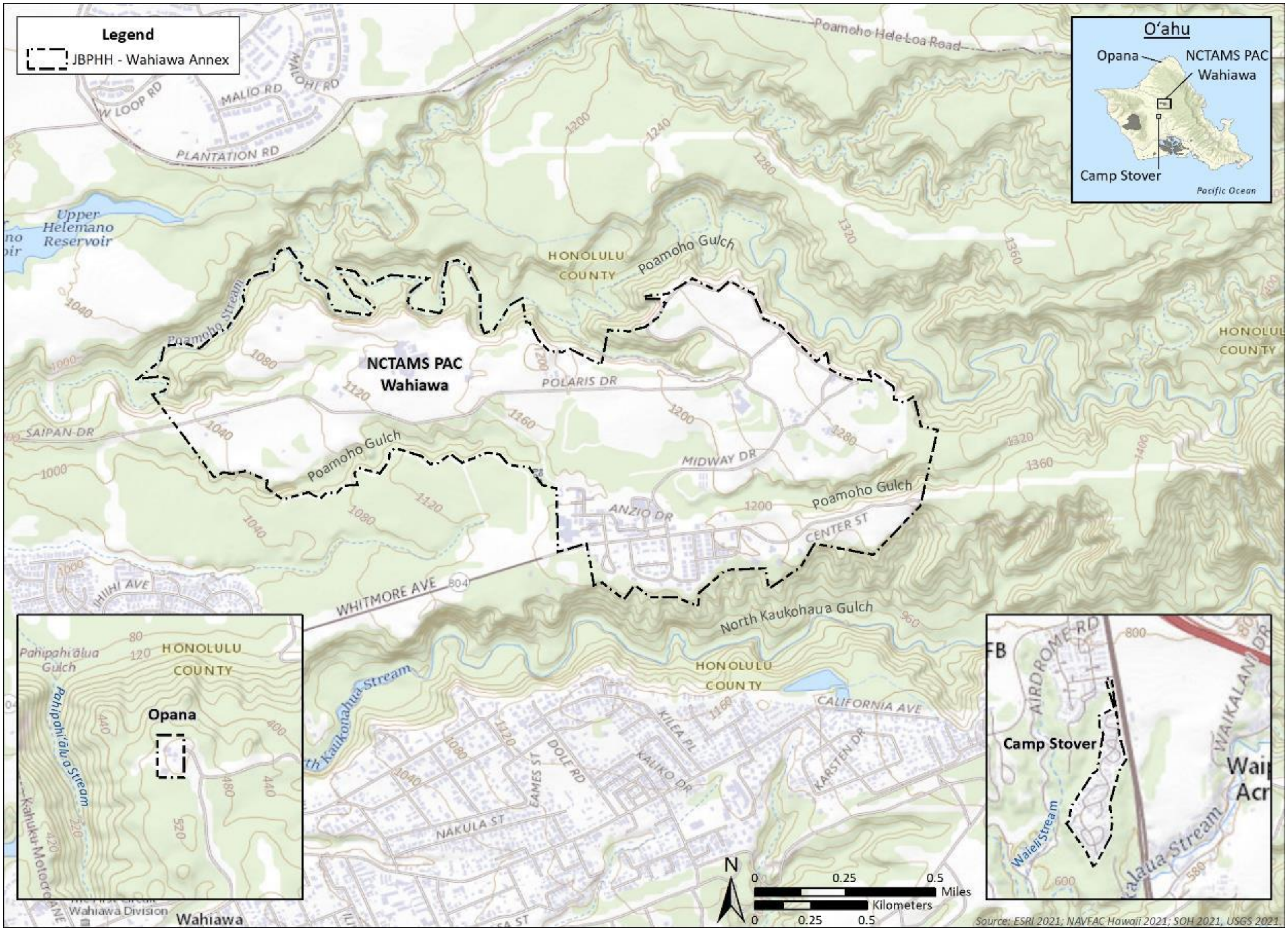

Figure 6-2 JBPHH Wahiawa Annex Topography

At Opana, the monthly average temperature ranges from 71.37°F (21.87°C) in winter and to 78.69°F (25.94°C) in summer. The highest maximum monthly averages range from 76.95°F (27.8°C) to 84.3 °F (29.0°C) and lowest minimum monthly averages range from 65.8°F (18.8°C) to 73.0°F (22.8°C) (NOAA, 2021) (Table 6-2).

Table 6-2 10-Year Monthly Average Air Temperature Ranges near Opana Radar Site (2011–2020)

Month	*Kahuku Training Station Air Temperature (Fahrenheit [Celsius])*		
	Monthly Average	*Monthly Maximum Average*	*Monthly Minimum Average*
January	71.91 (22.17)	77.77 (25.43)	66.04 (18.91)
February	71.37 (21.87)	76.95 (24.97)	65.76 (18.76)
March	71.50 (21.94)	77.04 (25.02)	65.97 (18.87)
April	73.77 (23.21)	79.46 (26.37)	68.06 (20.03)
May	74.69 (23.72)	80.48 (26.93)	68.91 (20.51)
June	76.46 (24.70)	82.32 (27.96)	70.60 (21.44)
July	78.01 (25.56)	83.74 (28.75)	72.27 (22.37)
August	78.69 (25.94)	84.29 (29.05)	73.04 (22.80)
September	78.30 (25.72)	84.10 (28.94)	72.51 (22.51)
October	77.25 (25.14)	82.83 (28.24)	71.68 (22.04)
November	75.03 (23.91)	80.10 (26.72)	69.96 (21.09)
December	72.93 (22.74)	77.86 (25.48)	68.00 (20.00)

Source: NOAA, 2021.

Rainfall records for a number of sites in the Wahiawā and North Shore regions have been published, but none are located within NCTAMS PAC Wahiawa, Camp Stover Housing Community, or Opana Radar Site areas. Normal tradewind weather brings substantial rainfall to the area. At least one-third of the annual rainfall total originates with orthographic showers associated with the tradewinds. Most of the remainder accompanies winter storms, and a small fraction falls as showers from convective clouds. NCTAMS PAC Wahiawa area receives an average annual rainfall of approximately 68 inches (173 cm) (Giambelluca et al., 2013). Opana receives an average annual rainfall of approximately 49 inches (124 cm) (Giambelluca et al., 2013).

6.2.4 Geology

A general discussion of the geology of Oʻahu is presented in Section 2.2.4. Located adjacent to the foothills of the Koʻolau Range on the Schofield Plateau of central Oʻahu, NCTAMS PAC Wahiawa is underlain by lavas from the Koʻolau Range. The rocks of the ancient Koʻolau Volcano are thin tholeiitic basalts with minor amounts of ash, and their associated dike feeders (Stearns, 1985).

The Camp Stover Housing Community is also located within the Schofield Plateau and is underlain by alluvium derived from the eroded Waiʻanae and Koʻolau Volcanoes.

Opana is located in the foothills of the Koʻolau Range on the North Shore of Oʻahu.

6.2.5 Soils

6.2.5.1 Naval Computer and Telecommunications Area Master Station, Pacific, Wahiawa

The soils at NCTAMS PAC Wahiawa reflect the geology of the region and are generally deep, well-drained silty clays. The surface soils consist of residuum overlying 50 to 100 feet (15 to 30 meters) of weathered basalt known as saprolite. Alluvium accumulation in gulches is too meager to be consequential. Soils found at the installation exhibit suitable properties for agricultural development. All of the soils at the installation support vegetative cover suitable for grazing purposes. HLMG, which is characterized as having a severe to very severe erosion hazard, is the only soil on the installation that cannot be used as cropland (USDA-NRCS, 1972). Figure 6-3 shows the soil types for the installation and Table 6-3 provides a description of these.

Current land practices maintain adequate vegetative cover and no major erosion problems are found at the installation. Two minor erosion problems have been identified in the Poamoho Gulch: (1) the southern slope of the gulch is vulnerable to serious erosion; and (2) extensive use of dirt bikes and other all-terrain vehicles in the gulches north of the installation have severely eroded gulches on both sides of the stream (DON, 2001; AECOM, 2016).

6.2.5.2 Camp Stover Housing Community

Camp Stover is largely underlain by Wahiawa Silty Clay, 0 to 3 Percent Slopes (WaA), with smaller portions near the gully underlain by HLMG (Figure 6-3). Currently, there are no major erosion hazards at Camp Stover.

6.2.5.3 Opana

Opana contains soils of the Kemoo Series with 2 to 6 (KpB) and 6 to 12 (KpC) Percent Slopes. The Kemoo Series soils are well-drained and found in the uplands of Oʻahu. Currently, there are no major erosion hazards at Opana.

6.2.6 Hydrology

A general discussion of the hydrogeology of the Hawaiian Islands and Oʻahu is presented in Section 2.2.5. The discussion of hydrology for the study area is divided into two sections: (1) a discussion of surface water resources, and (2) a discussion of hydrogeology or groundwater resources.

6.2.6.1 Surface Water Resources

Naval Computer and Telecommunications Area Master Station, Pacific, Wahiawa

NCTAMS PAC Wahiawa is located on the upper reaches of a sloping plateau adjacent to the ʻEwa Forest Reserve on the leeward slope of the Koʻolau Mountain Range. Two branches of Poamoho Stream dissect the plateau and as such, the installation is located within a series of watersheds off the leeward slope of the Koʻolau Mountain Range. The streams are contained in deep, forested gulches. NCTAMS PAC Wahiawa covers part of the wide interfluve separating the deep valleys of the north fork of Kaukonahua Stream on the south and Poamoho Stream on the north. The largest gulch within the installation is a tributary of Poamoho Stream about 50 feet (15 meters) deep and following an east-west course (Figure 6-3). Given the depth of the gulch and its small drainage area, flooding during heavy rainfall is unlikely. However, floodwaters could reach the low road crossings. The drop from the edge of the interfluve into Poamoho and the north fork of Kaukonahua Stream is approximately 200 feet (61 meters) over an average slope of 50 percent. The Poamoho Stream system ultimately drains into the ocean at Haleʻiwa approximately 9 miles (14.5 km) downstream (DON, 2001).

Table 6-3 Soils of JBPHH Wahiawa Annex

Soil Type	*Location*	*Description*	*Characteristics*
Helemano Series: This series consists of well-drained soils on alluvial fans and colluvial slopes on the sides of gulches. They developed in alluvium and colluvium derived from basic igneous rock.			
Helemano silty clay, 30 to 90 percent slopes (HLMG)	These soils can be found on the sides of V-shaped gulches, including portions of NCTAMS PAC Wahiawa and Camp Stover Housing Community.	The surface layer is neutral, dark reddish-brown silty clay (~10 inches [25 cm] thick). The subsoil (~50 inches [127 cm] thick) is neutral to slightly acidic, dark reddish-brown and dark-red silty clay that has subangular blocky structure. The substratum is soft, highly weathered basic igneous rock.	Permeability is moderately rapid. Runoff is medium to very rapid and the erosion hazard is severe to very severe. Available water capacity was not reported.
Kemoo Series: This series consists of well-drained soils on uplands. Soils of this series developed in material weathered from basic igneous rock.			
Kemoo silty clay, 2 to 6 percent slopes (KpB)	KpB occurs along the southeastern quadrant of Opana.	The surface layer is dusky-red silty clay about 12 inches (30 cm) thick. It contains strong effervescence with hydrogen peroxide and is slightly acidic. The subsoil is dusky-red silty clay with slight effervescence with hydrogen peroxide and neutral.	Permeability is moderate to moderately rapid. Runoff is slow to medium and the erosion hazard is slight.
Kemoo silty clay, 6 to 12 percent slopes (KpC)	KpC occurs in the northern and southwestern portions of Opana.	This soil is similar to KpB in soil profile.	Permeability is moderate to moderately rapid. Runoff is medium and the erosion hazard is slight to moderate.
Leilehua Series: This series consists of well-drained soils on uplands. Soils of this series developed in material weathered from basic igneous rock.			
Leilehua silty clay, 2 to 6 percent slopes (LeB)	LeB occurs as broad areas, as well as narrow areas, bordered by gulches, including portions of NCTAMS PAC Wahiawa.	In a representative profile, the surface layer of LeB is dark reddish-brown silty clay about 12 inches (30 cm) thick. It contains concentrations of heavy minerals. The subsoil, about 36 inches (91 cm) thick, is dark reddish-brown and dusky-red silty clay and clay that has subangular blocky structure. The substratum is dark reddish-brown clay mixed with weathered gravel. The soil is extremely acidic throughout the profile.	Permeability is moderately rapid, runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.3 inches (3 cm) per foot (30 cm) of soil.
Leilehua silty clay, 6 to 12 percent slopes (LeC)	LeC occurs as broad areas, as well as narrow areas, bordered by gulches, including portions of NCTAMS PAC Wahiawa.	This soil is similar to LeB in soil profile.	This soil is similar to LeB; however, for this soil, runoff is medium and erosion hazard is moderate. Workability is slightly difficult because of the slope.

Soil Type	*Location*	*Description*	*Characteristics*
Mānana Series: This series consists of well-drained soils on uplands. Soil of this series developed in material weathered from basic igneous rock.			
Mānana silty clay loam, 2 to 6 percent slopes (MoB)	MoB occurs on smooth slopes in the uplands, including portions of NCTAMS PAC Wahiawa.	This soil is similar to MoC in soil profile.	This soil is similar to MoC; however, runoff is slow and the erosion hazard is slight.
Mānana silty clay loam, 6 to 12 percent slopes (MoC)	These soils occur on smooth slopes, including portions of NCTAMS PAC Wahiawa.	The surface layer is strongly acidic, dark reddish-brown silty clay loam (8 inches [20 cm] thick). The subsoil (about 42 inches [107 cm] thick) is strongly to extremely acidic, dusky-red, dark reddish-gray, and dark reddish-brown silty clay that has subangular blocky structure. A nonporous, pan-like sheet (0.125 to 0.25 inch [0.32 to 0.64 cm] thick) occurs in the subsoil from 15 to 50 inches (38 to 127 cm). The substratum is strongly to extremely acidic, soft, weathered basic igneous rock.	Permeability is moderately rapid above the pan and moderate below. Runoff is medium, and the erosion hazard is moderate. The available water capacity is 1.2 inches/foot (10 cm/meters) in the surface layer and 1.3 inches/foot (11 cm/meters) in the subsoil.
Paʻaloa Series: This series consists of well-drained soils on uplands. Soils of this series developed in old alluvium and residuum derived from basic igneous rock.			
Paʻaloa silty clay, 3 to 12 percent slopes (PaC)	PaC occurs as narrow areas bounded by steep gulches, including portions of NCTAMS PAC Wahiawa.	In a representative profile of PaC, the surface layer, about 17 inches (44 cm) thick, is a mixture of dark brown and dark-reddish-brown silty clay and clay. The subsoil, about 43 inches (109 cm) thick, is dark reddish-brown silty clay and clay that has subangular blocky structure. The substratum is soft, weathered rock. The soil is strongly to very strongly acidic. The slope range is 3 to 12 percent, but in most places it is 3 to 8 percent. The slopes are smooth.	Permeability is moderately rapid, runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.2 inches (3 cm) per foot (30 cm) in the surface layer and 1.4 inches (4 cm) per foot (30 cm) in the subsoil.

Soil Type	***Location***	***Description***	***Characteristics***
Wahiawa Series: This series consists of well-drained soils on uplands. These soils developed in residuum and old alluvium derived from basic igneous rocks.			
Wahiawa silty clay, 0 to 3 percent slopes (WaA)	WaA occurs on smooth, broad, interfluves, including the majority of the Camp Stover Housing Community.	In a representative profile of WaA, the surface layer is very dusky-red and dusky-red silty clay about 12 inches (30 cm) thick. The subsoil, about 48 inches (122 cm) thick, is dark reddish-brown silty clay that has subangular blocky structure. The underlying material is weathered basic igneous rock. The soil is medium acidic in the surface layer and medium acidic to neutral in the subsoil.	Permeability is moderately rapid, runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.3 inches (3 cm) per foot (30 cm).

Sources: USDA-NRCS, 1972, 2021.

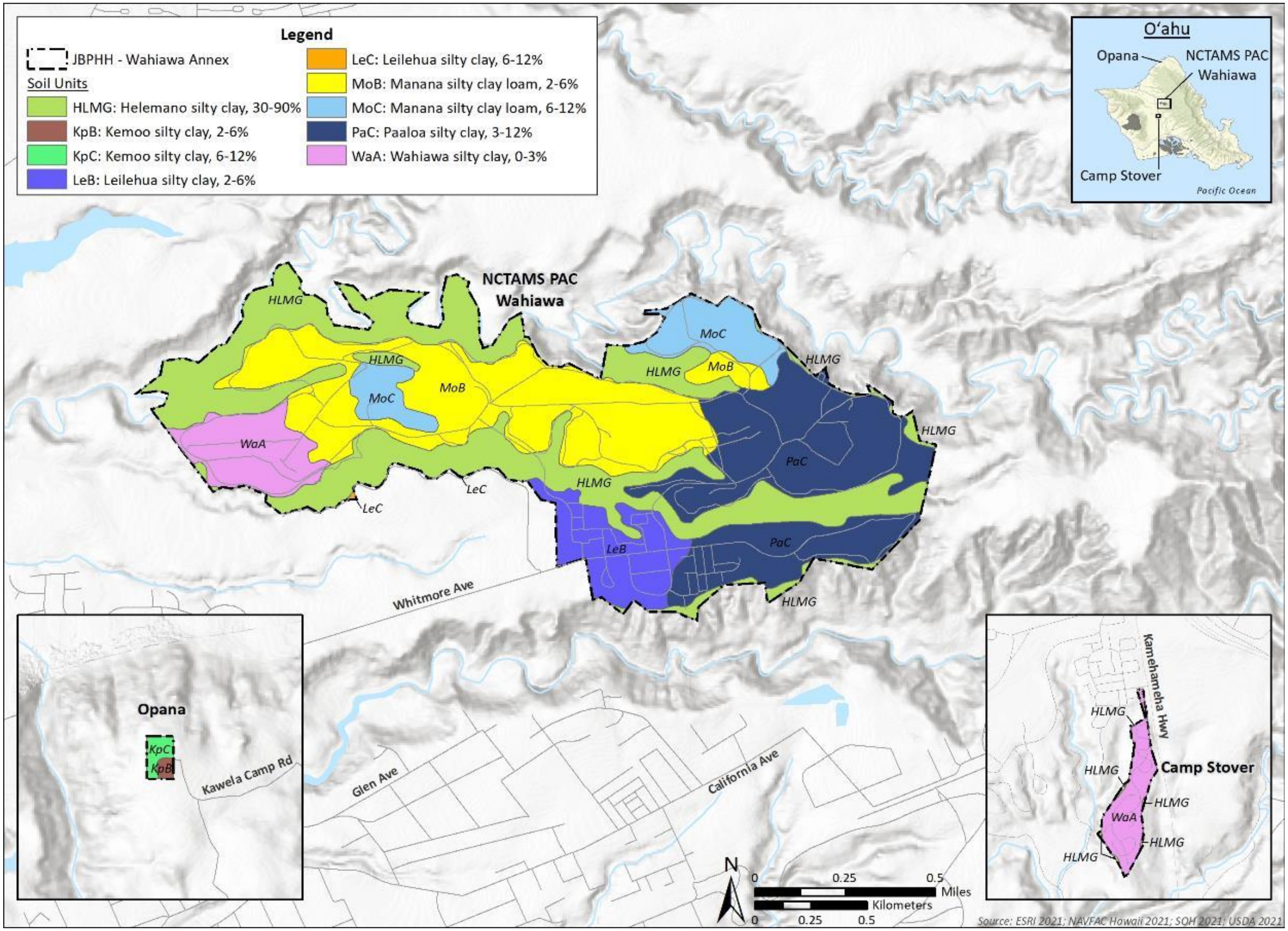

Figure 6-3 JBPHH Wahiawa Annex Soils

Camp Stover Housing Community

Waieli Stream is located immediately west of the Camp Stover Housing Community and Waikakalaua Stream is located approximately 0.25 mile (0.40 km) to the east and south (see Figure 6-2).

Opana

There is no surface water present at Opana, the Pahipahiʻālua stream is located approximately 0.25 mile (0.40 km) west of the site.

6.2.6.2 Hydrogeology

Section 2.2.5 describes the four major aquifer types that occur within the study area and other parts of Oʻahu.

Naval Computer and Telecommunications Area Master Station, Pacific, Wahiawa

NCTAMS PAC Wahiawa is underlain by a high-level, unconfined, dike-impounded aquifer of the Wahiawā System of the Central Aquifer Sector (30501212 [11111]). This aquifer is currently used as drinking water and is fresh. It is considered irreplaceable and has a high vulnerability to contamination (Mink and Lau, 1990). A potable water production well exists at the installation.

Camp Stover Housing Community

The Camp Stover Housing Community is underlain by a basal, unconfined, flank aquifer of the Waipahu Aquifer System of the Pearl Harbor Aquifer Sector (30203111 [11111]). This aquifer is irreplaceable with a high vulnerability to contamination, is currently used for drinking water, and is fresh (Mink and Lau, 1990).

Opana

Opana is on the western border of the Koolauloa Aquifer System, Windward Sector (30601112 [11111]). This aquifer is currently used as drinking water and is fresh. It is considered irreplaceable and has a high vulnerability to contamination (Mink and Lau, 1990).

6.3 General Biotic Environment

The discussion of the general biotic environment at NCTAMS PAC Wahiawa, Camp Stover Housing Community, and Opana is divided into three subsections (6.3.1 through 6.3.3): wetlands; ecosystems; and terrestrial biology.

6.3.1 Wetlands

There are no USACE jurisdictional wetlands within the study area. The USFWS classifies the stream gulches at NCTAMS PAC Wahiawa as “Palustrine System, Forested Class, Broad-leaved Evergreen Subclass, Non-tidal Temporary” (DON, 2001). The USFWS classification is consistent with an ephemeral stream through a forested area where the surface water is below the soil surface for most of the year. NWI maps are being used to classify systems and not the USFWS making some sort of on-site determination.

There are no surface water bodies at the Camp Stover Housing Community. Waieli Stream is located immediately west of the community and Waikakalaua Stream is located approximately 0.25 mile (0.4 km) east and south of the community.

There are no surface water bodies at Opana.

6.3.2 Ecosystems

The terrestrial ecosystems of NCTAMS PAC Wahiawa, Camp Stover Housing Community, and Opana are classified as non-native, and are all lands transformed by human activity (Juvik et al., 1998). The vegetation communities present in the study area are discussed further in Section 6.3.3.1, *Flora*.

6.3.3 Terrestrial Biology

Information on terrestrial biological resources presented in this section are primarily derived from the following surveys of terrestrial plants and animals conducted at NCTAMS PAC Wahiawa as part of the INRMP revision process.

- Botanical Surveys of U.S. Navy Properties in Support of Integrated Natural Resources Management Plan at Joint Base Pearl Harbor-Hickam, Oʻahu, Hawaiʻi (AECOM, 2016; Appendix L-1)
- Avian Point Counts at Eleven Sites within Joint Base Pearl Harbor-Hickam (Hamer Environmental, 2016; Appendix L-2)
- Field Biology Technical Assistance for Natural Resources Program Joint Base Pearl Harbor-Hickam (RCUH, 2017a-d, 2018a-d, 2019a-d, 2020a-d)
- Natural Resources Assessment for a Distributed Common Ground Facility, JBPHH Wahiawa Annex, Oʻahu. Prep for Jacobs (AECOS, 2020)

6.3.3.1 Flora

Threatened and Endangered Flora Species and Petitioned Flora Species

There are no critical habitats, natural resource research areas, or ecological reserves within the JBPHH Wahiawa Annex study area. There are no federally or SOH threatened or endangered plant species known to occur within the JBPHH Wahiawa Annex study area.

Vegetation Communities of Naval Computer and Telecommunications Area Master Station, Pacific, Wahiawa

Three hundred twenty-seven plant species have been recorded at NCTAMS PAC Wahiawa from surveys conducted in 1986, 2004, and 2015 with 237 species recorded in the botanical survey conducted in 2015 (DON, 2001; HNHP, 2004; AECOS, 2016) (Appendix L-1). The 2015 survey found 16 native indigenous species and 6 native endemic species, the remainder were introduced intentionally or accidentally after European contact (AECOM, 2016). The following paragraphs provide a description of the vegetation associated with: (1) the developed portions of the installation; and (2) Poamoho Gulch and Kaukonahua Gulch.

Developed Portions of NCTAMS PAC Wahiawa

The majority of the NCTAMS PAC Wahiawa is managed grass, non-native grassland, and non-native grassland with invasion by a variety of shrubs and trees (AECOM, 2016). The character-defining vegetation associated with NCTAMS PAC Wahiawa is the expansive carpet of grasses and lack of vertical vegetation in the antenna fields, and the dense, natural vegetation within the gulches (Figure 6-4). In the community support area, character-defining vegetation includes groves of trees associated with the historic housing neighborhood and historic streetscape plantings. Informal, yet visually prominent, plantings of Norfolk Island pine trees are scattered throughout the community area (DON, 2001).

The housing area borders a natural forest area and gulch, creating a natural boundary to the south with dense mature trees. Within the housing community, the homes are set back far enough from the street to provide for landscaped front yards, which blend to form a central open space. The large front and back yards are typically open and informal with personalized foundation plantings, common hibiscus (*Hibiscus syriacus*), dracaena (*Dracaena* spp.), panax (*Panax quinquefolius*), croton (*Croton* spp.), and ti. Large banyan, monkeypod, African tuliptree, eucalyptus, blue marble tree (*Elaeocarpus angustifolius*), silk oak, Norfolk Island pine, and coconut palm trees line the streets and are scattered around the homes providing shade and creating a park-like setting for this neighborhood (CNRH, 2008).

Aside from the administrative complex at NCTAMS PAC Wahiawa, mowed fields composed primarily of several grass and herbaceous species dominates the greater part of the 694-acre (280.5-hectare) site (Figure 6-4). A narrow band of vegetation along the perimeter of the lawn consists of a mixture of taller grass species and an assortment of shrubs and trees. The area occupied by the maintained lawn is composed almost exclusively of alien species.

Poamoho Gulch and North Kaukohaua Gulch

No rare or protected plant species were found in the forested gulches, which include: (1) a large branch of Poamoho Gulch at the northern boundary; (2) a smaller branch of Poamoho Gulch on the southwest boundary; (3) a smaller branch of Poamoho Gulch which bisects the southeastern portion of the installation; and (4) the North Kaukohaua Gulch at the southeastern boundary of the facility (HNHP, 2004; AECOS, 2016). A previous survey (HNHP, 2004) had identified native-dominated forest in portions of Poamoho Gulch; however, the 2015 botanical survey found few native plants in the DON-owned portion of the gulch and categorized the area as mixed native, non-native forest; ʻuluhe (*Dicranopteris linearis*) fern cover; and monotypic strawberry guava forest (Figure 6-4) (AECOM, 2016). There is an area of mixed native, non-native forest in a small side gulch of the larger Poamoho Gulch system at NCTAMS PAC Wahiawa. Native trees observed to be remaining in this area included ʻūlei, koa, ʻōhiʻā (*Metrosideros polymorpha*), ʻukiʻuki (*Dianella sandwicensis*), pūkiawe (*Leptecophylla tameiameiae*), and ʻākia. Ungulate damage was observed in the southern gulch that bisects the southeastern portion of the installation. Erosion damage associated with dirt bikes was observed in Poamoho Gulch at the northern boundary of the installation (DON, 2001; AECOM, 2016).

In 2020, a vegetation survey was conducted in support of a biological assessment for a proposed Distributed Common Ground Facility. The survey area included land south of Midway Drive and portions of Pamoho Gulch (AECOS, 2020). The 2020 survey supported the findings of the botanical surveys of 2015 (AECOM, 2016), reporting that the area is primarily developed with mixed native, non-native forest and ʻuluhe cover within Poamoho Gulch.

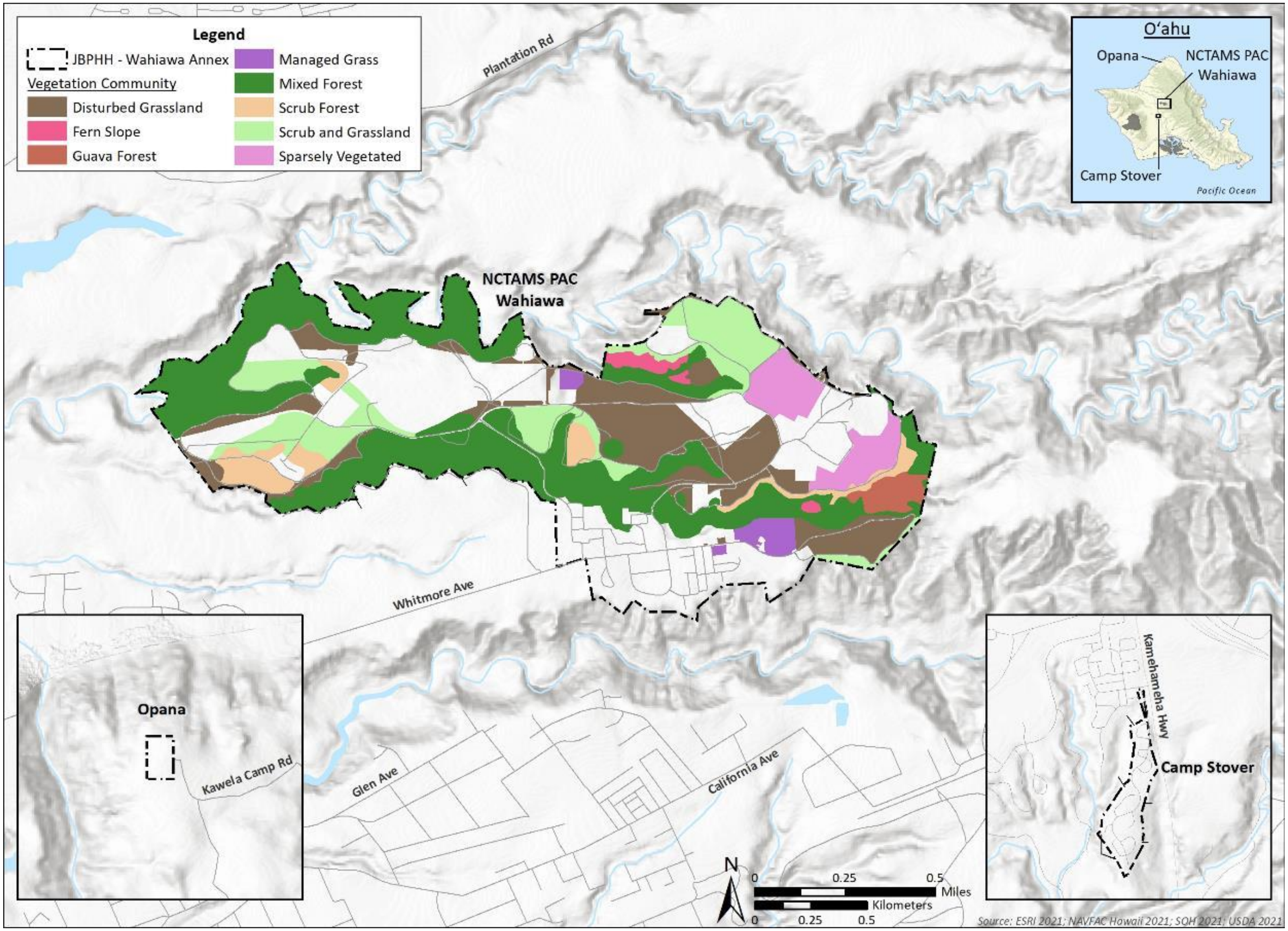

Figure 6-4 JBPHH Wahiawa Annex Communities

Vegetation Communities of Camp Stover Housing Community

During the 2015 JBPHH botanical survey, a brief windshield survey was conducted of the Camp Stover Housing Community. The survey did not include the steep gulch areas adjacent to the housing as those areas are mostly off DON property. Vegetation observed during the survey included ornamental plantings and manicured grass areas. No indigenous or endemic species were observed (AECOM, 2016).

Vegetation Communities of Opana

Opana is composed of landscaped and developed areas enclosed by chain link fence. The site contains large areas of mowed grass. Scattered ornamental plants and fruit trees occur by the parking area and NHL plaque. The site is bordered by non-native forest dominated by ironwood, koa haole, and strawberry guava.

Devil weed (*Chromolaena odorata*) was first observed on Oʻahu at the Kahuku Training Area in 2011. This species is a noxious weed and highly invasive. There are ongoing efforts by the U.S. Army to contain its spread and eradicate this species from the training area. During a site visit to Opana in April 2021, NAVFAC HI staff observed a single devil weed plant outside the perimeter fencing of Opana. Due to the landscaped and managed vegetation at Opana, it is unlikely devil weed will infiltrate the boundaries of the site.

6.3.3.2 Fauna

Threatened and Endangered Fauna Species

Bird Species

Avian point count surveys were conducted at seven stations at NCTAMS PAC Wahiawa (Hamer Environmental, 2016). Only one endemic species was thought to be observed, the federally and state endangered Oʻahu ʻelepaio. The observer, who had not surveyed for Oʻahu ʻelepaio previously, heard what they believed to be an Oʻahu ʻelepaio vocalizing in Poamoho Gulch north of Polaris Drive (see Figure 6-2). In response, focused surveys for the Oʻahu ʻelepaio were conducted by SMEs; none were observed and the habitat at NCTAMS PAC Wahiawa was found to be suboptimal for this species (Hamer Environmental, 2016). The SMEs concluded that Oʻahu ʻelepaio are not present at NCTAMS PAC Wahiawa and no subsequent focused surveys were necessary.

Suitable habitat for the SOH-listed (on Oʻahu only) endangered Hawaiian short-eared owl is present at NCTAMS PAC Wahiawa in the form of wooded gulches and open grass habitat. Suitable foraging habitat is also present adjacent to Opana in the form of non-native forest. It should be noted that during the point count surveys conducted in 2014 and 2015 and focused point count surveys from 2017 to 2020 at NCTAMS PAC Wahiawa, Hawaiian short-eared owl was not observed (Hamer Environmental, 2016; RCUH, 2017a-d, 2018a-d, 2019a-d, 2020a-d). No surveys have been conducted at Opana for this species. Hawaiian short-eared owl is further described in Section 4.3.3.2, *Fauna*.

The ESA-listed band-rumped storm petrel, Hawaiian petrel, and Newell's shearwater are not known to inhabit NCTAMS PAC Wahiawa, Camp Stover Housing Community, or Opana but have potential to fly over the study area from suitable nesting habitat in the Koʻolau and Waiʻanae Mountains to the ocean. These species are vulnerable to fallout – when fledgling or occasional migrating adult birds are disoriented by artificial light and become grounded) and collisions with powerlines (Griesemer and Holmes, 2011). Because of these vulnerabilities there is potential for these species to become grounded in the study area. These species are further described in Section 4.3.3.2, *Fauna*.

Terrestrial Mammal Species

The federally endangered Hawaiian hoary bat (see Section 4.3.3.2, *Fauna*) occurs at NCTAMS PAC Wahiawa and has potential to occur at Camp Stover Housing Community and Opana. USGS acoustic monitoring in 2012 confirmed Hawaiian hoary bat presence at NCTAMS PAC Wahiawa. Acoustic monitoring studies at U.S. Army Oʻahu facilities confirmed Hawaiian hoary bat presence at Helemano Military Reservation, 1.7 miles (2.7 km) northwest of NCTAMS PAC Wahiawa; Wheeler Army airfield, 1.2 miles (1.9 km) north of Camp Stover Housing Community; and Kahuku Training Area which surrounds Opana (Bonaccorso, et al. 2019). Given the distances Hawaiian hoary bat travels to forage and the presence of suitable roosting sites (mature trees over 15 feet [4.6 meters] in height), it is reasonable to assume this species occurs throughout the study area.

Other Fauna Species

Natural resources surveys have not been conducted for the Camp Stover Housing Community or Opana. Additionally, no amphibian and reptile species or invertebrate species surveys have been conducted within the study area. DON focused amphibian and reptile species (herpetological) surveys have been the focus on areas containing native plant and animal species, such as JBPHH Lualualei Annex (see Chapter 5), where they may have a more serious negative ecological impact. The following discussion of wildlife is limited to birds and terrestrial mammals within the study area.

Birds

A total of 1,073 birds and 26 species were recorded during avian point count surveys conducted at NCTAMS PAC Wahiawa (Hamer Environmental, 2016) (Appendix L-2). As discussed in the threatened and endangered fauna species discussion, the SOH-listed (on Oʻahu only) endangered Hawaiian short-eared owl may occur at NCTAMS PAC Wahiawa; however, this species was not observed during focused point count surveys conducted from 2017 through 2020 (RCUH, 2017a-d, 2018a-d, 2019a-d, 2020a-d). One MBTA-protected bird species, the Pacific golden plover, is a seasonal visitor to NCTAMS PAC Wahiawa. The Pacific golden plover is the second most abundant bird species occurring at NCTAMS PAC Wahiawa and is normally found on mown grasslands (DON, 2001). Table 4-9 (Section 4.3.3.2, *Fauna*) provides a description of this bird species.

Avian surveys were not conducted at Camp Stover Housing Community or Opana. During a NAVFAC HI site visit to Opana in April 2021, one native, MBTA-covered species was observed, the Pacific golden plover, which was abundant on the site and actively foraging throughout the mowed grass. Additionally, six introduced bird species were observed during the site visit: spotted dove, cattle egret, red-crested cardinal, waxbill, house finch, and chestnut munia.

Terrestrial Mammals

The only mammals, besides Hawaiian hoary bat, observed within the study area are non-native species. They include Indian mongoose, feral cats, feral dogs, feral pigs (Hawaiian Agronomics, 1986 in DON, 2001; HNHP, 2004; AECOS, 2020) (Appendix L-2). It is also likely that rat species such as roof rat, brown rat, and Polynesian rat are present throughout the study area (AECOS, 2020).

6.4 Current Management

6.4.1 Protected Species and Ecosystem Monitoring and Management

There is no ESA-protected species critical habitat present in the survey area. Several ESA-covered species and one MBTA-covered species are known to occur or have potential to occur within the study area (see Section 6.3.3.2, *Fauna*). Current management actions for these species are discussed below.

Hawaiian Short-eared Owl

When construction occurs in potential Hawaiian short-eared owl habitat, project personnel are notified of the potential for the species to occur. Twilight pre-construction surveys shall be conducted by a qualified biologist prior to clearing any vegetation. If Hawaiian short-eared owl is observed or a nest discovered, workers must stop work, implement a 100-foot (30.5-meter) buffer, and notify JBPHH natural resources staff. The buffer zone should remain established until nesting ceases.

ESA-Protected Seabirds

Per COMNAVREGHIINST 5090.9, JBPHH takes all reasonable actions to reduce potential effects on Hawaii‘s night-flying seabirds especially during nights around the new moon between September and December. These actions may include louver light covers and extinguishing lights temporarily when a bird is observed flying around lights at night (COMNAVREGHIINST 5090.9). These measures are implemented so long as they comply with safety and AT/FP requirements.

MBTA-Protected Species

There are no current management actions for Pacific golden plover that may be present within the study area.

Hawaiian Hoary Bat

To avoid impacts to Hawaiian hoary bat, trimming of vegetation over 15 feet (4.6 meters) in height is avoided whenever possible during the pupping season (June 1–September 15). When trimming vegetation over 15 feet (4.6 meters) is unavoidable, consultation with USFWS is required. The use of barbed wire fencing is avoided whenever possible to reduce the risk of Hawaiian hoary bat entanglement.

6.4.2 Invasive Species Prevention and Control

The U.S. Army funds devil weed removal and management activities at the Kahuku Training Area surrounding Opana. Due to the landscaped and managed vegetation at Opana, spread of devil weed into the site is unlikely and there are no current DON management actions for the species at Opana.

6.4.3 Restoration of Natural Resource Areas

DoDI 4715.3 directs DoD agencies to manage natural resources through principles of ecosystem management. Ecosystems with large proportions of native species are to be protected, and habitat restoration activities are to focus on these habitats. There are no current natural resource restoration projects at NCTAMS PAC Wahiawa, Camp Stover Housing Community, or Opana.

6.4.4 Natural Resources Studies

DON updated flora and fauna surveys for NCTAMS PAC Wahiawa in 2015 (AECOM, 2016; Hamer Environmental, 2016). In 2020, flora and fauna surveys were conducted in support of a biological assessment for the Distributed Common Ground Facility at NCTAMS PAC Wahiawa (AECOS, 2020). RCUH conducts ongoing Hawaiian short-eared owl surveys at NCTAMS PAC Wahiawa.

DON intends to update flora and fauna surveys for the installation in support of future INRMP updates and natural resources management efforts. Updates are conducted as feasibility and necessity allow, ideally every 5 years.

6.4.5 Wetlands

The JBPHH Natural Resources Manager's goal is to ensure that there is no net loss of wetlands on DON-controlled lands, while simultaneously establishing and/or enhancing native wetland species and reducing alien wetland species. Wetlands at NCTAMS PAC Wahiawa are limited to the stream gulches (see Section 6.3.2, *Ecosystems*); there are no surface water bodies at the Camp Stover Housing Community or Opana. DON has a no net loss of wetlands policy and has continued to protect the stream gulches from development. DON provides for formal wetland training for NRH, NAVFAC HI, and NAVFAC PAC Natural Resources and Environmental staff.

6.4.6 Flood Plains

Flooding is not a problem at NCTAMS PAC Wahiawa. The largest gulch within its boundaries is about 50 feet (15 meters) deep and covered with vegetation at channel level. Periods of stream flow are infrequent. South and upstream of the installation, the drainage area of the gulch is relatively small, only 60 acres (24 hectares); another 445 acres (178 hectares) are added in its course through the sub-installation. The depth of the gulch and its small drainage area generally prevents overflow.

Similar to NCTAMS PAC Wahiawa, flooding is not a problem at the Camp Stover Housing Community which is located upgradient from a tributary to the Waikele Stream and the Waikakalaua Stream.

Flooding is not a problem at Opana, which is located at 520 feet (159 meters) above MSL, is sloped, and no streams or rivers run through the site.

6.4.7 Land Management

Ongoing land management programs at NCTAMS PAC Wahiawa, Camp Stover Housing Community, and Opana are similar to those discussed in Section 4.5.8. They include base planning, reduction of point source pollution, utilization of BMPs during earthwork and construction and storm drain design, and non-point source pollution prevention for JBPHH. In addition, DON provides grass and vegetation management within the antenna fields and required buffer zones at NCTAMS PAC Wahiawa and Opana, and landscape management at the Camp Stover Housing Community. Also, DON manages, maintains, and promotes soil stability and erosion control for land areas with natural resources value (primarily within Poamoho Gulch) and other areas prone to soil erosion at NCTAMS PAC Wahiawa and the Camp Stover Housing Community.

6.4.8 Forestry

There is no existing forest management program for NCTAMS PAC Wahiawa, Camp Stover Housing Community, or Opana. There is a pocket of native, non-native mixed forest in a small side gulch of the larger Poamoho Gulch system at NCTAMS PAC Wahiawa. Native trees observed to be remaining in this area included ʻūlei, koa, ʻōhiʻā, ʻukiʻuki, pūkiawe, and ʻākia. This native, non-native mixed forest provides a good control for soil erosion and runoff as well as reduces siltation of the streams located on the gulch bottoms. In addition, the vegetated areas improve groundwater supplies and provide food and shelter for wildlife. However, the botanical surveys conducted by AECOM (2016) found that the western portion of Poamoho Gulch has been invaded by strawberry guava and shows evidence of extensive dirt bike use which is a significant contributor to slope erosions and subsequent sediment runoff to Poamoho Stream. Accelerated soil erosion is a primary concern on the precipitous gulch slopes and the rugged terrain of these areas would preclude harvesting of timber resources even if a market for wood products from the facility could be found. DON continues to protect mature and significant trees at NCTAMS PAC Wahiawa and the Camp Stover Housing Community.

6.4.9 Wildland Fire

Wildland fires have not impacted the study area in recent years; however, during dry conditions, wildland fires can impact adjacent ridgelines. The FFD would respond to any fires at the NCTAMS PAC Wahiawa, Camp Stover Housing Community, and Opana.

6.4.10 Use of Geographic Information Systems

JBPHH's natural resources data is continually being integrated into the enterprise geodatabase. NAVFAC HI Natural Resources staff are continually updating the GIS geodatabase to include the locations of native and/or protected animal and plant species.

6.4.11 Access Restrictions

Access to NCTAMS PAC Wahiawa and the Camp Stover Housing Community is restricted to authorized personnel, residents, and guests. Opana is secured by a fence and access is restricted to authorized personnel.

6.4.12 Community Outreach

There are no current community outreach natural resources management actions at NCTAMS PAC Wahiawa, Camp Stover Housing Community, or Opana.

6.4.13 Outdoor Recreation

Operational constraints (primarily electromagnetic radiation and security requirements) at NCTAMS PAC Wahiawa limit the availability of land suitable for development of outdoor recreation activities. In addition, the small number of on-base residents makes it difficult to justify additional recreational facilities. Although no formal recreational hiking/walking facilities are located on NCTAMS PAC Wahiawa, there are rough trails present throughout the Poamoho Gulch system and perimeter. Access to the Poamoho Valley trail is located off the southeastern point of the installation.

Outdoor recreation at the Camp Stover Housing Community is limited to passive nature walks and bicycling.

Outdoor recreation is not permitted at Opana and the site is not open to the public.

6.4.14 Law Enforcement

DON base police provide law enforcement at NCTAMS PAC Wahiawa and it is provided by the Honolulu Police Department and private security firms at Camp Stover Housing Community. Opana is equipped with security cameras and if a security breach is identified, Honolulu Police Department would be contacted for support.

6.4.15 Leases and Encroachment Management

Naval Computer and Telecommunications Area Master Station, Pacific, Wahiawa

There are currently no agricultural outleases within the JBPHH Wahiawa Annex study area and none are planned. The lands most suitable for agricultural outlease are located on the west end of the installation, below Saipan Drive. The Navy purchased a number of Restrictive Use Easements on a couple of parcels located outside and abutting to Wahiawa Annex. Encroachment Partnering and Readiness Environmental Protection Integration funds were used to partner with the Trust for Public Lands and SOH to ensure and protect long-term mission operations at Wahiawa Annex (Fong, personal communication, 2022).

Camp Stover Housing Community

Due to residential land use, there are no lands at the Camp Stover Housing Community suitable for agricultural outlease. Camp Stover Housing Community is a gated community and no encroachment issues have been identified for the site (DON, 2021).

Opana

Given Opana’s small size and current operations, it is not suitable for agricultural outlease. Opana is surrounded by natural areas and the perimeter is completely fenced. U.S. Army training and recreational dirt biking occur adjacent to the site. During a NAVFAC HI site visit, personnel reported they occasionally witness unauthorized hunting and dirt biking outside the perimeter fence surrounding Opana.

6.4.16 Climate Considerations

Chapter 3 provides an overview of the climate risks that may impact JBPHH. Table 6-4 describes specific climate considerations, vulnerabilities, and adaptations for NCTAMS PAC Wahiawa, Camp Stover Housing Community, and Opana.

Table 6-4 JBPHH Wahiawa Annex Climate Considerations, Vulnerabilities, and Adaptation

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies (Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)***
1.) ESA- and SOH-listed Species	Seabirds (ESA-listed) Band-rumped Storm Petrel (*Oceanodroma castro*) Hawaiian Petrel (Pterodroma sandwichensis) Newell's Shearwater (*Puffinus newelli*)	*LOW:* Although there is fallout and collision potential for these species within the study area, these species have not been documented within the installation.	Continued implementation of COMNAVREGHIINST 5090.9 - Lighting for Seabird Fledging Season.
	Birds (SOH-listed and MBTA-covered) Hawaiian Short-eared Owl (*Asio flammeus sandwichensis*)	*MEDIUM:* Although habitat and food availability will be impacted, Hawaiian short-eared owl may be able to relocate. Warmer Temperatures: Increased temperatures could affect their food supply and available breeding habitat.	When construction occurs in potential Hawaiian short-eared owl habitat, project personnel are notified of the potential for the species to occur. If Hawaiian short-eared owl is observed or a nest discovered, workers are to implement a 100-foot (30.5-meter) buffer and notify JBPHH natural resources staff. Monitor changes in distribution and numbers, and protect existing birds. *Table 8-7, Rows 2, 4, and 8* provide recommendations to include flora and fauna surveys/mapping every 1-5 years.

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies (Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)***
1.) ESA- and SOH-listed Species (continued)	Terrestrial Mammal (ESA- and SOH-listed): Hawaiian Hoary Bat (Lasiurus cinereus semotus)	*MEDIUM:* Although habitat and food availability may be impacted, the Hawaiian hoary bat may be able to relocate. *Warmer Temperatures, Change Precipitation*: Hawaiian hoary bat could be threatened by the effects of climate change if less habitat becomes available for foraging, roosting and pupping; however, there is a general lack of knowledge concerning its distribution, abundance, and habitat needs. While prime habitats include native moist and rain forests up to 6,000 feet (1,830 meters), bats also use native xeric and disturbed habitats as well as wet to moist non-native habitats and urban areas (Bonaccorso, 2010*)*. Changing precipitation and rising temperatures could affect the bat's food availability (moths, beetles, crickets, mosquitoes, and termites). In addition, bats tend to move to higher elevations with cooler temperatures during January through April, potentially because the cooler temperatures allow them to achieve a lower metabolic rate while roosting.	Monitor for changes in the distribution and numbers. *Table 8-7, Row 5* provides recommendations for NCTAMS PAC Wahiawa include Hawaiian hoary bat acoustic surveys. DON project recommendations include BMPs to prevent clearing trees greater than 15 feet (4.6 meters) in height during the bat pupping season 1 June through 15 September.
2) Wetlands Management	Wetlands and coastal dune habitats that support diverse flora and fauna assemblages (*Concurrently protects above ESA-listed waterbirds and federal Clean Water Act regulated wetland ecosystems)*	*LOW:* There are no wetlands within the study area.	There are no wetlands or dunes at the inland NCTAMS PAC Wahiawa site. The principles of ecosystem management to foster long-term sustainability of ecosystem services dovetails well with the climate adaptation risk-based management concepts and is adaptable to complex and changing requirements.

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies (Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)***
3) MBTA Bird Management	JBPHH is home to a diversity of MBTA-protected birds and bird habitats.	*MEDIUM:* <u>*Rising temperatures and changing precipitation patterns*</u> may increase the growth of certain bird populations, from longer breeding seasons and changes in habitat and cause shifts in the distribution and abundance of bird species. <u>*Severe Storms*</u> may increase the number of wedge-tailed shearwater (*Puffinus pacificus*) fallouts.	JBPHH INRMP management actions are to protect MBTA-protected birds. The DoD MBTA position is that incidental/unintentional take of migratory birds is still prohibited. While there is no specific INRMP MBTA project, the INRMP programs/projects for wetland restoration and predator control also benefit MBTA birds. *Table 8-7, Rows 2, 4, and 8* provide recommendations to include periodic flora and fauna surveys. DON project recommendations include BMPs to verify that trees or bushes scheduled for removal do not contain the active nests of migratory birds.
4) Invasive Species (IS) Management	PRIORITY SPECIES INCLUDE: <u>Plants:</u> Devil Weed (*Chromolaena odorata*) Fireweed (*Senecio madagascariensis*) <u>Vertebrates</u>: Barn Owl (*Tyto alba*) Brown Tree Snake (*Boiga irregularis*) Feral Cat (*Felis catus*) Mongoose (Herpestes javanicus) Ungulates Rodents	*HIGH:* Climate change and invasive species rank among the largest predicted threats to global ecosystems over the next century (Fey and Herren, 2014). Climate-related impacts often operate through amplifying the impact of existing stressors, such as IS. IS are, by nature, highly flexible, and respond to unusual environments more quickly than do natives. And with the help of climate change, IS also reap the benefits that come with early blooming, shading out competitors and capturing a larger share of nutrients, water, or pollinators. Changing rainfall patterns may increase the spread of IS. Warming air	DON maintains routine pest control throughout JBPHH to manage rodents. There are no other active invasive and alien species management programs within the survey area. *Table 8-7, Rows 1, 2, 9, 12, and 17,* provide recommendations for NCTAMS PAC Wahiawa includes predator control.

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies (Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)***
4) Invasive Species (IS) Management (continued)		temperatures lead to expanded IS. Extreme climatic events, such as hurricanes, floods, and droughts can transport IS to new areas and decrease the resistance of habitats to invasions. Climate change may increase available food for IS pigs, feral cats, mice, rats, and mongoose. Rising temperatures may be seen as universally beneficial for IS expansion, but a warmer world may help some IS and hurt others depending on how they and their competitors respond. Devil weed is established at Kahuku Training Area which surrounds Opana. However, given the landscaped and managed vegetation at Opana, it is unlikely devil weed could become established at the site.	
5) BASH	<u>Airfield Vicinity</u>: Near Ocean Surface (Pelagic, seabirds, petrels, shearwaters, tropicbirds, etc.) Drainage Ditches and Standing Water (Waterbirds, waterfowl, shorebirds, herons, stilts, cattle egrets, etc.) Turf, Tree, and Bush Habitat Birds (Gamebirds, pigeons, doves, owl, passerines, etc.)	*LOW:* There are no airfields at the inland NCTAMS PAC Wahiawa, Camp Stover, Opana.	*N/A:* There are no airfields at the inland NCTAMS PAC Wahiawa, Camp Stover, Opana sites.

INRMP Program Element Impacted by Climate Change *(Species, ecosystem, or program element)*	***Target Natural Resources*** *(Species, Habitat Types, Ecological Systems)*	***Vulnerability*** *(Very High, High, Medium, or Low, and reason for that rating)*	***INRMP Climate Adaptation Risk Reduction Strategies (Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)***
6) Wildland Fire Management	Wildfire poses a risk to dry ecosystem habitats (i.e., grassland and coastal mesic forest, etc.), personnel, facilities, and other infrastructure.	*LOW:* The rate of warming air temperature has increased in Hawaiʻi in recent decades which increases the risk of wildfires during drought occurrences. Wildland fires have not impacted NCTAMS PAC Wahiawa and the Camp Stover Housing Community in recent years; however, during dry conditions, wildland fires can impact the ridge line. The FFD would respond to any fires at the NCTAMS PAC Wahiawa, Camp Stover Housing Community, and Opana.	DON continues to maintain security fencing and fire breaks at both Red Hill Storage Area and Waiawa Watershed in order to minimize fire hazards at those outlying properties. Wildland fires have not impacted NCTAMS PAC Wahiawa, Camp Stover Housing Community, and Opana in recent years; however, during dry conditions, wildland fires can impact the ridge line. The FFD would respond to any fires at the NCTAMS PAC Wahiawa, Camp Stover Housing Community, and Opana. In case of fire during training exercises, all fires will be reported to the FFD and personnel will stop training and begin to fight the fire. Personnel will continue to fight the fire until released by the fire department. *Table 8-8, Row 36* provides recommendations *for* NCTAMS PAC Wahiawa to include coordination with the FFD and Honolulu Fire Department and to establish a WFMP.

Notes: IS = Invasive Species; BASH = Bird/Wildlife Aircraft Strike Hazard; BMP = Best Management Practice; COMNAVREGHIINST = Commander, Navy Region Hawaii Instruction; DLNR = Department of Land and Natural Resources; DoD = Department of Defense; ESA = Endangered Species Act; FFD = Federal Fire Department; IS = Invasive Species; INRMP = Integrated Natural Resources Management Plan; JBPHH = Joint Base Pearl Harbor-Hickam; MBTA = Migratory Bird Treaty Act; NCTAMS PAC = Naval Computer and Telecommunications Area Master Station, Pacific; SOH = State of Hawaii; WFMP = Wildland Fire Management Plan.

7 JBPHH Kalaeloa

7.1 Current Conditions and Use

7.1.1 Installation Information

Kalaeloa is the DON-retained land from the former NASBP, on the southern ʻEwa Coastal Plain of the island of Oʻahu, Hawaiʻi. NASBP was closed on July 2, 1999 after having served for over five decades as an important naval air station and technical training school on Oʻahu. DON now retains five parcels: Defense Reutilization Marketing Office (DRMO), Biosolids Treatment Facility, Barbers Point Golf Course and Stables, Nimitz Beach and Cottages, and White Plains Beach and Cottages.

7.1.1.1 General Description, Operations, and Activities

As described in Section 7.1.1, the DON-retained land at Kalaeloa includes five noncontiguous areas, intended for long-term retention; their locations are shown on Figure 7-1.

Defense Reutilization Marketing Office

DRMO is located in the central portion of the former NASBP. It is largely developed with limited natural resource value.

Biosolids Treatment Facility

The Biosolids Treatment Facility is located at the west end of the Kalaeloa Airport (also known as John Rodgers Field). In September 2020, the Biosolids Treatment Facility became non-operational and NRH is determining lease arrangements of the property to another agency.

Barbers Point Golf Course and Stables

Barbers Point Stables were built in the 1950s using the existing World War II-era bombproof revetments. The stables and surrounding area were incorporated as the Barbers Point Riding Club in 1993. Members may rent stables and practice horsemanship. The Barbers Point Golf Course was constructed in 1966 and is an active military golf course.

Nimitz Beach and Cottages and White Plains Beach and Cottages

DON's MWR manage Nimitz Beach and Cottages, and White Plains Beach and Cottages. The beaches are open to MWR-authorized patrons and the general public. The areas offshore are used for various watersports, beaches are used for volleyball and other recreational beach activities, and the pavilions and managed grass areas are used for picnics and other gatherings. The cottages are available for rental by MWR-authorized patrons only.

7.1.1.2 Abbreviated History and Pre-Military Land Use

According to Native Hawaiian traditions, life was difficult in the Kalaeloa region due to the general scarcity of potable water. Archaeological research indicates that limited short-term inland agriculture probably began between the years 1000 and 1400, with the first settlement of the ʻEwa Plain probably beginning between about 1250 to 1450. Small fishing villages were present along the coast at the time of European contact in the late 1700s. From the late nineteenth century through the early 1920s, the ʻEwa Plain was used for sugarcane and sisal cultivation as well as cattle ranching (CNRH, 2008).

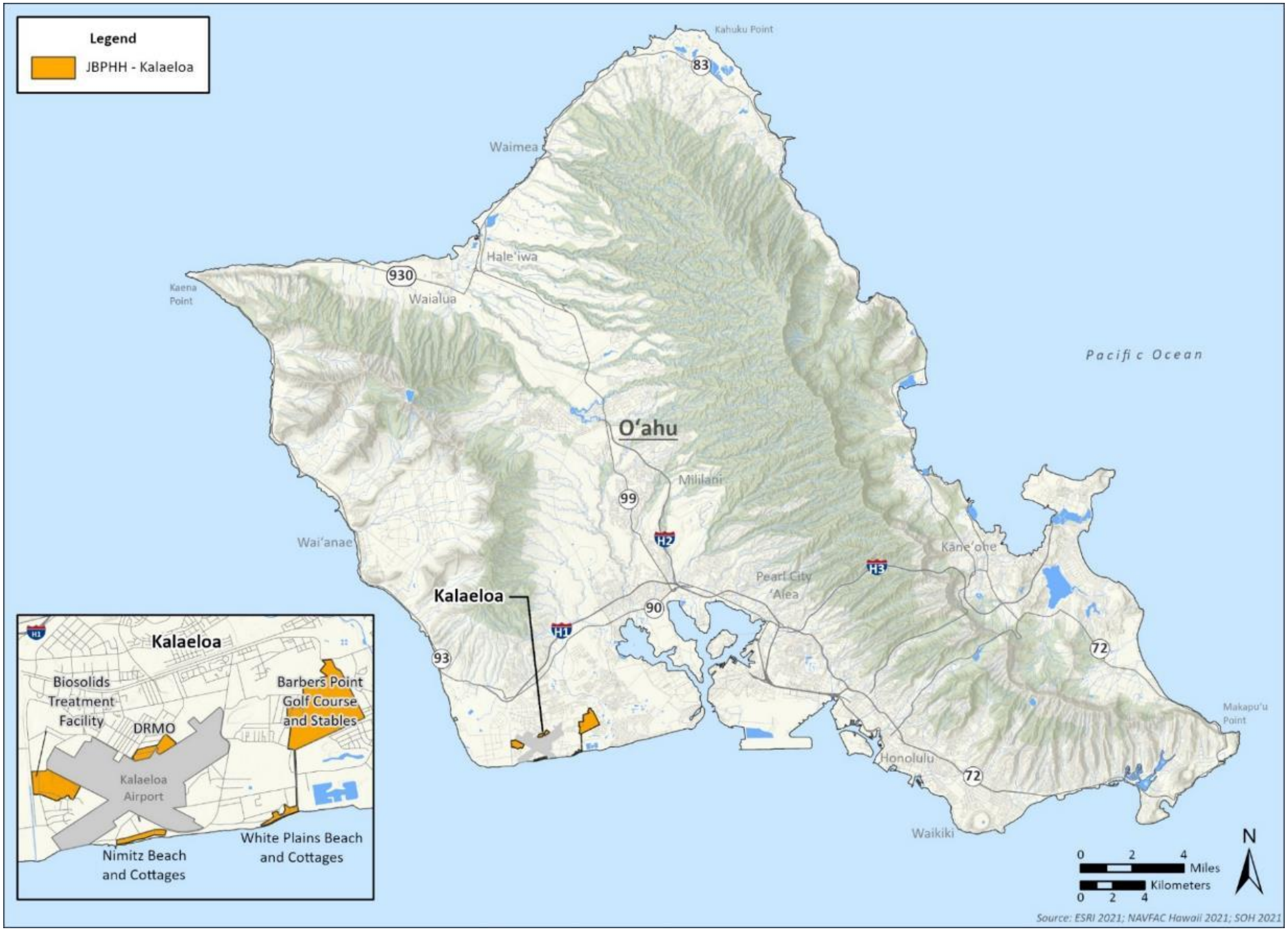

Figure 7-1 JBPHH Kalaeloa Overview

In March 1925, the U.S. executed a lease with Oahu Railway and Land to sublet 206 acres (83 hectares) from the James Campbell Estate. The U.S. military originally used the area as a dirigible mooring facility. Actual lease terms were negotiated between these three parties throughout the 1920s and 1930s. A DON contractor cleared and built a mooring mast, and associated facilities were built by the summer of 1925. The site was used only as an emergency station and was not used as a dirigible mooring until the 1930s. The ʻEwa Mooring Mast Field facilities consisted of two runways, two steel hangars, 12 wooden buildings, a number of tents, and a mooring mast. In the 1930s, a 1,500-foot (457-meter) long airfield was constructed near the mooring mast (CNRH, 2008).

In September 1940, the DON acquired over 3,000 additional acres (1,214 hectares) to enlarge the 1,500-foot (457-meter) airfield. It was usable by early 1941 and was commissioned as the U.S. Marine Corp Air Station (MCAS) Ewa in September 1942. Construction for a new DON airfield southwest of MCAS Ewa began in November 1941 and became known as NASBP.

On December 7, 1941, during the attack on Pearl Harbor, the Japanese bombed the nearly completed MCAS Ewa and destroyed numerous aircraft. The construction of NASBP took place between November 1941 and July 1943. During World War II, the air station became an important air center, technical training school, and fortification manned by 12,000 sailors (CNRH, 2008).

After World War II ended in 1945, NASBP became a rapid demobilization center, processing over 6,000 personnel transitioning out of the military. MCAS Ewa and NASBP coexisted as separate air stations at the installation until Hawaiʻi's naval facilities were consolidated in 1949. At this time, MCAS Ewa was deactivated and marine operations were moved to Kāneʻohe. NASBP absorbed MCAS Ewa and began supporting all aviation operations on leeward Oʻahu. NASBP was a critical staging area for supplies, equipment, and forward-deploying squadrons during the Korean War (1950–1953). NASBP activity increased during the Cold War and became famous for its Rainbow Fleet–the P-3 patrol squadrons used to track submarines that were deployed to the northern and western Pacific, Indian Ocean, and Arabian Gulf (CNRH, 2008).

In 1999, NASBP was closed as a result of the 1993 BRAC process. The DON-retained lands for military housing, MWR, and DRMO; however, the former base housing as well as other land initially retained by the DON were conveyed to a master developer under the Ford Island Development Legislation in 1999 and other SOH agencies. BRAC-disposed lands were acquired by various SOH and CCH agencies including the Hawaii Air National Guard, State Department of Transportation, Department of Hawaiian Homelands, and the University of Hawaiʻi. The airfield is now referred to as both Kalaeloa Airport and John Rodgers Field and is one of SOH's regional airports (CNRH, 2008).

Today, 417 acres (169 hectares) remain under DON control on five noncontiguous parcels (see Figure 7-1).

7.1.1.3 Land Use and Land Use Constraints

Environmental land use constraints for the DON-retained lands at Kalaeloa are defined by the presence of federally protected species. The federally endangered Hawaiian stilt has been reported at the Biosolids Treatment Facility and Barbers Point Golf Course and Stables (Section 7.3.3.2, *Fauna*). MBTA-protected birds are known to occur at the Biosolids Treatment Facility, Barbers Point Golf Course and Stables, Nimitz Beach and Cottages, and White Plains Beach and Cottages (Section 7.3.3.3, *Other Wildlife*). The federally endangered Hawaiian monk seal and federally threatened green sea turtle may occur at Nimitz Beach and White Plains Beach (Section 7.3.4, *Marine Biology*). In addition, the sedge kaluhā (*Bolboschoenus maritimus paludosus*), which is rare on Oʻahu, is located at a salt marsh adjacent to the White Plains Beach and Cottages former camping area (see Section 7.3.3.1, *Flora*).

No military land use constraints were identified for the DON-retained lands at Kalaeloa.

Nimitz Beach and Cottages and White Plains Beach and Cottages are located immediately adjacent to the Pacific Ocean and are used as outdoor recreation areas by MWR-authorized patrons as well as the general public.

7.1.1.4 Military Land Use Opportunities

New military mission training land use opportunities were not identified at the DON-retained lands at Kalaeloa.

7.1.1.5 Regional Land Uses

The lands comprising the former NASBP, including the DON-retained lands, are within the State Urban District. The DON-retained lands are zoned F-1 (Federal and Military Preservation District) (CCH, 2021).

7.2 General Physical Environment

The discussion of the general physical environment is divided into six subsections (7.2.1 through 7.2.6): physical geography, topography, climate, geology, soils, and hydrology–including surface water resources and hydrogeology (groundwater resources). General island-wide descriptions of these resources are presented in Section 2.2; the following discussion addresses Kalaeloa and its environs.

7.2.1 Physical Geography

A general discussion of the physical geography of the Hawaiian Islands and Oʻahu is presented in Section 2.2.1. The Kalaeloa District is situated on the ʻEwa Plain, the southern coastal plain of Oʻahu.

7.2.2 Topography

Kalaeloa slopes gently southward, from a maximum elevation of approximately 65 feet (20 meters) above MSL along the northern border, to sea level at the southern coastal boundary (Figure 7-2) (NAVFAC PAC, 1994).

7.2.3 Climate

See Section 2.2.3 for a discussion of island-wide climatic conditions. The trade winds are less pronounced on the leeward southern coastal plain of Oʻahu; however, local land and sea breezes are prevalent most of the year at Kalaeloa. The monthly average temperature at Kalaeloa ranges from 72.6°F (22.6°C) in the winter to 81°F (27.2°C) in the summer. The highest maximum monthly average is 89.2°F (31.8°C) for the month of August and lowest minimum monthly average is 64.2°F (17.9°C) for the month of January (NOAA, 2021) (Table 7-1).

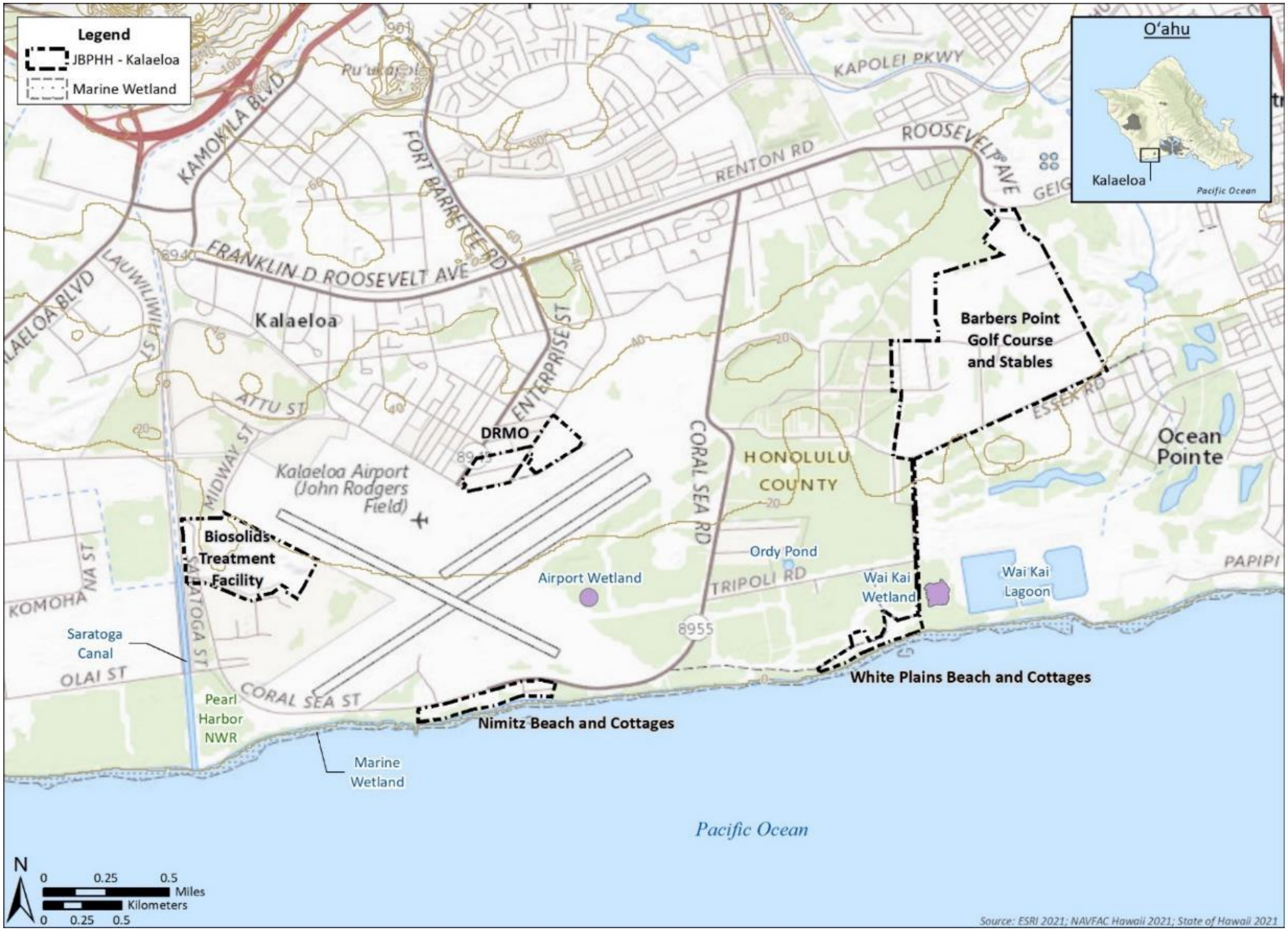

Figure 7-2 JBPHH Kalaeloa Topography and Surface Waters

Table 7-1 10-Year Monthly Average Air Temperature Ranges at Kalaeloa (2011-2020)

Month	*Kalaeloa Airport Air Temperature (Fahrenheit [Celsius])*		
	Monthly Average	*Monthly Maximum Average*	*Monthly Minimum Average*
January	72.55 (22.53)	80.96 (27.20)	64.16 (17.87)
February	73.16 (22.86)	80.90 (27.17)	65.42 (18.57)
March	73.42 (23.01)	81.32 (27.40)	65.53 (18.63)
April	75.50 (24.17)	83.39 (28.55)	67.66 (19.81)
May	76.73 (24.85)	84.76 (29.31)	68.74 (20.41)
June	78.65 (25.92)	86.78 (30.43)	70.54 (21.41)
July	80.13 (26.74)	88.25 (31.25)	72.00 (22.22)
August	81.00 (27.22)	89.19 (31.77)	72.80 (22.67)
September	79.87 (26.59)	87.96 (31.09)	71.77 (22.09)
October	78.43 (25.80)	86.36 (30.20)	70.51 (21.40)
November	76.52 (24.73)	84.03 (28.91)	69.01 (20.56)
December	74.19 (23.44)	81.84 (27.69)	66.53 (19.19)

Source: NOAA, 2021.

Rainfall in the Kalaeloa District averages 16.7 inches (42.4 cm) per year. October through January is normally the wettest season at Kalaeloa with rainfall averaging approximately 2.3 inches (6 cm) per month. June through August are the driest months of the year averaging approximately 0.4 inch (1.0 cm) per month (U.S. Climate Data, 2021).

7.2.4 Geology

A general discussion of the geology of Oʻahu is presented in Section 2.2.1. The marine and sedimentary rock or caprock at Kalaeloa range from 50 to 400 feet (15 to 122 meters) in thickness along the northern boundary and from 750 to 1,000 feet (229 to 305 meters) in thickness along the coast. The upper 100 feet (31 meters) of caprock is marine sediment, consisting mainly of coral reef limestone with minor layers of shell fragment limestone and beach sands. Beneath this uppermost layer, alternating layers of alluvial and marine sediments are present. Alluvial layers vary from 5 to 95 feet (1.5 to 29 meters) in thickness, and consist of poorly sorted clays, silts, sands, and gravels of volcanic origin. The alternating marine layers are somewhat thicker (NAVFAC PAC, 1994). In the Kalaeloa area, the caprock is underlain by Waiʻanae and possibly Koʻolau volcanic rock.

The coralline limestone unit beneath Kalaeloa contains numerous solution cavities of various shapes and sizes. Many of the cavities have been filled, or partially filled with materials derived from the breakup of old coral reefs and, in places, some cavities have been plugged or partially plugged by stream-laid alluvium derived from the erosion of volcanic and sedimentary rocks. The most unique geological features present at the DON-retained lands at Kalaeloa are the sinkholes. Sinkholes are natural cavities in the emerged coralline reef that make up much of the ʻEwa Plain. In most cases, these are the actual remnants of the original reef structure that have been enlarged or otherwise structurally altered through solution by groundwater (NAVFAC PAC, 1994).

7.2.5 Soils

Figure 7-3 shows the soil types for Kalaeloa and Table 7-2 provides a summary of the soil types found at Kalaeloa. The majority of Kalaeloa is situated on coral outcrop (CR), with little or no soil cover. DRMO is underlain by CR only. The Biosolids Treatment Facility is primarily underlain by CR but has an area of

Māmala cobbly silty clay loam (MnC) in the northwestern portion of the site. The Barbers Point Golf Course is underlain by MnC as well as CR and filled land (FL). The two beach areas (White Plains and Nimitz) are underlain by CR and Beach Sand (BS) (USDA-NRCS, 1972).

Table 7-2 Kalaeloa Soil Types

Soil Type	***Location***	***Description***	***Characteristics***
Beaches (BS) occur as sandy, gravelly, or cobbly areas. They are washed and rewashed by ocean waves. BS consists mainly of light-colored sands derived from coral or seashells.			
Coral Outcrop (CR)	Small areas of CR are exposed on the ocean shore, on the coastal plains, and the foot of the uplands.	Composed of coral or cemented calcareous sand. In a typical profile, CR makes up about 80 to 90 percent of the acreage with the remaining 10 or 20 percent consisting of a thin layer of friable, red soil material in cracks, crevices, and depressions within the coral outcrop.	Soil characteristics were not reported for this soil type.
Fill Land: This land type consists of areas filled with material from dredging, excavation from adjacent uplands, garbage, and bagasse and slurry from sugar mills. A few areas are filled with material from dredging and excavation. Generally, these materials are dumped and spread over marshes, low-lying areas along coastal flats, coral sand, coral limestone, or areas of shallow bedrock.			
Fill land, mixed (FL)	FL occurs mostly near Pearl Harbor and in Honolulu adjacent to the ocean.	Areas filled with material dredged from the ocean or hauled from nearby areas, garbage, and general material from other sources.	Soil characteristics were not reported.
Māmala Series: This series consists of shallow, well-drained soils along the coastal plains. These soils formed in alluvium deposited over coral limestone and consolidated calcareous sand.			
Māmala cobbly silty clay loam, 0 to 12 percent slopes (MnC)	These soils occur on coastal plains.	Neutral to mildly alkaline, dark reddish-brown stony silty clay loam in the surface layer (approximately 8 inches [20 cm] thick). The subsoil is neutral to mildly alkaline, dark reddish-brown silty clay loam (approximately 11 inches [28 cm] thick). The soil is underlain by coral limestone and consolidated calcareous sand at depths of 8 to 20 inches (20 to 51 cm). Stones, mostly coral rock fragments, are common in the surface layer and in profile.	Permeability is moderate. Runoff is very slow to medium and the erosion hazard is slight to moderate. The available water capacity is 2.2 inches/foot (18 cm/meter) in the surface layer and 1.9 inches/foot (16 cm/meter) in the subsoil.

Source: USDA, 1972.

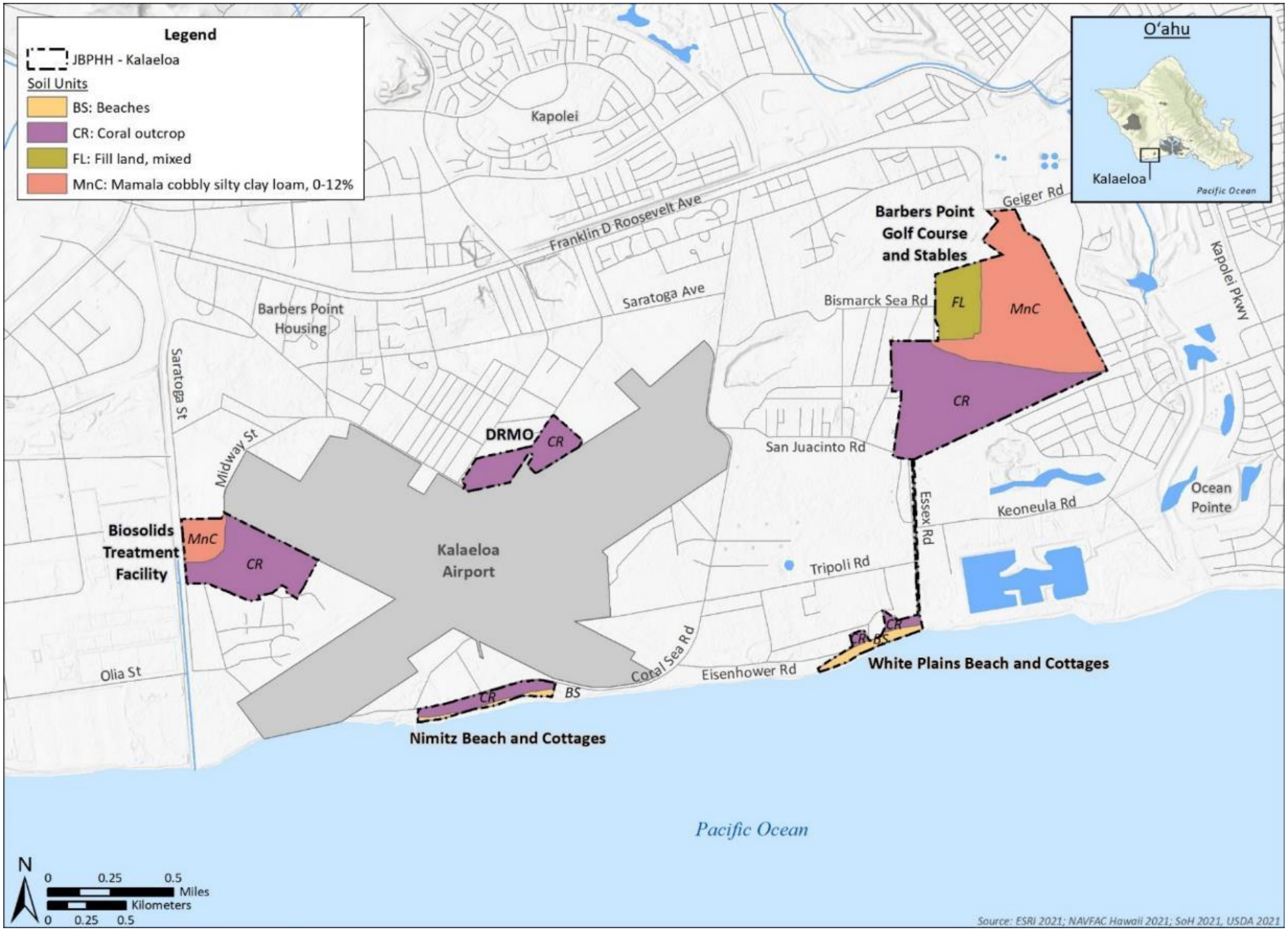

Figure 7-3 JBPHH Kalaeloa Soils

7.2.6 Hydrology

Section 2.2.5 provides a discussion of regional hydrology. The discussion of the hydrology of the DON-retained lands at Kalaeloa is divided into two subsections: surface water and hydrogeology.

7.2.6.1 Surface Water Resources

Kalaeloa is located within the Makakilo Gulch and Kaloi Gulch Watersheds (Figure 7-4). The Makakilo Gulch and Kaloi Gulch Watersheds consist primarily of developed areas and to a lesser extent, agricultural areas. Surface flows are directed via storm drains and canals to the ocean (SOH DAR and the Bishop Museum, 2008).

There are two surface water bodies located on BRAC-disposed parcels formerly part of NASBP: Ordnance Pond (more commonly referred to as Ordy Pond) and Airport Wetland (see Figure 7-2) BRAC land is not covered under the jurisdiction of this INRMP. Ordy Pond is considered a non-jurisdictional wetland (NAVFAC PAC, 1994). The pond is a brackish water-filled sinkhole with a depth of 22 feet (7 meters). The open water area is approximately 270 feet (82 meters) in diameter and accounts for less than 1 acre (0.4 hectare). Including the surrounding mangrove, the pond occupies an area of about 3 acres (1.2 hectares). The pond's sediment provides a geologic record of sedimentation and climatic change for the leeward region of the island. The pond was originally hydraulically connected to the ocean, although it is now nearly sealed off from groundwater due to the accumulation of fine sediments. As a result, there is very little tidal fluctuation in the pond (DON, 2011). Airport Wetland is a small (less than 1 acre [0.4 hectare], seasonal, non-jurisdictional wetland (DON, 2011).

There are several notable surface water bodies located adjacent to the study area. Wai Kai Wetland and Wai Kai Lagoon are located immediately east of White Plains Beach and Cottages. Numerous man-made ponds are scattered throughout Ocean Pointe located between Barbers Point Golf Course and Stables and White Plains Beach and Cottages. Saratoga canal is located immediately west of the Biosolids Treatment Facility. These surface water bodies are of note as they support ESA-listed and MBTA-protected bird species throughout the Kalaeloa District (see Section 7.3.3, *Terrestrial Biology*).

At Kalaeloa, storm water runoff is controlled primarily through diversion to a series of dry wells located throughout the former NASBP (NAVFAC PAC, 1994). The Flood Insurance Rate Maps published by FEMA (2015) identifies the majority of the project area within Zone D, which denotes areas in which flood hazards are undetermined, but possible. Nearshore portions of DON-retained lands are located in Zone "VE." Zone VE corresponds to the 100-year coastal flood plains that have additional hazards associated with storm waves and are shown in Figure 7-5 (FEMA, 2015).

Kalaeloa is a coastal site at a very low elevation (sea level to 32 feet [9.8 meters]) and is vulnerable to tsunami inundation. The CCH has established a tsunami evacuation zone that encompasses all of the Nimitz Beach and Cottages and White Plains Beach and Cottages (CCH, 2010) (Figure 7-5). The extreme tsunami evacuation zone includes the coastal areas, Biosolids Treatment Facility, and portions of DRMO and Barbers Point Golf Course and Stables (CCH, 2015).

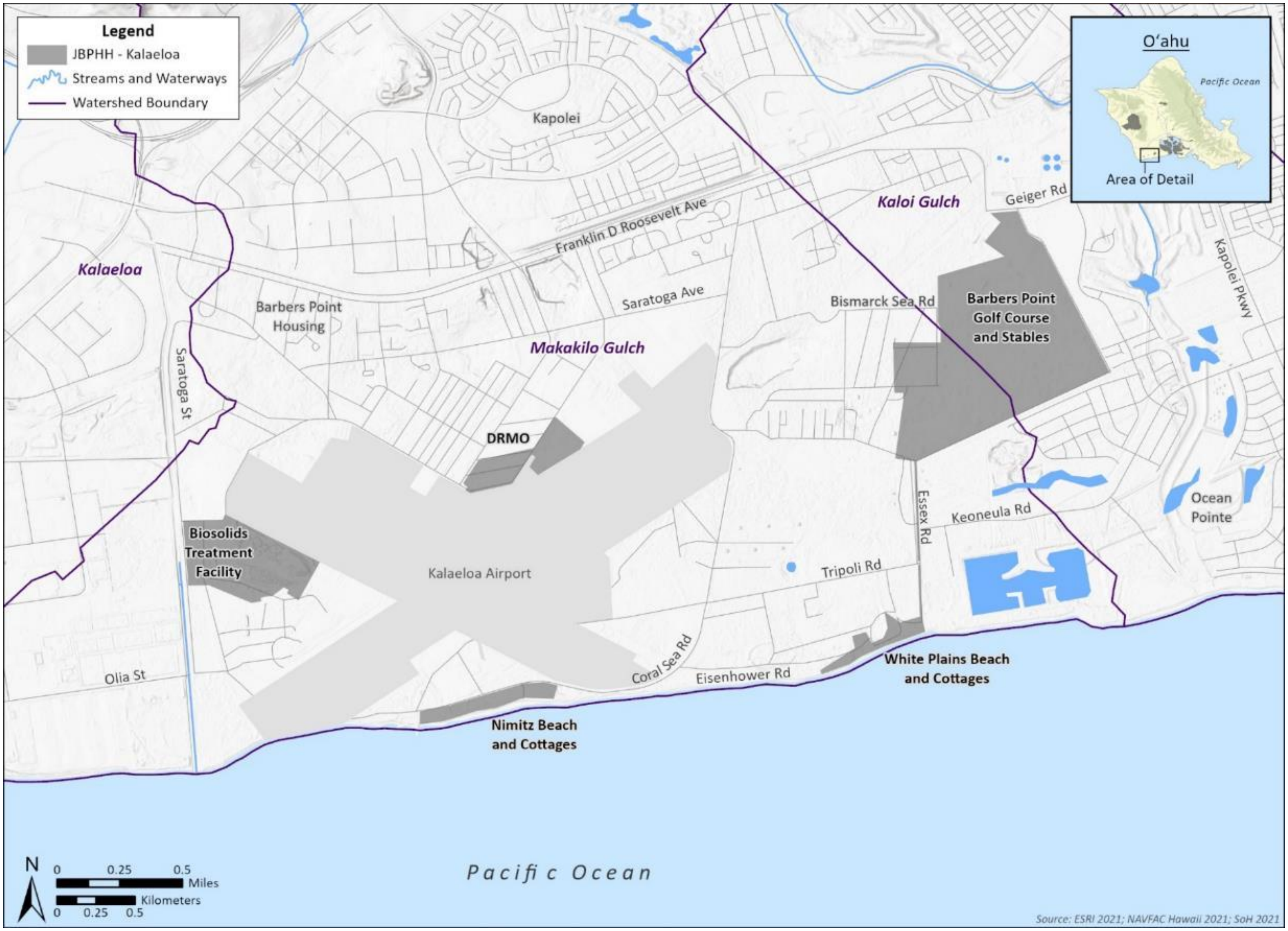

Figure 7-4 JBPHH Kalaeloa Watersheds

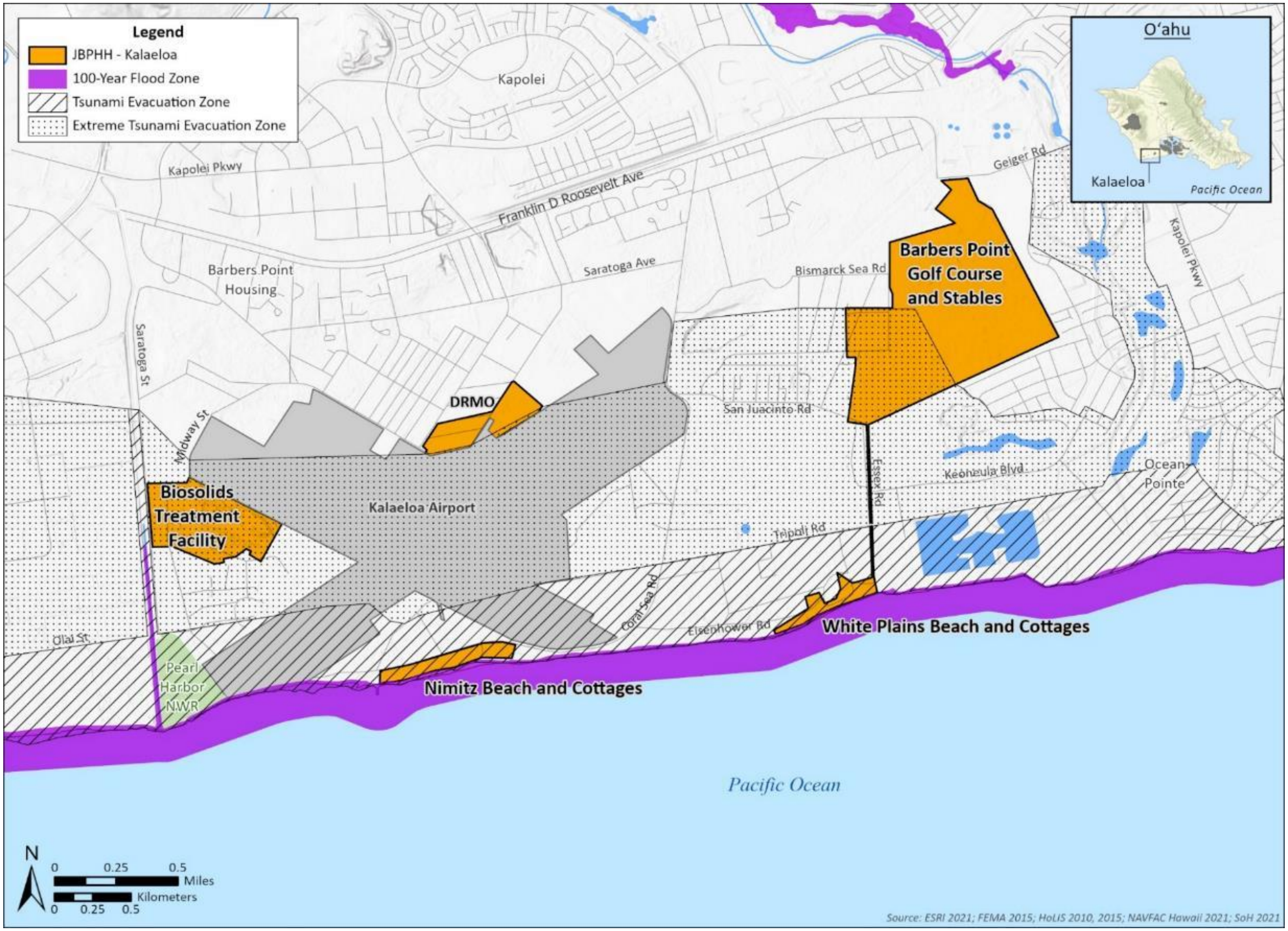

Figure 7-5 JBPHH Kalaeloa Tsunami and Flood Zone Map

7.2.6.2 Hydrogeology

Section 2.2.5 provides a summary of the four major aquifer types that occur on Oʻahu. The vast majority of the Kalaeloa District is within the ʻEwa aquifer system of the Pearl Harbor Aquifer Sector. However, a small portion of the eastern side of Kalaeloa (including portions of the Barbers Point Golf Course and the White Plains Beach and Cottages) are located within the Waipahu aquifer system of the Pearl Harbor Aquifer Sector. Both aquifer systems have two aquifers: a deep confined aquifer in the underlying basalt and an overlying shallow unconfined caprock aquifer (Mink and Lau, 1990).

The ʻEwa Plain and Kalaeloa contain anchialine pool resources. Anchialine pools are small land-locked bodies of water with varying salinity levels that have indirect underground connections to the ocean and are subject to tidal fluctuation in water levels. These pools typically include a number of different rare species (The Nature Conservancy, 2012).

Both of the deep aquifers are classified as basal, confined, flank aquifers. The ʻEwa aquifer system (30204121 [13213]) is currently used and has low salinity (250 to 1,000 mg/L Cl^-). It is not a drinking water source or considered ecologically important. It is considered irreplaceable with a low vulnerability to contamination. In contrast, the Waipahu aquifer system (30203116 [12211]) is currently used for drinking water and has low salinity and moderate vulnerability to contamination (Mink and Lau, 1990).

Both of the shallow aquifers are basal, unconfined, sedimentary aquifers. The ʻEwa aquifer system (30204116 [13321]) is currently used and has moderate salinity (1,000 to 5,000 mg/L Cl^-). It is not used for drinking water nor is it considered ecologically important. It is classified as replaceable and has a high vulnerability to contamination. In contrast, the Waipahu aquifer system (30203121 [12212]) is currently used, is ecologically important, and has low salinity. It is considered irreplaceable and has a moderate vulnerability to contamination (Mink and Lau, 1990).

The depth to groundwater at Kalaeloa ranges from about 60 feet (18.3 meters) along the northern border of Kalaeloa, to zero at the coast. These depths correspond to a seaward gradient of 1 to 2 feet/mile (0.2 to 0.4 meters/km). The alternating layers of marine and alluvial sediments underlying the coral aquifer are likely saturated with saline water hydraulically connected to the ocean. Hydraulic conductivity with the marine layers is high, allowing horizontal movement of groundwater, but less permeable alluvial layers inhibit vertical migration of groundwater within the caprock as a whole. Hydraulic conductivities of the marine layers are estimated to be on the order of 10-3 to 10-1 cm per second (cm/sec). Hydraulic conductivities of the volcanic rocks are likely several orders of magnitude lower. These volcanic rock units consist of finely crystalline to glassy basalts, with minor amounts of interbedded welded ashes and alluvial volcanic material. Cooling joints, fractures, lava tubes, brecciated zones, and other depositional features are present within the volcanic rock, resulting in hydraulic conductivities up to 10-2 cm/sec (NAVFAC PAC, 1994).

The BRAC Cleanup Plan for NASBP (DON, 1998) indicates that contaminants including petroleum hydrocarbons, pesticides and herbicides, polychlorinated biphenyls, solvents, and metals were detected at low concentrations in the groundwater. Sampling indicated that the contaminant concentrations were uniformly distributed across the Kalaeloa District and are representative of background levels. Although the low contaminant concentrations were not expected to have an impact on regional groundwater quality or to pose significant risk to humans or the environment, sediments with contaminant concentrations exceeding hazardous waste criteria were removed.

A systematic evaluation was conducted of impacts to overall groundwater quality resulting from known or potential sources of groundwater contamination from the former NASBP by the DON in 1999 (DON, 1999). Localized groundwater contamination exists; however, neither extensive nor widespread degradation of overall groundwater quality has resulted from known or potential point sources. The evaluation of risks posed by exposure to groundwater through the assumed exposure pathways (untreated potable water consumption and use) indicates negligible risk to human health. An ecological risk evaluation was completed for potential complete exposure pathways to the aquatic life at Ordy Pond and the Pacific Ocean. Ordy Pond is on BRAC land. BRAC land is not covered under the jurisdiction of this INRMP. Results indicated that risks posed by groundwater discharge to the pond are insignificant and risks posed to aquatic habitats of the Pacific Ocean (by groundwater) are also considered insignificant (DON, 1999).

7.3 General Biotic Environment

The discussion of the general biotic environment is divided into three subsections (7.3.1 through 7.3.3): wetlands, ecosystems, and terrestrial biology.

Information on biological resources presented in this and subsequent sections are primarily derived from the following surveys of terrestrial plants and animals conducted as part of the INRMP revision process.

- Botanical Surveys of U.S. Navy Properties in Support of Integrated Natural Resources Management Plan at Joint Base Pearl Harbor-Hickam, Oʻahu, Hawaiʻi (AECOM, 2016)
- Avian Point Counts at Eleven Sites within Joint Base Pearl Harbor-Hickam (Hamer Environmental, 2016)
- Field Biology Technical Assistance for Natural Resources Program Joint Base Pearl Harbor-Hickam (RCUH, 2017a-d, 2018a-d, 2019a-d, 2020a-d)
- Wildlife Hazard Assessment Kalaeloa Airport (JRF) Kapolei, Hawaiʻi (SOH Department of Transportation [DOT], 2020)

7.3.1 Wetlands

Within the Kalaeloa District there are freshwater wetlands, mangrove swamps, coastal salt flats, and the entire coastline which is a marine wetland with an intertidal subsystem. As described in Section 7.2.6.1, there are two surface water bodies on BRAC-disposed land: Ordy Pond and Airport Wetland (see Figure 7-2). BRAC land is not covered under the jurisdiction of this INRMP. Neither the Ordy Pond nor the Airport Wetland are jurisdictional wetlands. The coastline at Nimitz Beach and White Plains Beach are marine wetlands classified as “marine system, intertidal subsystem.” Nimitz Beach is further classified as “seasonal tidal, temporary tidal, hyperhaline, regularly flooded,” while the White Plains Beach is classified as “unknown, temporary tidal, euhaline, regularly flooded.” There are no jurisdictional wetlands on the DON-retained lands at Kalaeloa.

7.3.2 Ecosystems

The terrestrial ecosystems of Kalaeloa are classified as non-native, and are all lands transformed by human activity (Juvik et al., 1998). The vegetation communities present in the study area are discussed further in Section 7.3.3.1, *Flora*.

7.3.3 Terrestrial Biology

7.3.3.1 Flora

Threatened and Endangered Flora Species and Species of Concern

There are no ESA- or SOH-listed plant species known to occur within the study area. The federally-listed endangered plant species, ‘akoko and round-leaf chaff flower shrub, occur within the Kalaeloa District but not within DON-retained lands. Additionally, pua pilo (*Capparis sandwichiana* var. *zoharyi*), an endemic shrub that is a federal species of concern, has been documented along the southern boundary of the Kalaeloa District but not within DON-retained lands. Although critical habitat, specifically O‘ahu-Lowland Dry Units 10 and 11, has been designated in the vicinity of the study area for multiple plant species, the study area does not overlap the critical habitat boundaries (USFWS, 2012).

Vegetation Communities of Kalaeloa

The DON-retained lands at Kalaeloa have been previously developed and disturbed. Plant species found within Kalaeloa consist mostly of introduced species typically found within urban landscaped areas (Appendix M-1). The 2015 botanical survey of the study area described primarily developed areas and kiawe forest/scrub with pockets of coastal strand and ironwood forest (Figure 7-6). The results of the 2015 survey are summarized in the following paragraphs.

Vegetation Communities of Defense Reutilization Marketing Office

DRMO consisted primarily of developed areas with limited landscape and no vegetation communities or species of concern during the 2015 botanical survey (AECOM, 2016).

Vegetation Communities of the Biosolids Treatment Facility

The natural areas within the Biosolids Treatment Facility are fragmented by gravel roads and contain old, collapsed concrete structures, metal frames, and other signs of modification. The 2015 botanical survey focused on the natural areas of remaining kiawe forest, which is the typical vegetation community of highly disturbed areas in the ‘Ewa Plain. Kiawe and monkeypod comprise the dominant overstory at the Biosolids Treatment Facility. The midstory is also typical, containing koa haole and creeping indigo (*Indigofera hendecaphylla*). The understory is dominated by Guinea grass. Native species rarely to occasionally observed included kou (*Cordia subcordata*), kīpūkai, koali ‘awa (*Ipomoea indica*), ko‘oloa keokeo (*Abutilon incanum*), ‘ilima, naio (*Myoporum sandwicense*), and pōpolo (*Solanum americanum*) (AECOM, 2016).

Vegetation Communities of Barbers Point Golf Course and Stables

Barbers Point Golf Course and Stables is primarily developed with large areas of managed grass. Much of the area was used as part of an airfield during World War II and thus the remaining natural areas that include kiawe forest and grassland savannah (with kiawe) contain less diversity and native species than other DON-retained lands at Kalaeloa. Vegetation community composition is consistent with that described previously for the Biosolids Treatment Facility; however, only five native species were rarely to occasionally observed within natural areas at the site: ‘ilima, kīpūkai, ko‘oloa keokeo, ‘anunu (*Sicyos pachycarpus*), and milo (AECOM, 2016).

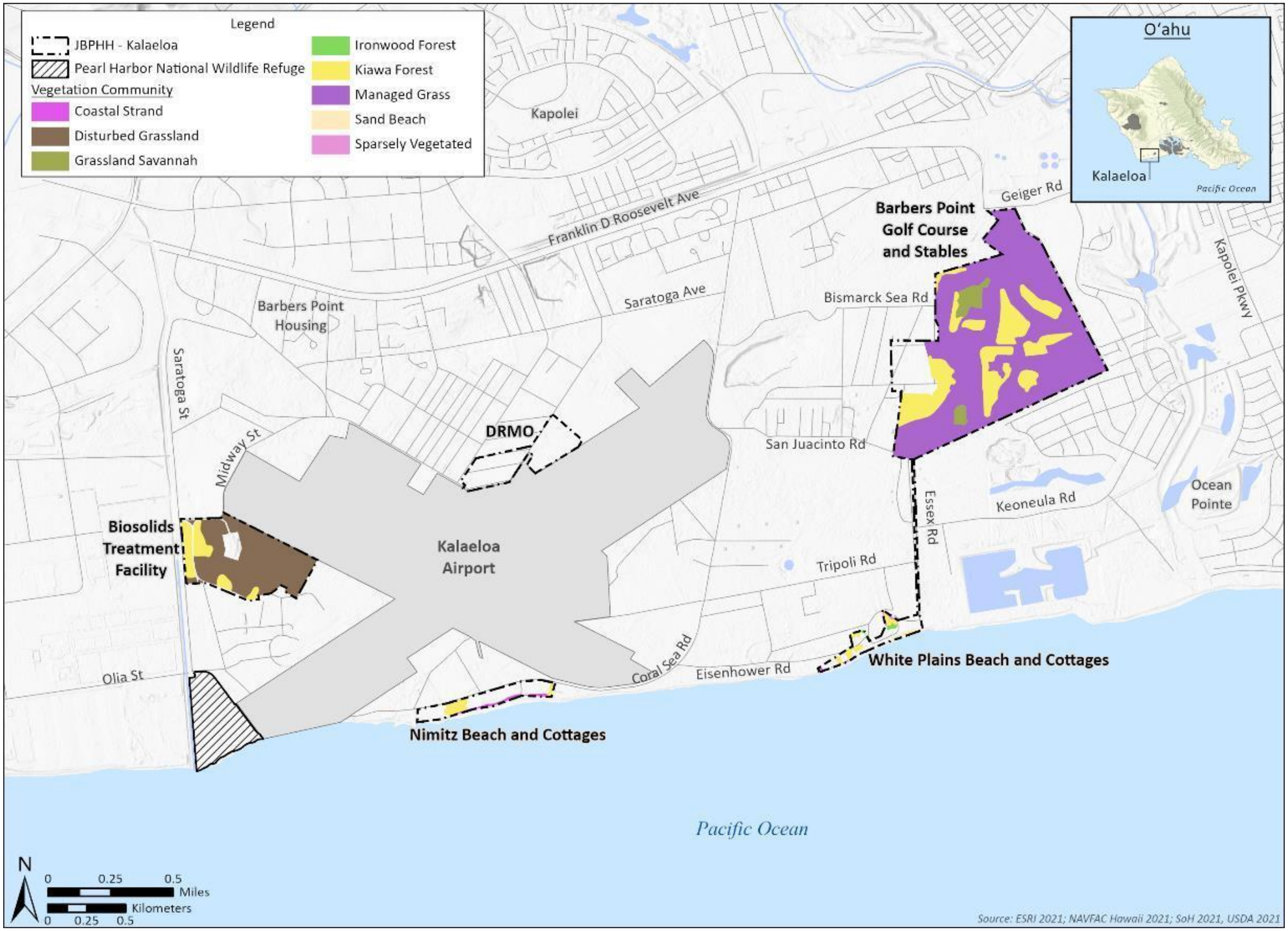

Figure 7-6 JBPHH Kalaeloa Vegetation Communities

Vegetation Communities of Nimitz Beach Park and Cottages

Nimitz Beach Park is a narrow coastal strip of land, containing cabins, shelters for day use picnic areas, and a restroom. Most of the areas are mowed and developed, with small pockets of kiawe forest and coastal strand. The coastal strand vegetation community includes native species such as koali ʻawa (*Ipomoea indica*), pōhuehue (*Ipomoea pes-caprae*), and naupaka kahakai (*Scaevola taccada*) (AECOM, 2016). Several long-thorn kiawe (*Prosopis juliflora*) were observed within the coastal strand, which is of concern as the species is considered an invasive, noxious weed (AECOM, 2016).

A single naio was observed at the western border of the property. Plantings of native species, milo and naupaka kahakai, are also present at the Nimitz Beach Park and Cottages.

Vegetation Communities of White Plains Beach Park and Cottages

White Plains Beach Park is a narrow strip of land containing cabins and shelters for day use picnic areas; several buildings used for a bath house/restroom, snack bar, and beach rentals. The site is largely developed with a mix of ironwood forest, kiawe forest, and strips of coastal strand. The coastal strand vegetation community at this site includes native plant species: ʻākulikuli, ʻilima, naupaka kahakai, ʻakiʻaki (*Sporobolus virginicus*), and beach morning glory (*Ipomoea pes-caprae*).

NAVFAC PAC (2006) reported a native sedge, kaluhā, present within a salt marsh at the former camping area. The former camping area is now largely dominated by ironwood forest and the high water table wetland lies across the property boundary (AECOM, 2016). Kaluhā is still present in the wetland and the species occurs mostly outside of DON-retained land (AECOM, 2016). Although this species is not federally- or SOH-listed, it is considered rare on Oʻahu and its habitat should not be disturbed (NAVFAC PAC, 2006).

7.3.3.2 Fauna

Amphibian, reptile, and invertebrate surveys have not been conducted within the study area. DON focused amphibian and reptile species (herpetological) surveys have been conducted in areas containing native plant and animal species, such as JBPHH Lualualei Annex (see Chapter 5), where they may have a more serious negative ecological impact. The following discussion of wildlife is limited to threatened and endangered species and other wildlife such as birds and terrestrial mammals within the study area.

Threatened and Endangered Fauna Species

Several threatened and endangered terrestrial fauna species occur or have potential to occur at Kalaeloa and are listed in Table 7-3. These species and their occurrence at Kalaeloa are described below.

Table 7-3 Federally- and SOH-listed Terrestrial Species with Potential to Occur at Kalaeloa

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence*
Bird Species				
Anas wyvilliana	Hawaiian Duck	Koloa maoli	FE, SE	Potential
Fulica alai	Hawaiian Coot	ʻAlae keʻokeʻo	FE, SE	Potential
Gallinula chloropus sandvicensis	Hawaiian Gallinule	ʻAlae ʻula	FE, SE	Potential
Gygis alba	White Tern	Manu-o-kū	ST	Potential

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence*
Bird Species (continued)				
Himantopus mexicanus knudseni	Hawaiian Stilt	Ae‘o	FE, SE	Confirmed
Oceanodroma castro	Band-rumped Storm Petrel	‘Akē‘akē	FE, SE	Within 5 miles of installation
Pterodroma sandwichensis	Hawaiian Petrel	‘Ua‘u	FE, SE	Within 5 miles of installation
Puffinus newelli	Newell’s Shearwater	‘A‘o	FT, ST	Within 5 miles of installation
Terrestrial Mammal Species				
Lasiurus cinereus semotus	Hawaiian Hoary Bat	‘Ōpe‘ape‘a	FE, SE	Potential
Arthropod Species				
Hylaeus spp.	Hawaiian Yellow-faced Bee	Nalo Meli Maoli	FE	Unconfirmed, Potential

Notes: FE = federally-listed endangered; FT = federally threatened; SE = state-listed endangered; SOH = State of Hawai‘i; ST = state-listed threatened. *Definitions provided in Appendix I.

Bird Species

The federally endangered Hawaiian stilt has been observed at the Biosolids Treatment Facility, Barbers Point Golf Course, and in wetland areas adjacent to DON-retained lands of Kalaeloa (RCUH, 2017a-d; Hamer Environmental, 2016; SOH DOT, 2020). The Hawaiian stilt is known to nest at Ordy Pond (RCUH, 2020a-d). Additionally, the Hawaiian stilt has been observed foraging at Wai Kai Wetland and Lagoon directly east of White Plains Beach and Cottages as well as Saratoga Canal directly west of the Biosolids Treatment Facility (SOH DOT, 2020). Ordy Pond is on BRAC land. BRAC land is not covered under the jurisdiction of this INRMP.

The ESA-listed Hawaiian duck (suspected Hawaiian duck-mallard hybrid, see Section 4.3.3.2, *Fauna*), Hawaiian coot, and Hawaiian gallinule have been observed in habitat directly adjacent to the study area. The Hawaiian coot has been observed nesting at Ordy Pond (RCUH, 2017a-d; SOH DOT, 2020) and in large numbers at Wai Kai Wetland and Lagoon directly east of White Plains Beach and Cottages (SOH DOT, 2020). The Hawaiian duck and Hawaiian gallinule have been observed at Saratoga Canal directly west of the Biosolids Treatment Facility (SOH DOT, 2020). The study area does not contain suitable nesting and foraging habitat for these species; however, there is potential for these species to occur within the study area as they move between wetlands within the Kalaeloa District.

The ESA-listed band-rumped storm petrel, Hawaiian petrel, and Newell’s shearwater are not known to inhabit Kalaeloa but have potential to fly over the study area from suitable nesting habitat in the Wai‘anae Mountains to the ocean. These species are particularly vulnerable to fallout – when fledglings or occasional migrating adult birds are disoriented by artificial light and become grounded. Due to the occasional flyovers and groundings, they have the potential to occur in the study area. These species are further described in Section 4.3.3.2, *Fauna*.

The white tern, SOH-listed as threatened, was observed during a point count survey conducted at Kalaeloa Airport, directly adjacent to DRMO and the Biosolids Treatment Facility, in 2019 (SOH DOT, 2020). Potentially suitable nesting habitat (e.g., large monkeypod trees) is present at the Biosolids Treatment Facility and Barbers Point Golf Course; however, the species is not known to nest there. This species is further described in Section 4.3.3.2, *Fauna*.

Terrestrial Mammal Species

Potentially suitable habitat for Hawaiian hoary bat is present within the study area (vegetation greater than 15 feet [4.6 meters] in height). It has not been confirmed if Hawaiian hoary bat is present within the study area and acoustic monitoring for the species is recommended (Table 8-7, Row 5).

Arthropod Species

Potentially suitable habitat for Hawaiian yellow-faced bees is present at Nimitz Beach and Cottages and White Plains Beach and Cottages in the form of coastal strand. The remaining coastal strand at these locations is minimal and fragmented; however, surveys are recommended to confirm if Hawaiian yellow-faced bee species are utilizing those areas (Table 8-7, Row 8).

7.3.3.3 Other Wildlife

Birds

Birds are the dominant wildlife within the Kalaeloa District; 22 species were detected during 2015 point counts on DON-retained land at Kalaeloa (AECOM, 2016; Appendix M-2) including the Hawaiian stilt (ESA-listed endangered) and two MBTA-protected species: Pacific golden plover and cattle egret. In support of BASH efforts at Kalaeloa Airport, USDA conducted point count surveys throughout the Kalaeloa District in 2019 and reported numerous MBTA-protected birds occurring in the Kalaeloa District. Although most of these species were not observed on DON-retained lands they have potential to occur within the study area. MBTA-protected bird species observed during these two surveys are listed in Table 7-4; a comprehensive species list is provided in Appendix M-2.

Table 7-4 Migratory Bird Treaty Act-Protected Species with Potential to Occur at Kalaeloa

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence*
Alauda arvensis	Eurasian Skylark	-	MBTA	Within 5 miles of installation
Anas acuta	Northern Pintail	Koloa Mapu	MBTA	Within 5 miles of installation
Anas americana	American Wigeon	-	MBTA	Within 5 miles of installation
Anas clypeata	Northern Shoveler	Koloa Mōhā	MBTA	Within 5 miles of installation
Anas discors	Blue-winged Teal	-	MBTA	Within 5 miles of installation
Anas platyrhynchos	Mallard	-	MBTA	Potential
Anas spp.	Hawaiian Duck-Mallard Hybrid	-	MBTA	Potential
Anas wyvilliana	Hawaiian Duck	Koloa maoli	FE, SE, MBTA	Potential
Arenaria interpres	Ruddy Turnstone	'Akekeke	MBTA	Within 5 miles of installation
Aythya affinis	Lesser Scaup	-	MBTA	Within 5 miles of installation
Branta hutchinsii	Cackling Goose	-	MBTA	Within 5 miles of installation
Bubulcus ibis	Cattle Egret	-	MBTA	Confirmed

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence*
Calidris alba	Sanderling	Hunakai	MBTA	Within 5 miles of installation
Cardinalis cardinalis	Northern Cardinal	-	MBTA	Within 5 miles of installation
Fregata minor palmerstoni	Great Frigatebird	'Iwa	MBTA	Within 5 miles of installation
Fulica alai	Hawaiian Coot	ʻAlae keʻokeʻo	FE, SE, MBTA	Potential
Gallinula chloropus sandvicensis	Hawaiian Gallinule	ʻAlae ʻula	FE, SE, MBTA	Potential
Gygis alba	White Tern	Manu-o-kū	ST, MBTA	Within 5 miles of installation
Haemorhous mexicanus	House Finch	-	MBTA	Confirmed
Himantopus mexicanus knudseni	Hawaiian Stilt	Aeʻo	FE, SE, MBTA	Confirmed
Leucophaeus atricilla	Laughing Gull	-	MBTA	Within 5 miles of installation
Leucophaeus pipixcan	Franklin's Gull	-	MBTA	Within 5 miles of installation
Minus polyglottos	Northern Mockingbird	-	MBTA	Within 5 miles of installation
Numenius tahitiensis	Bristle-thighed Curlew	Kioea	MBTA	Within 5 miles of installation
Nycticorax nycticorax	Black-crowned Night-heron	Auku'u	MBTA	Within 5 miles of installation
Phaethon rubricauda rothschildi	Red-tailed Tropicbird	Koaʻe ʻula	MBTA	Within 5 miles of installation
Phoebastria immutabilis	Laysan Albatross	Moli	MBTA	Within 5 miles of installation
Pluvialis fulva	Pacific Golden Plover	Kōlea	MBTA	Confirmed
Sula leucogaster plotus	Brown Booby	ʻĀ	MBTA	Within 5 miles of installation
Sula rubripes	Red-footed Booby	ʻĀ	MBTA	Within 5 miles of installation
Sterna fuscata	Sooty Tern	ʻEwaʻewa	MBTA	Within 5 miles of installation
Tringa incana	Wandering Tattler	'ūlili	MBTA	Within 5 miles of installation
Tyto alba	Barn Owl	-	MBTA	Within 5 miles of installation

Notes: FE= federally-listed endangered; MBTA = Migratory Bird Treaty Act; N = native; SE = state-listed endangered; ST = state-listed endangered; - = no data. *Definitions provided in Appendix I.

Mammals

Several non-native terrestrial mammal species occur within the study area. Indian mongoose and feral cats are common throughout the Kalaeloa District. Rodents such as the house mouse (*Mus musculus*), roof rat, brown rat, and Polynesian rat are likely to occur throughout the study area. To a lesser degree, feral dogs have also been reported within the study area.

Feral cat colonies have been established within the Kalaeloa District and are loosely managed by keepers[3]. Feral cats at Kalaeloa are a serious health concern to humans, birds, and terrestrial and marine life (e.g., toxoplasmosis exposure to federally endangered Hawaiian monk seal) (Lepczyk et al., 2020). Additionally, feral cats, mongoose, and rodents are known predators of ESA-listed waterbirds that nest at Ordy Pond and MBTA-protected species that occur throughout the Kalaeloa District.

7.3.4 Marine Biology

The following is a general summary of marine biological resources at Kalaeloa that are likely to occur offshore. Marine macroinvertebrates, found offshore of Kalaeloa, include reef-building corals, several species of sea cucumber, sea urchins, and colonial soft corals. Marine vertebrates include reef fish, although abundance and diversity are low. The most common are triggerfish (Balistidae) and hawkfish (Cirrhitidae). Detailed discussion of the marine biology of the submerged training areas adjacent to Kalaeloa is presented in Section 4.4.2, *JBPHH Main Base-administered Submerged Lands*.

Two ESA-listed marine species are known to occur at Nimitz Beach and White Plains Beach and are listed in Table 7-5. (See Chapter 4, *JBPHH Main Base and Surrounding Areas* for additional species information).

Table 7-5 Federally- and SOH-listed Marine Species with Potential to Occur at Nimitz Beach and White Plains Beach in Kalaeloa

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*Study Area Occurrence*
Marine Mammal Species				
Neomonachus schauinslandi	Hawaiian Monk Seal	Īlioholoikauaua	FE, SE, SGCN, MMPA	Confirmed
Reptilian Species				
Chelonia mydas	Green Sea Turtle (Central North Pacific DPS)	Honu	FT, ST	Confirmed
Eretmochelys imbricata	Hawksbill Sea Turtle	Honuʻea	FE, SE	Possible

Notes: DPS = distinct population segment; FE = federally-listed endangered; FT = federally-listed threatened; MMPA = Marine Mammal Protection Act; SE = state-listed endangered; SGCN = State of Hawaiʻi Species of Greatest Conservation Need; ST = state-listed threatened. *Definitions provided in Appendix I.

The ESA-listed endangered Hawaiian monk seal is occasionally observed hauling out at Nimitz Beach and White Plains Beach (Appendix J-8). As discussed in Section 1.6.3.1, *Critical Habitat*, during the revisions of critical habitat for Hawaiian monk seals, NMFS found that the 2011 JBPHH INRMP contained measures that benefit the Hawaiian monk seal (580 Federal Register 50925 and 50 CFR 226). NMFS concluded that all areas subject to the JBPHH INRMP (including Nimitz and White Plains Beach and Puʻuloa Underwater Training Range) are precluded from Hawaiian monk seal critical habitat designations. Additionally, the ESA-listed threatened green sea turtle is known to frequent the area immediately offshore of Kalaeloa and may bask at Nimitz Beach and White Plains Beach. Please refer to Section 4.4.8, *Marine Protected Species*, for more detailed discussion of these species.

[3] Person/organization harboring, regularly feeding, or possessing any feral cat.

7.4 Current Management

7.4.1 Protected Species and Ecosystem Monitoring and Management

Several ESA-listed and numerous MBTA-covered species are known to occur or have potential to occur within the study area (see Section 7.3, *General Biotic Environment*). Current management actions for these species are discussed below. See Appendix N, *Biological Opinions, Consultations, and Example BMPs* for more details.

Endangered Species Act-protected Waterbirds

The Hawaiian stilt is known to occur within the study area. The ESA-listed Hawaiian duck (suspected Hawaiian duck-mallard hybrid, see Section 4.3.3.2, *Fauna*), Hawaiian coot, and Hawaiian gallinule have been observed in wetlands directly adjacent to the study area. Currently, these species are not known to nest within DON lands at Kalaeloa. RCUH conducts regular surveys of Ordy Pond to monitor changes in distribution and abundance of these species within the survey area and to support future INRMP updates. Ordy Pond is on BRAC land and BRAC land is not covered under the jurisdiction of this INRMP. RCUH conducts regular surveys of Ordy Pond to monitor changes in distribution, nesting, and abundance of these species and will continue to so do until the land is sold (currently BRAC).

DON has provided funding, as part of the JBPHH environmental program, for nuisance animal/predator control (primarily trapping and removal of feral cats and dogs) on White Plains Beach, which includes the public beach area and the MWR cabins area, and on Nimitz Beach, which includes the MWR cabins area and the pavilion area.

Endangered Species Act-protected Seabirds

Per COMNAVREGHIINST 5090.9, JBPHH takes all reasonable actions to reduce potential effects on Hawaii‘s night-flying seabirds with focus on the seabird fledging season (September through December). These actions may include louver light covers and extinguishing lights temporarily when a bird is observed flying around lights at night (COMNAVREGHIINST 5090.9).

White Tern

The white tern may breed in a wide variety of environments, including taller trees within urban or suburban neighborhoods on Oʻahu. However, while it has potential to occur within the study area, the white tern is not known to nest within DON-retained lands at Kalaeloa (Vanderwerf and Downs, 2022).

Migratory Bird Treaty Act-protected Birds

Numerous MBTA-protected birds have been recorded within the Kalaeloa District (see Table 7-4). Management actions regarding MBTA-protected bird species at the DON-retained lands at Kalaeloa include predator control at the White Plains Beach public recreation area and White Plains and Nimitz Beach cabin areas and outreach on migratory birds with MWR patrons.

As stated previously, DON has provided funding for nuisance animal/predator control (primarily trapping and removal of feral cats and dogs) on White Plains Beach, which includes the public beach area and the MWR cabins area, and on Nimitz Beach, which includes the MWR cabins area and the pavilion area.

Outreach includes placing information on migratory birds and the MBTA inside cabins and funding an information booth or kiosk with volunteers that would be set up during weekends, holidays, or other high usage times in order to educate MWR patrons on interaction with wildlife.

Hawaiian Hoary Bat

It is unknown if Hawaiian hoary bat occupies habitat within the study area and acoustic monitoring for the species is recommended to determine presence.

Endangered Species Act-protected Arthropod Species

It is not known if Hawaiian yellow-faced bee species occurs at Kalaeloa. Invertebrate surveys are recommended at the coastal strand habitat present at Nimitz Beach and Cottages and White Plains Beach and Cottages to verify if Hawaiian yellow-faced bee species are present in those areas (Table 8-7, Row 2).

Endangered Species Act-protected Marine Species

The conservation and management activities at Kalaeloa that provide a benefit to Hawaiian monk seals, green sea turtles, and hawksbill turtles are the same as those described for JBPHH Main Base and Surrounding Areas (Section 4.4.8, *Marine Protected Species*). DON continues to require that established procedures be followed during amphibious crew inserts. These include having designated lookouts watching for other vessels, obstructions to navigation, and marine mammals including whales, dolphins, monk seals, and sea turtles. Exercise planners are required to review training overlays that identify the insertion points and any nearby restricted areas. All sensitive biological receptors are avoided during training.

There is public access to all Kalaeloa beaches, and the interaction between ESA-protected species (i.e., Hawaiian monk seal and green sea turtles) and the public in these areas is managed through coordination with the NAVFAC HI environmental program, federal law enforcement, DON MWR lifeguards, and NMFS.

DON coordinates with NMFS to ensure that seal monitoring and data, records, and communication are up to date. The NAVFAC HI Natural Resources Program maintains a logbook of all sightings of Hawaiian monk seals at Kalaeloa (Appendix J-8). The DON has SOPs related to Hawaiian monk seal haul outs (Appendix J-8).

Lifeguards at the White Plains Beach public recreation area monitor the public’s interaction with seals that have hauled out on the beach. Lifeguards are present at White Plains Beach every day from 0900 to 1700 and help prevent disturbance to seals and turtles by intervening to stop the disturbance, installing barriers and signs, and notifying Hawaiʻi Marine Animal Response if required.

DON will work to limit human interaction with seals and turtles in areas where lifeguards are not present (beaches fronting the White Plains and Nimitz MWR cabins) through outreach efforts within the MWR program. Outreach activities include installing signs and/or information panels in the cabin areas, placing information on Hawaiian monk seals and green sea turtles inside the cabins, and funding an information booth or kiosk with volunteers that would be set up during weekends, holidays, or other high usage times to educate MWR patrons on human/Hawaiian monk seal and green sea turtle interaction.

The coordination between DON, NMFS, volunteer groups, and law enforcement and the plan for protecting Hawaiian monk seals and green sea turtles at Kalaeloa is an adaptive and evolving strategy. The effectiveness of the arrangement and interaction between all parties involved and the adequacy of the allocated funding is revisited each year as part of the annual JBPHH INRMP review. This is particularly important due to the increasing popularity of beach areas at Kalaeloa.

7.4.2 Invasive Species Prevention and Control

As defined by EO 13112, an IS is an alien (non-native) species whose introduction does or is likely to cause economic or environmental harm or harm to human health. The DON requires decontamination (cleaning, including brushing and visual inspection) of all vehicles, equipment, personal gear, shoes, and clothing before personnel may enter a training area at JBPHH in order to minimize the introduction of IS to Kalaeloa and other DON lands.

DON has provided funding for nuisance animal/predator control at Kalaeloa. However, feral cat colonies outside of DON-retained lands in the Kalaeloa District are prolific and have made management of feral cats at Kalaeloa a challenging task.

7.4.3 Restoration of Natural Resource Areas

DoDI 4715.3 directs DoD agencies to manage natural resources through principles of ecosystem management. Ecosystems with large proportions of native species are to be protected, and habitat restoration activities are to focus on these habitats. There are no current natural resources restoration management actions for the DON-retained lands at Kalaeloa.

7.4.4 Natural Resources Studies

Bird surveys and botanical surveys were conducted at Kalaeloa in 2015 (Hamer Environmental, 2016; AECOM, 2016) (Section 7.3.3.2, *Fauna*) and RCUH conducts regular bird surveys at Ordy Pond. DON intends to update the JBPHH flora and fauna surveys periodically in support of future INRMP updates and natural resources management efforts (Table 8-7, Row 2).

7.4.5 Wetlands

The JBPHH Natural Resources Manager's goal is to ensure that there is no net loss of wetlands on DON-controlled lands, while simultaneously establishing and/or enhancing native wetland species and reducing alien wetland species. The DON's intent is the conservation and protection of the marine wetlands located at Nimitz and White Plains Beaches (Section 7.3.2, *Ecosystems*).

7.4.6 Flood Plains

As described in Section 7.2.6.1, *Surface Water Resources*, Kalaeloa is a coastal site at a very low elevation and is vulnerable to tsunami inundation. Other than the land management practices described in Section 7.4.7, *Land Management*, there are no specific flood plain management actions at Kalaeloa. CCH maintains a civil defense siren system within the Kalaeloa District, which would alert beach goers and others in the vicinity in the event of a tsunami warning or threat.

7.4.7 Land Management

Ongoing land management programs at the DON-retained lands at Kalaeloa are similar to those discussed in Section 4.5.8, *Land Management*. They include base planning, reduction of point source pollution, utilization of BMPs during earthwork and construction and storm drain design, and non-point source pollution prevention for JBPHH. In addition, DON prohibits vehicle traffic off existing roads, use of rocks from rock piles or walls for training purposes, and establishment of new vehicle tracks during troop maneuvers. In addition, during maneuvers, digging, including entrenchments and foxholes, are prohibited, except in areas specifically designated by exercise planners. No new placement of barbed wire or concertina wire near signs marking the presence of sensitive ecological areas or fences are allowed by troops during maneuvers. No road, trail, or fire break clearing is allowed during maneuvers without permission from exercise planners. No grading or construction of buildings or other permanent structures is allowed without permission from exercise planners.

In addition, as discussed in Section 4.5.8, *Land Management*, the DON continues to include native plants in landscape design at DON-retained lands at Kalaeloa.

7.4.8 Forestry

There are no current forest management actions at the DON-retained land at Kalaeloa. There are small pockets of kiawe forests on portions of the DON-retained land at Kalaeloa; however, the size of these forested areas does not warrant a forestry program.

7.4.9 Wildland Fire

Wildland fires have impacted unused and/or undeveloped portions of Kalaeloa in recent years; the FFD in coordination with the Honolulu Fire Department (HFD), responds to any fires at DON-retained lands. In case of fire during troop training exercises, all fires will be reported to the FFD and troops will stop training and begin to fight the fire. Troops will continue to fight the fire until released by the fire department. Suggested management includes grass mowing and fuels management to minimize the potential for wildland fire to impact resources.

NRH has responded to public safety concerns regarding overgrown vegetation along DON-retained roadways and overflowing dumpsters on DON-retained vacant buildings reported from the Kalaeloa Crash Fire Rescue station (SOH, 2017).

7.4.10 Use of Geographic Information Systems

NAVFAC HI staff continually maintain their GIS database to include the locations of protected flora and fauna species at Kalaeloa. This continually updated GIS database will include the ESA-listed bird species (e.g., Hawaiian stilt), MBTA-protected bird species, and vegetation types.

7.4.11 Access Restrictions

The DON continues to prohibit training in areas marked by signs or fences indicating the presence of rare and/or protected species. The DON continues to prohibit bivouacking within 3,280 feet (1,000 meters) of posted signs marking the presence of rare and/or protected plant and animal species or restoration projects. No training units larger than 30 persons (platoon size) are allowed to bivouac outside of reusable bivouac sites provided with portable or reusable latrines. No open fires, burying, or leaving of trash, food preparation, cutting, or clearing of vegetation, or disturbing of vegetation including mosses, grasses, shrubs, bushes, and trees are allowed during bivouacking. All DON training activities at Kalaeloa are performed in accordance with all applicable Biological Opinions and existing USCG regulations. Any potential impacts to ESA-listed bird species such as the Hawaiian stilt would be addressed through coordination and/or consultation with USFWS.

7.4.12 Community Outreach

Currently, the RCUH team attends community outreach events to help inform and educate the public about Hawaiian monk seals and green sea turtles at Kalaeloa. Outreach materials on protected species such as monk seals and sea turtles will be developed and distributed to beaches, cabins, etc.

7.4.13 Outdoor Recreation

Nimitz Beach and White Plains Beach are open to the public for outdoor recreation including swimming, surfing, beach walking, and fishing. Additionally, the flat topography at Kalaeloa renders the area ideal for riding bicycles. Although the DON maintains cabins at both beaches for recreation purposes to MWR-authorized patrons, these cabins are not considered to be part of the outdoor recreation activities covered under this INRMP.

7.4.14 Law Enforcement

The DON-retained lands at Kalaeloa are policed by federal law enforcement officers. The non-DON lands at Kalaeloa are patrolled by Honolulu Police Department.

7.4.15 Leases and Encroachment Management

DRMO is currently leased to Hawaiʻi Department of Business, Economic Development and Tourism, who has subleased the complex. In September 2020, the Biosolids Treatment Facility became non-operational and NRH may lease the property to another agency.

The Committee on Foreign Investment in the U.S. is investigating development of the Atlantic Resort as a potential security concern.

The threat of SLR is an encroachment hazard for Kalaeloa, particularly at Nimitz Beach and Cottages and White Plains Beach and Cottages. Projected SLR and recurrent flooding could damage facilities and recreation areas and render these locations unusable in the long-term (DON, 2021).

Significant historic and archaeological resources are present at DON-retained lands of Kalaeloa. As a steward of cultural resources, DON must comply with federal regulations related to those resources (e.g., NRHP and NHL). The presence of cultural resources increases costs associated with staffing, planning, and mitigation of effects to cultural resources at Kalaeloa (DON, 2021).

Long-term homeless encampments are present throughout the Kalaeloa District. The homeless population and unauthorized civilians have been known to trespass, break in, use drugs, and illegally dump at Kalaeloa. Unauthorized access of DON-retained lands at Kalaeloa is a security concern and may lead to additional costs for repairs (e.g., fencing and/or equipment repairs, illegal dumping removal) (DON, 2021).

7.4.16 Climate Considerations

Chapter 3 provided an overview of the climate risks that may impact the study area. Table 7-6 describes specific climate considerations, vulnerabilities, and adaptations for Kalaeloa.

Table 7-6 Kalaeloa Climate Considerations, Vulnerabilities, and Adaptations

INRMP Program Element Impacted by Climate Change (*Species, ecosystem, or program element*)	***Target Natural Resources*** (*Species, Habitat Types, Ecological Systems*)	***Vulnerability*** (*Very High, High, Medium, or Low, and reason for that rating*)	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
1) ESA- and SOH-listed Species	ESA- and SOH-listed Waterbirds: • Hawaiian Stilt (*Himantopus mexicanus knudseni*) • Hawaiian Coot (*Fulica alai*) • Hawaiian Gallinule (*Gallinula chloropus sandvicensis*) • Hawaiian Duck (*Anas wyvilliana*)	*MEDIUM*: Although habitat and food availability will be impacted by climate changes, waterbirds may be able to relocate. *SLR, Severe Storms:* Loss of terrestrial habitat as a result of rising sea levels and associated storm surge is a serious threat to Hawaiian waterbirds. Waterbirds nesting at Ordy Pond are less vulnerable to sea rise and storm surge than coastal sites. *Warmer Temperatures, Diseases*: Warming temperatures could affect waterbird food supply, available breeding habitat, predation (rat, mongoose, cat, etc.) and increase the risk of avian botulism. Botulism is an important cause of mortality in waterbirds, including some endangered species, and climate change may have consequences on the ecology of wetlands that favor the occurrence of botulism outbreaks (USFWS, 2019a, 2019b, 2019c; USFWS, 2018).	Monitor changes in distribution and numbers and protect existing birds. Management Actions described in *Section 7.4.1.* include: Hawaiian waterbird surveys and monitoring. *Table 8-7, Rows 2, 4, and 6* for JBPHH include minimum monthly waterbird surveys and predator control to trap feral cats along Nimitz and White Plains Beaches. Recommendations for DON projects that could impact waterbirds include BMPs to inform personnel of the presence of ESA waterbirds and conduct nest surveys both prior to project initiation and repeat surveys if nests are found.

INRMP Program Element Impacted by Climate Change (*Species, ecosystem, or program element*)	***Target Natural Resources*** (*Species, Habitat Types, Ecological Systems*)	***Vulnerability*** (*Very High, High, Medium, or Low, and reason for that rating*)	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
1) ESA- and SOH-listed Species (continued)	SOH-listed Birds: • White Tern (*Gygis alba*)	*MEDIUM:* Although habitat and food availability will be impacted, MBTA birds may be able to relocate. *Warmer Temperatures*: Warming temperatures could affect their food supply and available breeding habitat.	White terns have been observed flying over the Kalaeloa District. Potentially suitable nesting habitat (e.g., large monkeypod [*Pithecellobium dulce*] trees) is present at the Biosolids Treatment Facility and Barbers Point Golf Course; however, the species is not known to nest there. DON will continue to monitor changes in distribution and numbers and protect existing birds through routine bird surveys. Management Actions described in *Section 7.4.1* include bird surveys. *Table 8-7, Rows 2 and 4* for JBPHH include flora and fauna surveys every 1-5 years. Additionally, white terns are SOH-listed threatened on Oʻahu. If adults/nests/chicks are found and/or flushed out during vegetation clearing operations, contractors must stop work and inform NAVFAC HI Natural Resources Manager of white tern presence which contributes to population survey data.

INRMP Program Element Impacted by Climate Change (*Species, ecosystem, or program element*)	***Target Natural Resources*** (*Species, Habitat Types, Ecological Systems*)	***Vulnerability*** (*Very High, High, Medium, or Low, and reason for that rating*)	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
1) ESA- and SOH-listed Species (continued)	Terrestrial Mammals: • Unconfirmed, Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) Arthropod: Unconfirmed, Hawaiian Yellow-faced Bee (*Hylaeus* spp.)	*MEDIUM:* Although habitat and food availability may be impacted, Hawaiian hoary bat may be able to relocate. *Warmer Temperatures, Change Precipitation:* Hawaiian hoary bat could be threatened by the effects of climate change if less habitat becomes available for foraging, roosting, and pupping; however, there is a general lack of knowledge concerning its distribution, abundance, and habitat needs. While prime habitats include native moist and rain forests up to 6,000 feet (1,830 meters), bats also use native xeric and disturbed habitats as well as wet to moist non-native habitats and urban areas (Bonaccorso, 2010). Changing precipitation and rising temperatures could affect the bat's food availability (moths, beetles, crickets, mosquitoes, and termites). In addition, bats tend to move to higher elevations with cooler temperatures during January through April, potentially because the cooler temperatures allow them to achieve a lower metabolic rate while roosting. *HIGH:* Although habitat and food availability will be impacted, insects may be able to relocate. *SLR, Storm Surge:* A rise in the sea level and storm surge may severely impact Hawaiian yellow-faced bee coastal nesting sites and wetland inundation may adversely impact mature vegetation also used by Hawaiian yellow-faced bee to nest.	Monitor for changes in the distribution and numbers. *Table 8-7, Row 5* for JBPHH include Hawaiian hoary bat acoustic surveys. DON project recommendations include BMPs to prevent clearing trees greater than 15 feet (4.6 meters) in height during the bat pupping season 1 June through 15 September. The presence of Hawaiian yellow-faced bee at Kalaeloa is unconfirmed. *Table 8-8, Row 3* for JBPHH include periodic flora and fauna surveys and coastal restoration to out-plant native pollinator flora.

INRMP Program Element Impacted by Climate Change (*Species, ecosystem, or program element*)	***Target Natural Resources*** (*Species, Habitat Types, Ecological Systems*)	***Vulnerability*** (*Very High, High, Medium, or Low, and reason for that rating*)	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
1) ESA- and SOH-listed Species (continued)	Marine Mammals: • Hawaiian Monk Seal (*Neomonachus schauinslandi*)	*HIGH:* Although habitat and food availability will be impacted, marine mammals may be able to relocate. *Ocean Warming, Acidification, SLR:* Changes in seawater temperature, freshening of seawater, acidification, rises in sea levels, and the decline of food sources are just some of the many risks which climate change poses for marine mammals. Due to oceanic temperature changes alone, numerous marine habitats will drastically change, which will result in the endemic marine mammal species (i.e., whales, seals) to either quickly adapt or move to more habitable environment. Climate change may also affect the health of marine mammals and infectious diseases (i.e., toxoplasmosis, etc.) may emerge and affect marine mammals differently depending upon their habitat (estuarine/inshore versus pelagic). *SLR, Storm Surge:* Loss of terrestrial habitat as a result of rising sea levels and associated storm surge is a serious threat to Hawaiian monk seals. The majority of the seal haul outs at JBPHH have been at the Iroquois Point-Puʻuloa Beach area. In general, the majority of the JBPHH shoreline would remain relatively unattractive due to the lack of preferred sandy beach.	Monitor for changes in the distribution and numbers. Management Actions described *in Section 7.4.1.* include: Marine mammal monitoring. *Table 8-8, Row 8* for JBPHH include annual monk seal monitoring, protection program with BMPs, and predator control to reduce cat populations which are vectors to transmit toxoplasmosis. The DON project recommendations include BMPs to halt work when marine mammals or sea turtles are within 50 yards (46 meters) of the work area (depending on the intensity and duration of work).

INRMP Program Element Impacted by Climate Change (*Species, ecosystem, or program element*)	***Target Natural Resources*** (*Species, Habitat Types, Ecological Systems*)	***Vulnerability*** (*Very High, High, Medium, or Low, and reason for that rating*)	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
1) ESA- and SOH-listed Species (continued)	Marine Reptiles: • Green Sea Turtle (*Chelonia mydas*) (Central North Pacific DPS) • Hawksbill Turtle (*Eretmochelys imbricata*)	*VERY HIGH:* The effects of climate change are likely to be very high for sea turtles because they use both marine and terrestrial habitats during their life cycles. *SLR:* A rise in the sea level will reduce available beach habitat for nesting and basking. *Increased Sand Temperature:* An increase in nesting beach temperatures impact many aspects of turtle embryonic development. Hotter nest temperatures have been linked to a decrease in hatchling fitness and increased occurrence of defects. *Ocean Warming, Acidification:* Warmer ocean temperatures are also likely to negatively impact food resources for sea turtles, and virtually all marine species. Coral reefs, which are an important food source for sea turtles, are at risk from bleaching and acidification that kills off parts of the reef. Warmer ocean temperatures may cause changes in ocean circulation and alter sea turtle movements and possibly shift their range and the timing of their reproductive cycles. *Severe Storms:* Severe storms could increase the chance that sea turtle nests will flood and/or wash out.	Monitor for changes in the distribution and numbers. Management Actions described in *Section 7.4.1* include: Marine surveys of Kalaeloa. *Table 8-8, Rows 10 and 11* for JBPHH include marine resources and fisheries survey. The DON project recommendations include BMPs to halt work when marine mammals or sea turtles are within 50 yards (46 meters) of the work area (depending on the intensity and duration of work).
2) Wetlands Management	Wetlands that support diverse flora and fauna assemblages (Concurrently protects ESA-listed waterbirds [discussed above] and federal CWA-regulated wetland ecosystems).	*HIGH:* The direct impacts of *rising temperatures (including ocean acidification), changing precipitation patterns, extreme weather events and SLR* may increase chronic flooding,	DON-retained lands at Kalaeloa contain marine wetlands along Nimitz Beach and White Plains Beach which are susceptible to SLR.

INRMP Program Element Impacted by Climate Change (*Species, ecosystem, or program element*)	***Target Natural Resources*** (*Species, Habitat Types, Ecological Systems*)	***Vulnerability*** (*Very High, High, Medium, or Low, and reason for that rating*)	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
2) Wetlands Management (continued)		sediment/pollutant runoff, beach/shoreline erosion and high wave impacts. *Rising sea levels* may lead to inundation and loss of coastal wetlands and contribute to elevated coastal storm surges. In some instances, water inundation may create new wetlands. Collectively these climate changes may have significant impacts on ecologically productive wetlands and dune habitats that support diverse flora and fauna ecosystems.	The JBPHH Natural Resources Manager ensures that there is no net loss of wetlands on DON-controlled lands, while simultaneously establishing and/or enhancing native wetland species and reducing alien wetland species. The DON conserves and protects the marine wetlands located at Nimitz and White Plains Beaches.
3) MBTA Bird Management	Kalaeloa is home to a diversity of MBTA-protected birds and bird habitats.	*MEDIUM*: *Rising temperatures and changing precipitation patterns* may increase the growth of certain bird populations from longer breeding seasons and changes in habitat and cause shifts in the distribution and abundance of bird species. Warmer temperatures may favor the occurrence of botulism outbreaks in waterfowl and shorebirds which may impact migrating waterfowl and shorebirds (e.g., plovers, turnstones, tattlers, etc.). *Severe Storms* may increase the number of wedge-tailed shearwater fallouts.	JBPHH INRMP management actions are to protect MBTA-protected birds. The DoD MBTA position is that incidental/unintentional take of migratory birds is still prohibited. While there is no specific INRMP MBTA project, the INRMP programs/projects for wetland restoration and predator control also benefit MBTA birds. *Table 8-7, Rows 4 and 6* for JBPHH include periodic flora and fauna surveys. DON project recommendations include BMPs to verify that trees or bushes scheduled for removal do not contain the active nests of migratory birds.

INRMP Program Element Impacted by Climate Change (*Species, ecosystem, or program element*)	***Target Natural Resources*** (*Species, Habitat Types, Ecological Systems*)	***Vulnerability*** (*Very High, High, Medium, or Low, and reason for that rating*)	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
4) Invasive Species (IS) Management	Flora • Long-thorn Kiawe (*Prosopis juliflora*) Fauna: • Feral Cat (*Felis catus*) • Mongoose (*Herpestes javanicus*) • Rodents	*HIGH:* Climate change and IS rank among the largest predicted threats to global ecosystems over the next century. Climate-related impacts often operate through amplifying the impact of existing stressors, such as IS. IS are, by nature, highly flexible, and respond to unusual environments more quickly than do natives. Changing rainfall patterns may increase the spread of IS. Climate change may increase available food for IS pigs, feral cats, mice, rats, and mongoose.	Management Actions described in *Section 7.4.2* include decontamination (cleaning) of all vehicles, equipment, personal gear, shoes, and clothing before personnel may enter a training area at JBPHH in order to minimize the introduction of IS to Kalaeloa and other DON lands. *Table 8-7, Rows 1, 26, and 28* for JBPHH include predator control, invasive species biosecurity, reduce/prevent release AIS, early detection roadside surveys, and predator control.
5) BASH	Airfield Vicinity: • Near Ocean Surface (Pelagic, seabirds, petrels, shearwaters, tropicbirds, etc.) • Drainage Ditches and Standing Water (Waterbirds, waterfowl, shorebirds, herons, stilts, cattle egrets, etc.) • Turf, Tree, and Bush Habitat Birds (Gamebirds, pigeons, doves, owl, passerines, etc.)	*LOW:* There are no airfields at the Kalaeloa site.	N/A: There are no airfields at the Kalaeloa study area.

INRMP Program Element Impacted by Climate Change (*Species, ecosystem, or program element*)	***Target Natural Resources*** (*Species, Habitat Types, Ecological Systems*)	***Vulnerability*** (*Very High, High, Medium, or Low, and reason for that rating*)	***INRMP Climate Adaptation Risk Reduction Strategies*** *(Current & Future INRMP Management Programs, Plans, Projects and BMPs to benefit natural systems and reduce negative effects)*
6) Wildland Fire Management	Wildfire poses a risk to dry ecosystem habitats (i.e., grassland and coastal mesic forest, etc.), personnel, facilities, and other infrastructure.	LOW: The rate of warming air temperature has increased in Hawaiʻi in recent decades which increases the risk of wildfires during drought occurrences. Wildland fire risks are low at JBPHH based on historical records.	Wildland fires have impacted unused and/or undeveloped portions of Kalaeloa in recent years; the FFD in coordination with the HFD responds to any fires at DON-retained lands. In case of fire during troop training exercises, all fires will be reported to the FFD and troops will stop training and begin to fight the fire. Troops will continue to fight the fire until released by the fire department. *Table 8-8, Row 36* provides recommendations for JBPHH to include coordination with the FFD and HFD and to establish a WFMP.

Notes: BASH = Bird/Wildlife Aircraft Strike Hazard; CWA = Clean Water Act; NCN=No Common Name; DPS = distinct population segment; E=ESA-listed Endangered; FFD= Federal Fire Department; HFD = Honolulu Fire Department; IS = Invasive Species; JBPHH = Joint Base Pearl Harbor-Hickam; MBTA = Migratory Bird Treaty Act; SLR = Sea Level Rise; SOH= State of Hawaiʻi-listed; CH=Critical Habitat; SOC=Species of Concern; WFMP = Wildland Fire Management Plan.

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8 Planning, Integration, and Implementation

8.1 Introduction

This chapter summarizes the planning, funding, staffing, coordination, and documentation associated with the INRMP implementation for JBPHH and the land and nearshore areas it owns, leases, or controls. Details about the JBPHH-administered and Leased Terrestrial and Submerged Lands are provided in Table 1-1 of Chapter 1 (Overview) of this INRMP, and includes:

- JBPHH Main Base and Surrounding Areas (e.g., Pearl Harbor Shipyard, Intermediate Maintenance Facility, and former Hickam AFB)
- JBPHH Lualualei Annex (NAVMAG PH Lualualei and NRTF Lualualei)
- JBPHH Wahiawa Annex (NCTAMS PAC Wahiawa, Camp Stover, and Opana Radar Site)
- JBPHH Kalaeloa

As described in Chapter 1 of this INRMP, the Sikes Act is the overarching legislation mandating the preparation and implementation of INRMPs for DoD installations. DoDI 4715.03 (2018) and DoD Manual 4715.03 (2013) require that current and planned installation activities (e.g., development plans, construction requests, site approval requests, host-tenant agreements, and outleases) are effectively coordinated and consistent with activities described in this INRMP. It also requires DoD components to ensure that their INRMPs provide for no net loss in the capability of installation lands to support the military mission, pursuant to Section 670a(b)(1)(I) of the Sikes Act (as amended), to the extent appropriate, applicable, and consistent with the installation's use. Relevant U.S. DON guidance includes:

- October 2002 SECNAV Memorandum on Sikes Act Improvement Amendments
- OPNAV M 5090.1
- April 2006 Integrated Natural Resources Management Plan Guidance for Navy Installations

Additional guidance includes:

- Marine Corps Order P5090.2A
- Air Force Instruction 32-7064
- Army Regulation 200-1, USFWS INRMP guidance
- 2013 Memorandum of Understanding Between the U.S. Department of Defense and the U.S. Fish and Wildlife Service and the Association of Fish and Wildlife Agencies for a Cooperative Integrated Natural Resource Management Program on Military Installations
- July 20, 2015, Mutual Department of Defense & U.S. Fish and Wildlife Service Guidelines for Streamlined Review of Integrated Natural Resources Management Plan Updates, a memorandum from the USFWS to DON, Army, and USAF.

Per the Sikes Act, an INRMP is considered implemented if an installation:

- actively requests, receives, and funds "Must Fund" management projects and activities (see Section 8.7.1, Programmatic Management)
- ensures that sufficient numbers of professionally trained natural resources management staff are available to perform the tasks required by the INRMP
- coordinates annually with all cooperating offices

- documents specific INRMP action accomplishments undertaken each year

This chapter establishes the requirements for maintaining the health and long-term ecological integrity of the environment while ensuring the continued availability of the land, air, and sea space necessary for the readiness of the operating forces and the shore support of the DON (DON, 2021). JBPHH depends on natural resources for the sustainability of many mission-related programs (e.g., operations, recreation for military personnel, drinking water, stormwater collection and conveyance, etc.). JBPHH will manage these natural resources to support INRMP goals and objectives, incorporate sustainable practices, and apply ecosystem management principles.

8.2 Implementation

8.2.1 Climate Change Vulnerability Tables

Chapter 3 of the INRMP provided an overview of the climate risks that may impact JBPHH. Climate consideration, vulnerability, and adaptation tables were developed for each of the INRMP Study Areas (JBPHH Main Base and Surrounding Areas, JBPHH Lualualei Annex, JBPHH Wahiawa Annex, and JBPHH Kalaeloa) at the end of Chapters 4, 5, 6, and 7, respectively. A unique identifier was used in those tables to tie them to the actual project descriptions and funding, which are shown in detail in Chapter 8, Tables 8-7 and 8-8.

8.2.2 Goals and Objectives

As described in Section 1.9 of the INRMP, the following goals and objectives have been developed for the JBPHH INRMP. A unique classification code is assigned in Table 8-1 to show which INRMP goals and objectives are achieved by ongoing and future planned projects.

Table 8-1 JBPHH Goals and Objectives

Goals	*Objectives*	*Code*
I. The primary goal of the INRMP is to support and sustain the military mission of JBPHH while managing, protecting, and enhancing biological diversity and ecosystem integrity of military lands and waters and all associated threatened and endangered species and their habitats.	a. Integrate climate change considerations like sea level rise, temperature variations, and changes in precipitation into adaptive management strategies, missions, and operations to ensure long-term sustainability of marine and terrestrial ecosystems.	I. a
	b. Develop and encourage coordination, communication, outreach, and partnerships between JBPHH, Government Agencies, and other stakeholders, including but not limited to researchers, educational institutions, Native Hawaiian Organizations, citizen science projects, non-governmental organizations, and volunteer groups through collaborative projects.	I. b
II. Apply ecosystem-based adaptive management strategies to ensure the long-term health, restoration, protection, and recovery of marine and terrestrial natural resources and biodiversity.	c. Maintain and update inventories of marine and terrestrial ecosystems and resources.	II. c
	d. Manage, maintain, and enhance native habitats and ecosystems, prioritizing areas where threatened and endangered species are known to be present.	II. d
	e. Provide a conservation benefit for threatened and endangered species.	II. e

Goals	*Objectives*	*Code*
	f. Control, eradicate, and/or prevent the establishment of invasive species.	II. f
III. Ensure the management, conservation, recreation, and protection of natural resources is meeting or exceeding regulatory requirements through enforcement and outreach.	g. Promote and enhance opportunities for engagement in natural resources management-related activities.	III. g
	h. Assess and monitor recreational activities and their potential impact on natural resources.	III. h
	i. Improve communication, education, and enforcement of conservation laws and regulations.	III. i

Notes: INRMP = Integrated Natural Resources Management Plan; JBPHH = Joint Base Pearl Harbor-Hickam.

8.2.3 Funding and Prioritization of INRMP Projects

INRMP-related projects are defined in the Navy's Environmental Portal, Environmental Program Requirement web (EPR-Web) database, and prioritized through the DoDI 4715.03, *Natural Resources Conservation Program*'s Environmental Readiness Levels (ERLs), policies, and legislation. Funding for projects comes from multiple sources. Each project supports operations and trainings on JBPHH, various ecosystems, and threatened and endangered species in line with the goals and objectives in the INRMP. These appropriated funds are the primary source of resources to support program elements such as DON ERL 3 and 4 projects (Table 8-2). DON policy requires funding of all "Must Fund" projects, which DON INRMP guidance identifies as ERL 4 projects.

8.2.3.1 Environmental Program Requirements

The EPR-Web is an online database located on DON's Environmental Portal that is used to define all programming for the DON environmental requirements. EPR-Web tracks project expenditures and provides immediate, web-based access to requirements entered for multiple DON environmental programs, including environmental compliance, pollution prevention, conservation, radiological controls, and range sustainment as related to environmental costs on military installations. In some cases, DON projects may be funded by other agency sources, such as the U.S. Marine Corps, in which case those projects are financially processed outside of the DON and not tracked in the EPR-Web. It is the DON's policy to fund compliance with all applicable federal, territorial, and commonwealth laws, EOs and associated implementation rules, regulations, and DoD instructions and directives. All natural resources requirements are entered into the EPR-Web and are available for review/approval by the chain of command by the dates specified in the Guidance Letter that is provided annually by Chief of Naval Operations (CNO) (N45). This database is the source for determining all programming and budgeting requirements of the Environmental Program. EPR-Web is also the tool used to document the four ERL capabilities, which are used in determining programming and budgeting requirements for the review processes within the budget planning system.

8.2.3.2 Environmental Readiness Levels

DON's budget programming hierarchy for this INRMP is based on both DoD and DON funding level classifications. The four programming and budgeting priority ERLs detailed in DoDI 4715.03, *Natural Resources Conservation Program*, implement policy, assign responsibilities, and prescribe procedures for the integrated management of natural and cultural resources on property under DoD control. Budget priorities are also described in OPNAV M-5090.1. The four DON ERLs (Table 8-2) enable capability-based programming and budgeting of environmental funding to facilitate capability versus cost trade-off decisions. ERL 4 is the absolute minimum level of environmental readiness capability required to maintain compliance with applicable legal requirements. Budget priorities for threatened and endangered species management, especially compliance with applicable Biological Opinions, receive the highest possible budgeting priority, and supports the need for JBPHH to comply with EO 13089 and avoid EFH Conservation Recommendations under MSFCMA and Critical Habitat designations under Section 4(b)(2) of the ESA, or ESA 4(a)(3)(B)(i) (exclusions from Critical Habitat designations).

Table 8-2 Environmental Readiness Levels

Environmental Readiness Level	*Supported Capabilities*
ERL 4 "Must Fund" is the absolute minimum requirement to achieve compliance and has the highest funding priority. ERL 4 is for legal requirements derived from existing laws, regulations, EOs, Final Governing Standards, or the Overseas Environmental Baseline Guidance Document, as applicable; and applies to DON activities, platforms, and operations. It supports all actions and projects specifically required by law, regulation, or EO.	• Supports all DoD Class 0 requirements as they relate to a specific statute, such as hazardous waste disposal, permits, fees, monitoring, sampling and analysis, reporting, and record keeping.
	• Supports recurring administrative, personnel, and other costs associated with managing environmental programs that are necessary to meet applicable compliance requirements.
	• Supports minimum feasible DON executive agent responsibilities, participation in OSD sponsored inter-department and interagency efforts, and OSD mandated regional coordination efforts.
ERL 3 is for requirements derived from DoD policy and DON policy, or proactive initiatives that could enable future compliance or result in a positive return on DON investments. They could also support critical readiness activities by decreasing encumbrances of statutory compliance requirements. These efforts are not mandated by law or other federal, state, or local requirements but would minimize current or future impacts (including costs) to the DON mission.	• Supports all capabilities provided by ERL 4.
	• Supports existing level of DON executive agent responsibilities, participation in OSD sponsored inter-department and interagency efforts, and OSD mandated regional coordination efforts.
	• Supports proactive involvement in the legislative and regulatory process to identify and mitigate requirements that will impose excessive costs or restrictions on operations and training.
	• Supports proactive initiatives critical to the protection of DON operational readiness.
ERL 2 is for requirements derived from pending federal, state, or local legal requirements, laws, regulations, or EOs that could enable future compliance but result in less certain returns on investments and uncertain benefits to the DON's mission. These project efforts are not mandated by existing law or other federal, state, or local requirements. Funding requirements should be based on best available scientific or commercial data; or on pending federal, state, or local regulations under development (where publication is scheduled) using model state regulations or permit standards, if available.	• Supports all capabilities provided under ERL 3.
	• Supports enhanced proactive initiatives critical to the protection of DON operational readiness.
	• Supports all DON and DoD policy requirements.
	• Supports investments in pollution reduction, compliance enhancement, energy conservation, and cost reduction.

Environmental Readiness Level	*Supported Capabilities*
ERL 1 is for investments in environmental leadership and general proactive environmental stewardship.	• Supports all capabilities provided under ERL 2.
	• Supports proactive actions and projects required to ensure compliance with pending/strong anticipated laws and regulations in a timely manner and/or to prevent adverse impact to DON mission.
	• Supports investments that demonstrate DON environmental leadership and proactive environmental stewardship.

Notes: DoD = Department of Defense; DON = Department of the Navy; EO = Executive Order; ERL = Environmental Readiness Level; OSD = Office of the Secretary of Defense.

Pursuant to the Sikes Act, the natural resources conservation program for each installation with an INRMP is to identify all requirements (management projects) based on the goals and objectives of the INRMP no matter the ERL level. Once requirements are identified through the funding process, they are reviewed by the chain of command for accuracy and appropriateness. Appropriate requirements are approved, but some may not be funded due to DON-wide funding controls (or availability). All requirements are further prioritized based on funding levels authorized/appropriated by Congress, the degree to which they ensure “no net loss in the capability of installation lands to support the military mission of the installation,” and DON risk prioritization. The ERL ranking does not guarantee funding; however, JBPHH is unique in that the program receives funding from multiple DoD sources. In addition, JBPHH works to implement the natural resources conservation program through coordination with other partners. Finally, annual feedback and coordination allow for partner feedback to assist with management project prioritization through the Annual Metrics and JBPHH’s enhanced coordination process outlined in Section 8.2.6.4, *Resource Partners*.

8.2.3.3 Funding Sources

In addition to the EPR-based funding as noted in Section 8.2.3, other sources of funding that support the conservation program include funding from facilities maintenance and housing to address pest management issues; Military Construction (MILCON) funding; and Research and Development, Testing, and Evaluation funding. AG Outlease Program funds and Forestry Reserve Account funds are two other sources available to support conservation program requirements.

DoD programs that provide limited competitive funding opportunities for conservation program initiatives include the Legacy Resource Management Program (Legacy), Living Marine Resources Program, Strategic Environmental Research and Development Program, Environmental Security Technology Certification Program, and the DON Environmental Sustainability Development to Integration Program. The U.S. Marine Corps and USAF also provide other sources of funding. The Readiness and Environmental Protection Integration Program is an alternative funding tool administered by the Office of the Secretary of Defense (OSD) that leverages public and private funds to alleviate encroachment that can limit or restrict military training, testing, and operations. In addition to DoD funding sources to implement natural resources projects on JBPHH-administered lands, federal partner agencies (such as the USDA-Animal and Plant Health Inspection Service, the USGS Fort Collins Science Center, NMFS, etc.) implement projects on JBPHH-administered lands with agency allocated funds or grants that align with INRMP management objectives.

8.2.3.4 Reference and Drivers

As discussed in Section 1.2 of the INRMP, one of the functions of the INRMP is to provide guidance on how JBPHH is to comply with regulatory and planning processes, such as those required by the NEPA (42 U.S.C. 4321-4370h), ESA, CWA (33 U.S.C. 1251 et seq.), MSFCMA, and DoD and DON policies and legal requirements. The legal requirements that pertain to this INRMP are summarized in Section 1.6 of the INRMP. Appendix B of the INRMP also provides the complete list of relevant environmental laws, regulations, policies, guidance, instructions, and EOs that guided the preparation of this INRMP. Table 8-3 provides a selection of those legal drivers, with acronyms, which are used to help prioritize project implementation.

Table 8-3 Key Project Prioritization References and Drivers

Instruction	*Acronym*
Addendum to the Integrated Natural Resources Management Plan, June 2012	Addendum 2012
Animal Damage Control Act of 1931	ADCA
Brown Tree Snake Control and Eradication Act of 2004	BTSA
Clean Water Act	CWA
Coastal Zone Management Act	CZMA
Conservation Programs on Military Installations (Sikes Act)	Sikes
Coral Reef Conservation Act	CRCA
DoD Instruction and Manual 4715.3	DoDI 4715.3
DoD Instruction 5525.ee Conservation Law Enforcement Program	DoDI 5525.ee
Endangered Species Act	ESA
Executive Order 11990, Wetlands Protection	EO 11990
Executive Order 13089, Coral Reef	EO 13089
Executive Order 13148, Environmental Management	EO 13148
Executive Order 13186 Migratory Birds	EO 13186
Executive Orders 13751/13112, Invasive Species	EO 13751/13112
Executive Order 13443 Facilitation of Hunting Heritage and Wildlife	EO 13443
Fish and Wildlife Conservation Act	FWCA
Migratory Bird Treaty Act	MBTA
Magnuson-Stevens Fishery Conservation and Management Act	MSFCMA
Marine Mammal Protection Act	MMPA
Military Readiness Rule	MRR
National Invasive Species Act	NISA4713
National Environmental Policy Act	NEPA
OPNAV Instruction 5090.1	OPNAV 5090.1
Plant Protect Act	PPA7701
Sikes Act	16 U.S.C. 670a-670f
Soil and Water Conservation Act	SWCA590A
2012 Formal Section 7 Consultation on Endangered Waterbird Air Strike Hazard Interaction at Hickam Air Force Base, Oahu	2012 Hickam BO
2020 Formal Section 7 Consultation on the Hawaiian Hoary Bat at JBPHH West Loch Annex, Oahu	2020 West Loch BO
2021 Formal Section 7 Consultation on West Loch Oxidation Pond Operations and Maintenance, Joint Base Pearl Harbor-Hickam, Oahu, August 2021	2021 Oxidation Pond BO

Mission Supported

In accordance with DoDI 4715.03 (2018), the INRMP provides for no net loss in the capability of installation lands to support the military mission, pursuant to section 670a(b)(1)(I) of the Sikes Act. Accordingly, the INRMP is designed to be integrated in a way that supports the primary mission of operations and training at JBPHH. Key areas of operations and training at JBPHH are listed in Table 8-4.

Table 8-4 JBPHH Operation and Training Types

Title	*Short Name*	*Description*
Aircraft Ops	Air Ops	Military mission activities that include operation and maintenance of all types of fixed wing and rotary aircraft.
Amphibious Ops	Amphib Ops	Military mission activities that involve special training and equipment for conducting landings from naval vessels, watercraft, and other special vehicles to the shore.
Communications (C4)	Comm	Those military activities that include telecommunications, radio transmissions, computer equipment, signal relays, satellite ground stations, and other forms of military communications.
Education & Training	E&T	This includes facilities and associated activities that involve military training in the operation and maintenance of weaponry and other military issued technical equipment, battlefield planning, military leadership, seamanship, and combat tactics.
Ground-Based Ops	Ground Ops	Military mission activities that involve training personnel and mobile equipment for conducting land-based operations in a wide variety of environments.
Helicopter Ops	Helo Ops	Activities associated with rotary wing aircraft. Such as: landings, take-offs, hovering, dropping off cargo/personnel, picking up cargo/personnel, fast lining, or other helicopter operations. This includes hybrid wing aircraft such as V-22 Osprey.
Homeport/Shipyard Ops	Shore Ops	The permanent location of active-duty units which may include ships, submarines, or other sea-going vessels. A land facility designated for reception of personnel or material moved by sea, and that serves as an authorized port of entrance into or departure from the country in which located.
Logistics	Log	Military activities that include the planning and carrying out of movement, storage, and maintenance of military forces equipment and associated hardware and platforms including supplies such as fuel and ammunitions.
Military Construction	MILCON	A base that supports the construction, alteration, development, demolition, conversion, or extension of any kind carried out with respect to a military installation.
Military Housing	Housing	Land areas and structures developed for the housing, health and welfare of military personnel and their families. This includes support centers and facilities for the morale, welfare, and recreation of military personnel.
Ordnance Ops	Ord Ops	Military mission activities that involve the storage or transfer of explosives, chemicals, pyrotechnics, and similar stores, e.g., bombs, guns and ammunition, flares, smoke, or other chemicals.

Title	*Short Name*	*Description*
Research & Development	R&D	When installation activities support military efforts directed toward increased knowledge of natural phenomena and environment and toward the solution of problems in all fields of engineering and science. This includes basic and applied research in a wide variety of subject matter.
Special Forces	Spec Ops	An installation or site mission that supports the unconventional warfare capabilities of Special Forces and any command, control, and support base established and operated by any Special Forces or tactical group or specialized battalion from organic and attached resources.
Submarine Ops	Sub Ops	An installation or site established for the support of submarine operations, servicing, and maintenance.

Notes: Air = Aircraft; Amphib = Amphibious; Comms = Communications; E&T = Education & Training; Helo = Helicopter; MILCON = Military Construction; Ops = Operations; Ord = Ordnance; R&D = Research & Development; Spec = Special; Sub = Submarine.

8.2.3.5 Ecosystem Supported

The INRMP is designed to be integrated in a way that supports the terrestrial and marine ecosystems present at JBPHH. Terrestrial and marine ecosystems at JBPHH are listed in Table 8-5.

Table 8-5 JBPHH Terrestrial and Marine Ecosystems

Terrestrial Ecosystem	*Acronym*
Scrub-Shrub Wetland	SSW
Hawaiian Riparian Forest & Shrubland	HRF
Hawaiʻi Lowland Mesic Forest	HLF
Hawaiʻi Lowland Dry Shrubland	HLS
Unconsolidated substrate	USB
Marine Ecosystem	***Acronym***
Coral Reef Substrate	CRS
Faunal Reef	FRF
Estuarine Shallow Water	ESW
Marine Nearshore	MNS
Pelagic	PEL

Note: Ecosystem classifications are derived from NatureServe 2003 and augmented by NatureServe 2021.

8.2.3.6 Federally and State Protected Species and Species of Concern

Federal and state ESA-listed threatened and endangered species known to occur on the JBPHH-administered lands or submerged lands are provided for each of the INRMP Study Areas (JBPHH Main Base and Surrounding Areas, JBPHH Lualualei Annex, JBPHH Wahiawa Annex, and JBPHH Kalaeloa) in Chapters 4, 5, 6, and 7, respectively. Table 8-6 combines those tables from the individual INRMP Study Areas to provide a master list of all Federal and state ESA-listed threatened and endangered species known to occur on the JBPHH-administered lands or submerged lands. Of the 108 species listed in the table below, 30 federally endangered species are confirmed to occur on JBPHH.

Table 8-6 Federal and State ESA-Species with Potential to Occur at JBPHH

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*JBPHH Occurrence*
Arthropod Species				
Drosophila montgomeryi; and other *Drosophila* spp.	Hawaiian Picture-wing Flies	-	FE	Potential
Hylaeus anthracinus and other spp.	Hawaiian Yellow-faced Bees	Nalo Meli Maoli	FE	Potential
Megalagrion xanthomelas	Orangeblack Hawaiian Damselfly	-	FE	Potential
Bird Species				
Anas wyvilliana	Hawaiian Duck	Koloa maoli	FE, SE, MBTA	Potential
Asio flammeus sandwichensis	Hawaiian Short-eared Owl	Pueo	SE	Confirmed
Branta sandvicensis	Hawaiian Goose	Nēnē	FE, SE, MBTA	Potential
Chasiempis ibidis	Oʻahu ʻElepaio	Oʻahu ʻElepaio	FE, SE, CH	Potential
Chlorodrepanis flava	Oʻahu Amakihi	O'ahu Amakihi	SC	Potential
Drepanis coccinea	Scarlet Honeycreeper	ʻIʻiwi	FT, SE (Oʻahu, Molokaʻi, and Lānaʻi populations)	Potential
Fulica alai	Hawaiian Coot	ʻAlae keʻokeʻo	FE, SE, MBTA	Confirmed
Gallinula chloropus sandvicensis	Hawaiian Gallinule	ʻAlae ʻula	FE, SE	Confirmed
Gygis alba	White Tern	Manu-o-kū	SE, MBTA	Confirmed
Himantopus mexicanus knudseni	Hawaiian Stilt	Aeʻo	FE, SE	Confirmed
Himatione sanguinea	ʻApapane	ʻApapane	SC	Potential
Oceanodroma castro	Band-rumped Storm Petrel	ʻAkēʻakē	FE, SE	Potential
Pterodroma sandwichensis	Hawaiian Petrel	ʻUaʻu	FE, SE, MBTA	Potential
Puffinus newelli	Newell's Shearwater	ʻAʻo	FT, ST, MBTA	Potential
Coral Species				
Cyphastrea ocellina	Ocellated Coral	-	SGCN	Confirmed
Coral Species (continued)				
Leptastrea bewickensis	-	-	SGCN	Within 5 miles nearshore waters
Leptastrea purpurea	Crust Coral	-	SGCN	Confirmed
Leptoseris incrustans	Swelling Coral	-	SGCN	Confirmed
Montipora capitata	Rice Coral	-	SGCN	Confirmed
Montipora dilatata	Hawaiian Reef Coral	-	SGCN, RT	Confirmed
Montipora flabellata	Blue Rice Coral	-	SGCN, RT	Confirmed
Montipora patula	Spreading Coral	-	SGCN	Confirmed

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*JBPHH Occurrence*
Montipora tuberculosa	-	-	SGCN	Within 5 miles nearshore waters
Montipora turgescens	-	-	SGCN, RT	Confirmed
Montipora verrilli	-	-	SGCN	Within 5 miles nearshore waters
Pavona duerdeni	Flat Lobe Coral	-	SGCN	Confirmed
Pavona varians	Corrugated Coral	-	SGCN	Confirmed
Pocillopora damicornis	Lace Coral	-	SGCN	Confirmed
Pocillopora ligulata	-	-	SGCN	Within 5 miles nearshore waters
Pocillopora meandrina	Cauliflower Coral	-	SGCN, RT	Confirmed
Pocillopora verrucosa	-	-	SGCN	Confirmed
Porites compressa	Finger Coral	-	SGCN	Confirmed
Porites evermanni	Evermann's Coral	-	SGCN	Confirmed
Porites lobata	Lobe Coral	-	SGCN	Confirmed
Psammocora nierstraszi	-	-	SGCN	Within 5 miles nearshore waters
Fish Species				
Atherinomorus insularum	Hawaiian Silverside	ʻIao	SGCN	Confirmed
Caranx ignobilis	Giant Trevally	ʻUlua Aukea	SGCN	Confirmed
Fish Species (continued)				
Carcharhinus longimanus	Oceanic Whitetip Shark	-	FT	Within 5 miles nearshore waters
Chlorurus perspicillatus	Spectacled Parrotfish	Uhu Uliuli, Uhu ʻAhuʻula	SGCN	Confirmed
Coris venusta	Elegant Coris	Hinālea	SGCN	Confirmed
Elops hawaiensis	Hawaiian Tenpounder	Kōkala	SGCN	Confirmed
Encrasicholina purpurea	Hawaiian Anchovy	Nehu	SGCN	Confirmed
Hippocampus kuda	Smooth Seahorse	-	SGCN	Confirmed
Kuhlia xenura	Hawaiian Flagtail	Āholehole	SGCN	Confirmed

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*JBPHH Occurrence*
Manta birostris	Giant Manta Ray	Hāhālua	FT	Within 5 miles nearshore waters
Oxyurichthys lonchotus	Goby	Oʻopu	SGCN	Confirmed
Parupeneus porphyreus	Whitesaddle Goatfish	Kūmū	SGCN	Confirmed
Marine Mammal Species				
Balaenoptera borealis	Sei Whale	-	FE, SGCN	Within 5 miles nearshore waters
Balaenoptera musculus	Blue Whale	Koholā Polū	FE, SGCN	Within 5 miles nearshore waters
Balaenoptera physalus	Fin Whale	-	FE, SE, SGCN	Within 5 miles nearshore waters
Megaptera novaeangliae	Humpback Whale	koholā	SE, SGCN, MMPA	Confirmed
Neomonachus schauinslandi	Hawaiian Monk Seal	Īlioholoikauaua	FE, SE, SGCN, MMPA	Confirmed
Physeter macrocephalus	Sperm Whale	Palaoa, Koholā Kēpama	FE, SE SGCN, MMPA	Within 5 miles nearshore waters
Marine Mammal Species (continued)				
Pseudorca crassidens	Main Hawaiian Islands Insular False Killer Whale DPS	-	FE, SE, SGCN	Confirmed
Stenella longirostris	Spinner Dolphin	Naia	SGCN, MMPA	Confirmed
Non-Coral Invertebrates				
Nerita picea	Black Nerite	Pipipi Kai	SGCN	Confirmed
Octopus cyanea	Octopus	Heʻe Mauli	SGCN	Within 5 miles nearshore waters
Pinctada margaritifera	Black-lipped Pearl Oyster	-	SGCN	Confirmed
Plants				
Abutilon menziesii	-	Koʻoloaʻula	FE, SE	Confirmed
Abutilon sandwicense	-	-	FE, SE	Confirmed
Alectryon macrococcus var. *macrococcus*	Hawaiʻi Alectryon	Māhoe	FE, SE	Confirmed
Asplenium dielfalcatum	Sickle Island Spleenwort	-	FE, SE	Potential

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*JBPHH Occurrence*
Asplenium unisorum	Singlesorus Island Spleenwort	-	FE, SE	Confirmed
Bobea sandwicensis	Hawaiʻi dogweed	Ahakea	SSC	Potential
Bonamia menziesii	Hawaiʻi lady's nightcap	-	FE, SE	Confirmed
Cenchrus agrimonioides var. *agrimonioides*		Kamanomano	FE, SE	Offsite, within 5 miles
Chrysodracon forbesii	-	Hala Pepe	FE, SE	Confirmed
Cyanea calycina	Waiʻanae Range Rollandia	Hāhā	FE, SE	Potential
Cyanea grimesiana ssp. *obatae*	Splitleaf Cyanea	Haha	FE, SE	Offsite, within 5 miles
Cyanea membranacea	Papery Cyanea	Hāhā	SSC	Potential
Cyanea pinnatifida	Sharktail Cyanea	Haha	FE, SE	Offsite, within 5 miles
Cyanea superba ssp. *Superba*	Mt. Kaʻala Cyanea	-	FE, SE	Offsite, within 5 miles
Cyperus trachysanthos	Sticky Flatsedge	Puʻukaʻa	FE, SE	Confirmed
Plants (continued)				
Delissea waianaeensis	-	-	FE, SE	Offsite, within 5 miles
Dissochondrus biflorus	False Bristlegrass	-	SSC	Potential
Dracaena forbesii	Waianae Range Hala Pepe	Hala Pepe	FE, SE	Offsite, within 5 miles
Dubautia sherffiana	-	-	SSC	Potential
Euphorbia herbstii	-	-	FE, SE	Offsite, within 5 miles
Euphorbia kuwaleana	-	Kōkōmālei, ʻAkoko	FE, SE	Confirmed
Exocarpos gaudichaudii	-	-	SC	Offsite, within 5 miles
Flueggea neowawraea	Mēhamehame	Mēhamehame	FE, SE	Confirmed
Gardenia brighamii	Hawaiian Gardenia	Naʻu	FE, SE	Offsite, within 5 miles
Gardenia mannii	Oahu Gardenia	Nanu	FE, SE	Offsite, within 5 miles

Scientific Name	*Common Name*	*Hawaiian Name*	*Regulatory Status**	*JBPHH Occurrence*
Hesperomannia arbuscula	Maui Island-Aster	-	FE, SE	Offsite, within 5 miles
Hibiscus brackenridgei mokuleianus	Mokulei Rosemallow	-	FE, SE	Offsite, within 5 miles
Joinvillea ascendens ssp. *ascendens*	-	ʻOhe	FE, SE	Potential
Kadua parvula	-	-	FE, SE	Confirmed
Labordia kaalae	-	Kāmakahala	SSC	Confirmed
Lepidium arbuscula	Waiʻanae Range Pepperwort	ʻĀnaunau, Naunau, Kūnānā	FE, SE	Confirmed
Lipochaeta lobata var. *leptophylla*	-	Nehe	FE, SE	Confirmed
Lobelia niihauensis	-	ʻŌhā, Hāhā, ʻ Ōhā wai	FE, SE	Confirmed
Lobelia yuccoides	-	Pānaunau	SSC	Confirmed
Marsilea villosa	Villous Waterclover	ʻIhi, ʻIhi lāʻau	FE, SE	Confirmed
Melanthera tenuis	-	Nehe	SSC	Confirmed
Plants (continued)				
Melicope christophersenii	Waiʻanae Range Melicope	Alani	FE, SE	Confirmed
Melicope (Platydesma) cornuta var. *decurrens*	-	-	FE, SE	Confirmed
Melicope pallida	Pale Melicope	Alani	FE, SE	Offsite, within 5 miles
Melicope saint-johnii	St. John's Melicope	Alani	FE, SE	Offsite, within 5 miles
Neraudia angulata var. *angulata*	-	Maʻaloa, ʻOloa	FE, SE	Confirmed
Neraudia melastomifolia	Angularfruit Maoloa	Maʻaloa, ʻOloa	SSC	Confirmed
Nototrichium humile	Kaʻala Rockwort	Kuluʻī	FE, SE	Confirmed
Phyllostegia hirsuta	Molokai Phyllostegia	-	FE, SE	Offsite, within 5 miles
Phyllostegia kaalaensis	Kaala Phyllostegia	-	FE, SE	Offsite, within 5 miles
Phyllostegia mollis	Waianae Range Phyllostegia	-	FE, SE	Offsite, within 5 miles
Plantago princeps var. *princeps*	-	Ale	FE, SE	Confirmed

Scientific Name	***Common Name***	***Hawaiian Name***	***Regulatory Status****	***JBPHH Occurrence***
Platydesma cornuta var. decurrens	Oahu Pilo Kea	Alani	FE, SE	Offsite, within 5 miles
Pritchardia kaalae		-	FE, SE	Offsite, within 5 miles
Pritchardia martii	-	-	SSC	Confirmed
Pteralyxia macrocarpa	-	Kaulu	FE, SE	Potential
Schiedea hookeri	Sprawling Schiedea	-	FE, SE	Confirmed
Schiedea kaalae	Oahu Schiedea	-	FE, SE	Offsite, within 5 miles
Schiedea ligustrina	-	Maʻoliʻoli	SSC	Potential
Schiedea mannii	Ridgetop Schiedea	-	SC	Offsite, within 5 miles
Schiedea pentandra	Hairy Schiedea	-	SSC	Confirmed
Plants (continued)				
Sicyos lanceoloideus	-	ʻAnunu	SC	Offsite, within 5 miles
Silene perlmanii	Cliff Face Catchfly	-	FE, SE	Potential
Solanum sandwicense	Hawaii Horsenettle	ʻAiakeakua, Popolo	FE, SE	Offsite, within 5 miles
Spermolepis hawaiiensis	Hawaiʻi Scaleseed	-	FE, SE	Confirmed
Stenogyne kanehoana	Oahu Stenogyne	-	FE, SE	Offsite, within 5 miles
Strongylodon ruber	Hawaii Jadevine	-	SC	Offsite, within 5 miles
Tetramolopium filiforme var. *filiforme*	Ridgetop Tetramolopium	-	FE, SE	Confirmed
Tetramolopium lepidotum ssp. *lepidotum*	Waiʻanae Range Tetramolopium	-	FE, SE	Potential
Urera kaalae	-	Ōpuhe	FE, SE	Offsite, within 5 miles
Viola chamissoniana subsp. *chamissoniana*	-	ʻOlopū, Pāmakani	FE, SE	Confirmed
Zanthoxylum dipetolum var. depetalum	-	Kawaʻu	FE, SE	Offsite, within 5 miles
Reptilian Species				

Scientific Name	***Common Name***	***Hawaiian Name***	***Regulatory Status****	***JBPHH Occurrence***
Caretta caretta	Loggerhead Turtle (North Pacific DPS)	-	FE, ST	Within 5 miles nearshore waters
Chelonia mydas	Green Sea Turtle (Central North Pacific DPS)	Honu	FT, ST	Confirmed
Dermochelys coriacea	Leatherback Turtle	-	FE	Within 5 miles nearshore waters
Eretmochelys imbricata	Hawksbill Turtle	Honuʻea	FE, SE	Confirmed
Lepidochelys olivacea	Olive Ridley Turtle	-	FT, ST	Within 5 miles nearshore waters
Terrestrial Mammal Species				
Lasiurus cinereus semotus	Hawaiian Hoary Bat	ʻŌpeʻapeʻa	FE, SE	Confirmed
Terrestrial Mollusks				
Achatinella mustelina	Oʻahu Tree Snail	Kāhuli	FE	Potential
Amastra cylindrica	-	-	SC	Potential

Notes: DPS = distinct population segment; FE= federally-listed endangered; FT=federally-listed threatened, MBTA = Migratory Bird Treaty Act; MMPA = Marine Mammal Protection Act; SC = species of concern; SSC = state species of special concern; N = native; SE = state-listed endangered; SGCN = Species of Greatest Conservation Need; ST = state-listed endangered; RT = resolved taxon; - = no data. *Definitions provided in Appendix I.

8.2.4 Implementation Table – Current and Planned Projects and Species Benefits

Actions discussed in this INRMP are implemented through projects. Currently funded projects are discussed in detail in Table 8-7. Projects planned for future implementation are provided in Table 8-8. All actions contemplated in this INRMP are subject to the availability of funds properly authorized and appropriated under Federal law. Nothing in this INRMP is intended to be nor must be construed to be a violation of the Anti-Deficiency Act (31 U.S.C. 1341 et seq.).

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Table 8-7 Currently Funded Projects on JBPHH

Unique Identifier	*Goals and Objectives*	*INRMP Project Code/Title (Abbreviated)*	*EPR Number*	*EPR Project Title*	*Planned Implementation (Fiscal Year [FY])*	*Reference/Driver (ESA/Sikes Act etc.)*	*ERL Priority*	*Funding Source*	*Missions Supported*	*Ecosystems Supported[1]*	*Species Supported*									
											Arthropod	*Bird*	*Coral*	*Fish*	*Marine Mammal*	*Non-Coral Invertebrates*	*Plant*	*Reptile*	*Terrestrial Mammal*	*Terrestrial Mollusk*
1	I. a; II. D-f	JBPHH Predator Control	6144914R10	2 BO CNRH JBPHH - ESA-Listed Species Predator/ Feral Animal Control	Recurring annually	Sikes, DoDI 4715.3, ESA, EO 13751/13112, MMPA, OPNAV 5090.1, 2012 Hickam BO	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW	x	x			x		x	x		x
2	I. a-b; II. C-f	Lualualei Pueo Survey, Lualualei Arthropod Survey, JBPHH Field Biology Support, Management of Black Twig Borer around ESA	6281314R20	CHE/S and SIKES CNRH JBPHH - Flora Fauna Surveys	Recurring annually	Addendum 2012, Sikes, DoDI 4715.3, ESA, EO 13186, MBTA, MRR, OPNAV 5090.1	4	CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, Spec Ops	ESW, FRF, HLF, HLS, HRF, MNS, SSW	x	x					x		x	x
3	I. a-b; II. C-f; III. g, i	Āhua Wetland Restoration	B526009R03	2 BO CNRH JBPHH - Hickam Āhua Reef Wetland Habitat Restoration	Recurring annually	CWA, Sikes, DoDI 4715.3, ESA, EO 13186, MBTA, MSFCMA, MRR, OPNAV 5090.1, 2012 Hickam BO	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW		x	x	x	x	x		x		
4	I. a-b; II. c-e; III. g-i	JBPHH Field biology Support	6144914R01	CHS MBTA CNRH JBPHH - JBPHH Protected Bird Species Surveys	Recurring annually	Sikes, DoDI 4715.3, ESA, EO 13186, MBTA, NEPA, OPNAV 5090.1	4	CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops	ESW, HLF, HLS, HRF, MNS, SSW		x								
5	I. a-b; II. c-e; III. i	JBPHH Field biology Support	6144914R05	1 S CNRH JBPHH Hawaiian Hoary Bat Acoustic Surveys	Recurring annually	Sikes, DoDI 4715.3, ESA, NEPA, OPNAV 5090.1, 2020 West Loch BO	4	CNIC	Air Ops, Log, MILCON	HLF, HLS, SSW, USB									x	
6	I. a-b; II. c-e; III. g-i	JBPHH Field biology Support	6281314R02	2 BO CNRH JBPHH Hawaiian Waterbird Monitoring	Recurring annually	Sikes, DoDI 4715.3, ESA, EO 13186, MBTA, MRR, OPNAV 5090.1	4	CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops	ESW, HLF, HLS, HRF, MNS, SSW		x								
7	I. a-b; II. e; III. g-i	JBPHH Field biology Support	6144914R08	1 CP ESA CNRH JBPHH Marine Debris Reduction	Recurring annually	CWA, CZMA, Sikes, DoDI 4715.3, ESA, EO 11990, MSFCMA, MMPA, OPNAV 5090.1, SWCA590A	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW		x	x	x	x	x		x		
8	I. a-b; II. c-f; III. g-i	JBPHH Field biology Support	6281314R20	CHE/S and SIKES CNRH JBPHH - Flora Fauna Surveys	Recurring annually	Addendum 2012, Sikes, DoDI 4715.3, ESA, EO 13186/13112, MBTA, OPNAV 5090.1, PPA7701, 2012 Hickam BO	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW, USB	x	x		x	x		x	x	x	x
9	I. a-b; II. d-f; III. g-i	JBPHH Field biology Support	6144914R13	CHE/S EO13751 CNRH JBPHH Control of Invasive Plants	Recurring annually	Addendum 2012, Sikes, DoDI 4715.3, ESA, EO 13751/13112, OPNAV 5090.1, PPA7701	4	CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, Spec Ops	ESW, HLF, JLS, HRF, MNS, SSW, USB		x					x		x	

Unique Identifier	*Goals and Objectives*	*INRMP Project Code/Title (Abbreviated)*	*EPR Number*	*EPR Project Title*	*Planned Implementation (Fiscal Year [FY])*	*Reference/Driver (ESA/Sikes Act etc.)*	*ERL Priority*	*Funding Source*	*Missions Supported*	*Ecosystems Supported[1]*	*Species Supported*									
											Arthropod	*Bird*	*Coral*	*Fish*	*Marine Mammal*	*Non-Coral Invertebrates*	*Plant*	*Reptile*	*Terrestrial Mammal*	*Terrestrial Mollusk*
10	I. a-b; II. d-f; III. g-i	JBPHH Field biology Support	6144914R18	CHS and SWCA CNRH JBPHH Revegetation with Native Plants	Recurring annually	CWA, Sikes, DoDI 4715.3, ESA, EO 11990, EO 13148, OPEO 13751/13112, OPNAV 5090.1, PPA7701, SWCA590A	4	CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops	ESW, HLF, HLS, HRF, MNS, SSW		x								
11	I. a-b; II. e-f; III. g-i	JBPHH Field biology Support	6829713R04	CHE and EO 13751 CNRH JBPHH - Endangered Plant Species Rodent Control	Recurring annually	Addendum 2012, Sikes, DoDI 4715.3, ESA, EO 13751/13112, OPNAV 5090.1	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW, USB	x	x			x		x		x	x
12	I. a-b; II. e-f; III. g-i	JBPHH Field biology Support	6144914R10	2 BO CNRH JBPHH - ESA-Listed Species Predator/ Feral Animal Control	Recurring annually	Sikes, DoDI 4715.3, ESA, EO 13186, EO 13751/13112, MBTA, MMPA, OPNAV 5090.1	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW	x	x	x	x	x	x	x	x	x	x
13	I. a-b; II. c-f; III. g-i	JBPHH Field biology Support	B526009R03	2 BO CNRH JBPHH - Hickam Āhua Reef Wetland Habitat Restoration	Recurring annually	Sikes, DoDI 4715.3, ESA, EO 13186, MBTA, MRR, OPNAV 5090.1	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW, USB		x						x		
14	I. a-b; II. d-f; II. g-i	Pearl Harbor Wetland Restoration	6281310R00	1 RP CNRH JBPHH – ESA-Listed Species Mangrove and Pickelweed Removal	Recurring annually	CWA, CRCA, ESA, EO 11990, EO 13089, EO 13751/13112, MBTA, MSFCMA, MRR, 2012 Hickam BO	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW		x	x	x	x	x		x	x	
15	I. a-b; II. c-f; III. g-i	JBPHH INRMP Revision	614490N004	CHE/D/S CNRH JBPHH INRMP	Non-Annual Recurring	Addendum 2012, CWA, Sikes, DoDI 4715.3, ESA, EO 13751/13112, MBTA, MSFCMA, MMPA, OPNAV 5090.1, PPA7701	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW	x	x	x	x	x	x	x	x	x	x
16	I. a-b; II. c-f; III. g-i	LLL Protected Species Management	6829713R05	1 CP CNRH JBPHH Lualualei Endangered Plant Species Outplanting	Recurring annually	Sikes, DoDI 4715.3, ESA, EO 13186, MBTA, MRR, OPNAV 5090.1	4	CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, Spec Ops	ESW, HLF, HLS, HRF, MNS, SSW, USB		x					x		x	x
17	I. a-b; II. d-f; III. g, i	LLL Protected Species Management	6829714R30	1 CP CNRH JBPHH Lualualei Ungulate Fencing	Recurring annually	Sikes, DoDI 4715.3, ESA, EO 13751/13112, OPNAV 5090.1, PPA7701, SWCA590A	4	CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, Spec Ops	ESW, HLF, HLS, HRF, MNS, SSW, USB		x					x		x	x
18	I. a-b; II. c-f; III. g-i	LLL Protected Species Management	682973N001	1 CP CNRH JBPHH Lualualei Endangered Plant and Snail Management	Recurring annually	Sikes, DoDI 4715.3, ESA, EO 13751/13112, OPNAV 5090.1, PPA7701, SWCA590A	4	CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, Spec Ops	ESW, HLF, HLS, HRF, MNS, SSW, USB		x					x		x	x

Unique Identifier	*Goals and Objectives*	*INRMP Project Code/Title (Abbreviated)*	*EPR Number*	*EPR Project Title*	*Planned Implementation (Fiscal Year [FY])*	*Reference/Driver (ESA/Sikes Act etc.)*	*ERL Priority*	*Funding Source*	*Missions Supported*	*Ecosystems Supported[1]*	*Species Supported*									
											Arthropod	*Bird*	*Coral*	*Fish*	*Marine Mammal*	*Non-Coral Invertebrates*	*Plant*	*Reptile*	*Terrestrial Mammal*	*Terrestrial Mollusk*
19	I. a-c; II. f; III. g, i	CRB Trap Monitoring and Maintenance	6144915R01	EO 13751 CNRH Coconut Rhinoceros Beetle Monitoring and Management	Recurring annually	Sikes, ESA, EO 13751/13112, NISA4713	4	CNIC	Comm, E&T, Log, MILCON, Ord Ops, Spec Ops	HLF, HLS, HRF							x			
20	I. a-b; II. c-f; III. g-i	CLEP Program	6281317R01	CHE/S CNRH JBPHH Conservation Law Enforcement (REPACKAGED)	Annual Recurring	CWA, CZMA, Sikes, CRCA, DoDI 4751.3, DoDI 5525.ee, ESA, EO 11990, EO 13089, EO 13186, EO 13751/13112, MBTA, MSFCMA, OPNAV 5090.1	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW	x	x	x	x	x	x	x	x	x	x
21	I. a; II. e-f; II. g, i	Wildland Fire Management Plan	6829714R35	1 CP CNRH JBPHH - Lualualei Wildland Fire Management Plan	Non-Annual Recurring	Addendum 2012, Sikes, DoDI 4715.3, ESA, EO 13751/13112. OPNAV 5090.1, PPA7701, SWCA590A	4	CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, Spec Ops	ESW, FRF, HLF, HLS, HRF, MNS, SSW, USB	x	x					x		x	x
22	I. b; II. d-e; III. g-i	N/A	6829714R29	1 CR CNRH JBPHH Signage for ESA-Listed Species	Non-Annual Recurring	Addendum 2012, Sikes, DoDI 4715.3, ESA, EO 13751/13112. OPNAV 5090.1	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW, USB	x	x			x		x	x	x	x
23	I. a-b; II. c-f	N/A	6281317R02	CHE/S CHRH JBPHH Marine Resources and Fisheries Surveys	Annual Recurring	Sikes, ESA, MBTA, MSFCMA, EFH Assessment for Pearl Harbor Maintenance Dredging Phase 1 Consultation, FWCA	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW		x	x	x	x	x		x		
24	I. a-b; II. c-f; III. g-i	N/A	6144914R22	CHE/S CNRH JBPHH GIS Data Management	Annual Recurring	Addendum 2012, Sikes, DoDI 4715.3, ESA, MSFCMA, OPNAVINST 5090.1	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW, USB	x	x		x	x		x	x	x	x
25	I. a-b; II. c-f; III. g-i	N/A	6144914R23	CHE and CHS and SIKES CNRH JBPHH - Feral Ungulate (Pig) Control	Annual Recurring	Addendum 2012, Sikes, DoDI 4715.3, EO 13751/13112, EO 13443, FWCA, OPNAV 5090.1, SWCA590A, and the Presidential Memorandum establishing the America's Great Outdoors Initiative	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW	x	x	x	x	x	x	x	x		x
26	I. a; II. f	Naio thrips surveys CRB breeding site surveys	6144914R17	CHE/S and EO 13751 CNRH JBPHH Invasive Species Early Detection Roadside Surveys	Annual Recurring	Addendum 2012, Sikes, DoDI 4715.3, ESA, EO 13751/13112, OPNAV 5090.1, PPA7701	4	CNIC	Comm, E&T, Log, MILCON, Ord Ops, Spec Ops	HLF, HLS, HRF							x			

Unique Identifier	*Goals and Objectives*	*INRMP Project Code/Title (Abbreviated)*	*EPR Number*	*EPR Project Title*	*Planned Implementation (Fiscal Year [FY])*	*Reference/Driver (ESA/Sikes Act etc.)*	*ERL Priority*	*Funding Source*	*Missions Supported*	*Ecosystems Supported[1]*	*Species Supported*									
											Arthropod	*Bird*	*Coral*	*Fish*	*Marine Mammal*	*Non-Coral Invertebrates*	*Plant*	*Reptile*	*Terrestrial Mammal*	*Terrestrial Mollusk*
27	I. a; II. d; III. g, h	JBPHH Field Biology Services	6144914R07	1 CP CNRH JBPHH Management Actions for Protected Species During Training	Annual Recurring	CWA, Sikes, CRCA, DoDI 4715.3, ESA, EO 13089, EO 13186, EO 13751/13112, MBTA, MSFCMA, MMPA, NEPA, OPNAV 5090.1	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW, USB	x	x		x	x		x	x	x	x
28	I. a-b; II. f; III. h, i	N/A	6144914R11	CHS and NISA CNRH JBPHH Biosecurity Management	Annual Recurring	ADCA, BTSA, DoDI 4715.3, ESA, EO 13751/13112, MSFCMA, NISA4713, OPNAV 5090.1	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW	x	x	x	x	x	x	x	x	x	x
29	I. a; II. c-f	N/A	00950B7C05	1 RP CNRH JBPHH - NRTF Niuliʻi Ponds Waterbird Habitat Management	Annual Recurring	CWA, DoDI 4715.3, ESA, EO 11990, EO 13186, MBTA, MMPA, OPNAV 5090.1, SWCA590A. This project is a condition of the wildlife cooperative agreement between NCTAMS PAC, USFWS, State of Hawaii, and NAVFAC	4	CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, Spec Ops	ESW, HLF, JLS, HRF, MNS, SSW, USB		x					x		x	

Notes: ADCA = Animal Damage Control Act of 1931; Air = Aircraft; Amphib = Amphibious; BO = Biological Opinion; BTSA = Brown Tree Snake Control and Eradication Act of 2004; CLEP = Conservation Law Enforcement Program; CNIC = Commander, Navy Installations Command; CNRH = Commander, Navy Region Hawaii; Comm = Communication; CRB = Coconut rhinoceros beetle; CRCA = Coral Reef Conservation Act; CRS = Coral Reef Substrate; CWA = Clean Water Act; CZMA = Coastal Zone Management Act; DoDI = Department of Defense Instruction; E&T = Education & Training; EFH = Essential Fish Habitat; EO = Executive Order; ESA = Endangered Species Act; ESW = Estuarine Shallow Water; FRF = Faunal Reef; FWCA = Fish and Wildlife Coordination Act; GIS = Geographic Information System; Helo = Helicopter; HLF = Hawaiʻi Lowland Mesic Forest; HLS = Hawaiʻi Lowland Dry Shrubland; HRF = Hawaiian Riparian Forest & Shrubland; INRMP = Integrated Natural Resources Management Plan; JBPHH = Joint Base Pearl Harbor-Hickam; LLL = Lualualei; MBTA = Migratory Bird Treaty Act; MILCON = Military Construction; MMPA = Marine Mammal Protection Act; MNS = Marine Nearshore; MRR = Military Readiness Rule; MSFCMA = Magnuson-Stevens Fishery Conservation and Management Act; NAVFAC = Naval Facilities Engineering Systems Command; NCTAMSPAC = Naval Computer and Telecommunications Area Master Station, Pacific; NEPA = National Environmental Policy Act; NISA = National Invasive Species Act; NRTF = Naval Radio Transmitter Facility; OPNAV = Office of the Chief of Naval Operations; OPNAVINST = Office of the Chief of Naval Operations Instruction; OPEO = [OP] Executive Order; Ops = Operations; Ord = Ordnance; PEL = Pelagic; PPA = plant protect act; R&D = Research & Development; Spec = Special; SSW = Scrub-Shrub Wetland; Sub = Submarine; SWCA = soil and water conservation act; USB = Unconsolidated substrate; USFWS = United States Fish and Wildlife Service.

Table 8-8 Planned Implementation Summary of Projects Supported by DON

Unique Identifier	*Goals and Objectives*	*EPR Number*	*Project Description*	*Reference/ Driver (ESA/Sikes Act etc.)*	*ERL Priority*	*Funding Source*	*Missions Supported*	*Ecosystem Supported*[1]	*Species Supported*									
									Arthropod	*Bird*	*Coral*	*Fish*	*Marine Mammal*	*Non-Coral Invertebrates*	*Plant*	*Reptile*	*Terrestrial Mammal*	*Terrestrial Mollusk*
Projects Underway																		
1	I. b; II. e. III. h-i	N/A	BASH	Sikes, DoDI 4715.3, ESA, MBTA, OPNAV 5090.1, 2012 Hickam BO	4	Non-CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops	ESW, HLF, HLS, HRF, MNS, SSW		x								
2	I. a-b; II. d-f; III. g, i	N/A	Āhua Reef volunteer events	CWA, Sikes, DoDI 4715.3, ESA, EO 13186, MBTA, MSFCMA, MRR, OPNAV 5090.1, 2012 Hickam BO	1	In the past National Public Lands Day Grants, non-CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW		x	x	x	x	x		x	x	
3	I. a; II. c	6281314R20	Arthropod Surveys in Lualualei	Sikes, DoDI 4715.3, ESA, EO13186, MBTA, MRR, OPNAV 5090.1	4	CNIC	E&T, Shore Ops, Log, MILCON	FRF, HLF, HLS	x									
4	I. a; II. c-d	6281314R20	Biodiversity in Stream Mouths	CWA, CRCA, DoDI 4715.3, ESA, EO 13089, EO 13751/13112, MSFCMA, MBTA, MMPA, OPNAV 5090.1	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW		x	x	x	x	x		x		
5	I. a-b; II. d-f; III. g, i	6144914R13/ 6281314R02	Fishpond Restoration	CWA, Sikes, DoDI 4715.3, ESA, EO 13186, MBTA, MSFCMA, MRR, OPNAV 5090.1	2	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW		x	x	x	x	x		x	x	
6	I. a-b; III. g, i	None needed, should be funded by non-CNIC	Earth Day Events	Sikes, DoDI 4715.3, OPNAV 5090.1	2		Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW	x	x	x	x	x	x	x	x	x	x
7	I. a; II. c	6281314R20	Oʻahu ʻElepaio surveys in Lualualei	Sikes, DoDI 4715.3, ESA, EO 13186, MBTA, MRR, OPNAV 5090.1	4	CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops	ESW, HLF, HLS, HRF, MNS, SSW		x								
8	I. a-b; II. c-e; III. g-i	N/A	Hawaiian Monk Seal Haul-out locations	Sikes, DoDI 4715.3, ESA, MMPA, OPNAV 5090.1	4	Other agencies or in-house. Lifeguards	Air Ops, Amphib Ops, Comm, E&T, Ground, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, MNS, PEL					x					
9	I. a-b; II. d-e; III. g, i	6829713R05	Native Hawaiian Plant Nursery	Addendum 2012, Sikes, ESA, EO 11990, OPNAV 5090.1, PPA7701	2	CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, Spec Ops	ESW, HLF, HLS, HRF, MNS, SSW, USB		x					x			
10	I. a-b; II. d; III. i	TBD	Pearl Harbor Water Quality Remediation Using Oysters	CWA, CRCA, DoDI 4715.3, ESA, EO 13089, EO 13751/13112, MSFCMA, MBTA, MMPA, OPNAV 5090.1	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW		x	x	x	x	x		x		

Unique Identifier	*Goals and Objectives*	*EPR Number*	*Project Description*	*Reference/ Driver (ESA/Sikes Act etc.)*	*ERL Priority*	*Funding Source*	*Missions Supported*	*Ecosystem Supported[1]*	*Species Supported*									
									Arthropod	*Bird*	*Coral*	*Fish*	*Marine Mammal*	*Non-Coral Invertebrates*	*Plant*	*Reptile*	*Terrestrial Mammal*	*Terrestrial Mollusk*
11	I. a-b; II. c-e; III. g-i	6281317R02	Sea turtle presence/absence and use of Pearl Harbor	Sikes, DoDI 4715.3, ESA, OPNAV 5090.1	4	CNIC	Amphib Ops, Comm, E&T, Shore Ops, Log, MILCON, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, MNS, PEL								x		
12	I. a-b; II. c-e; III. g-i	6281317R02	Sea turtle stranding data	Sikes, DoDI 4715.3, ESA, OPNAV 5090.1	4	CNIC	Amphib Ops, Comm, E&T, Shore Ops, Log, MILCON, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, MNS, PEL								x		
13	I. a-b; II. c-e; III. g-i	6144914R01	Shearwater fallout Emergency line/pickup and drop off to rehabilitation centers	Sikes, DoDI 4715.3, ESA, MBTA, OPNAV 5090.1	4	CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops	ESW, HLF, HLS, HRF, MNS, SSW		x								
14	I. a-b; II. c-e; III. g-i	6281317R02?	Whale presence in Pearl Harbor	Sikes, DoDI 4715.3, ESA, MMPA, OPNAV 5090.1	2	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, MNS, PEL					x					
15	I. a-b; II. c-f; III. g-i	N/A	Working Group and Committee Participation	ADCA, BTSA, CWA, CZMA, Sikes, CRCA, DoDI 4715.3, DoD 5525.ee, ESA, EO 13089, EO 13148, EO 13186, EO 13751/13112, E13443, FWCA, MBTA, MSFCMA, MMPA, MRR, NISA4713, NEPA, OPNAV 5090.1, PPA7701, SWCA590A, 2012 HICKAM BO, 2020 West Loch BO	1	Labor	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW, USB	x	x			x		x	x	x	x
Potential Future Projects																		
16	I. a-b; II. d-f; III. g, i	N/A	Combine terrestrial ecosystem restoration with cleanup projects from EV1	EO 11990, EO 13751/13112, MBTA, MRR	2	Non-CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops	ESW, HLF, HLS, HRF, MNS, SSW, USB		x							x	
17	I. b; II. e; III. h-i	6281317R01	Conservation Enforcement Education for Security	CWA, CZMA, Sikes, CRCA, DoDI 4751.3, DoDI 5525.ee, ESA, EO 11990, EO 13089, EO 13186, EO 13751/13112, MBTA, MSFCMA, OPNAV 5090.1	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW	x	x	x	x	x	x	x	x	x	x
18	I. a; II. c-f; III. g-i	6281314R02	Development of waterbird management plan informed by data from waterbird tracking study	Sikes, DoDI 4715.3, ESA, EO 13186, MBTA, MRR, OPNAV 5090.1	4	CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops	ESW, HLF, HLS, HRF, MNS, SSW		x								
19	I. b; II. c-e; III. i	6281317R02	Early coordination for Essential Fish Habitat	CWA, CRCA, DoDI 4715.3, ESA, EO 13089, EO 13751/13112, MSFCMA, MBTA, MMPA, OPNAV 5090.1	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, MNS, PEL			x	x	x	x		x		

Unique Identifier	*Goals and Objectives*	*EPR Number*	*Project Description*	*Reference/ Driver (ESA/Sikes Act etc.)*	*ERL Priority*	*Funding Source*	*Missions Supported*	*Ecosystem Supported[1]*	*Species Supported*									
									Arthropod	*Bird*	*Coral*	*Fish*	*Marine Mammal*	*Non-Coral Invertebrates*	*Plant*	*Reptile*	*Terrestrial Mammal*	*Terrestrial Mollusk*
20	I. a-b; II. e-f; III. i	6281317R02	Eradicate invasive species that are established in Pearl Harbor (i.e., *Unomia stolonifera.*, *Gracilaria salicornia*)	CWA, CRCA, DoDI 4715.3, ESA, EO 13089, EO 13751/13112, MSFCMA, MBTA, MMPA, OPNAV 5090.1	3	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, MNS, PEL			x	x	x	x		x		
21	I. a-f; II. d-f;	6281317R02	Establish a mitigation bank account for future impacts to ESA and EFH	CWA, CRCA, DoDI 4715.3, ESA, EO 13089, EO 13751/13112, MSFCMA, MBTA, MMPA, OPNAV 5090.1	2	Unknown	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW	x	x	x	x	x	x	x	x	x	x
22	I. a-b; II. d-f; III. i	6281317R02	Establish a programmatic consultation and agreed upon BMPs for in-water work and trainings with NMFS, USFWS, USACE, and HDOH	CWA, CRCA, DoDI 4715.3, ESA, EO 13089, EO 13751/13112, MSFCMA, MBTA, MMPA, OPNAV 5090.1	2	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW	x	x	x	x	x	x	x	x	x	x
23	I. b; III. g-i	6281317R02	Establish a project which controls sediment impacts at the Hawaii Air National Guard parking lot	CWA, CRCA, DoDI 4715.3, ESA, EO 13089, EO 13751/13112, MSFCMA, MMPA, OPNAV 5090.1	2	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, MNS, PEL			x	x	x	x		x		
24	I. b; II. d-e; III. g-i	6281317R02	Establish speed limits in areas with heavy Green Sea Turtle presence	CWA, Sikes, CRCA, DoDI 4715.3, ESA, EO 13089, EO 13186, EO 13751/13112, MBTA, MSFCMA, MMPA, NEPA, OPNAV 5090.1	3	CNIC	Amphib Ops, Comm, E&T, Shore Ops, Log, MILCON, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, MNS, PEL								x		
25	I. a-b; II. c-e; III. g-i	6281317R02	Establish unused areas that do not and will not impact the mission, in JBPHH that will permanently serve, protect, and sustain EFH and ESA-listed species	CWA, CRCA, DoDI 4715.3, ESA, EO 13089, EO 13751/13112, MSFCMA, MBTA, MMPA, OPNAV 5090.1	2	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, MNS, PEL			x	x	x	x		x		
26	I. b; III. g-i	6281317R01	Increase the priority of Conservation Enforcement	CWA, CZMA, Sikes, CRCA, DoDI 4751.3, DoDI 5525.ee, ESA, EO 11990, EO 13089, EO 13186, EO 13751/13112, MBTA, MSFCMA, OPNAV 5090.1	4	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW	x	x	x	x	x	x	x	x	x	x
27	I. a-b; II. f	6281317R02	Invasive Algae Control	CWA, CRCA, DoDI 4715.3, ESA, EO 13089, EO 13751/13112, MSFCMA, MBTA, MMPA, OPNAV 5090.1	3	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, MNS, PEL			x	x	x	x		x		
28	I. a; II. c-f	6281314R02	Nest mortality study for Silts & Coots identifying causes & mortality rates	Sikes, DoDI 4715.3, ESA, EO 13186, MBTA, MRR, OPNAV 5090.1	4	CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops	ESW, HLF, HLS, HRF, MNS, SSW		x								

Unique Identifier	*Goals and Objectives*	*EPR Number*	*Project Description*	*Reference/ Driver (ESA/Sikes Act etc.)*	*ERL Priority*	*Funding Source*	*Missions Supported*	*Ecosystem Supported*[1]	*Species Supported*									
									Arthropod	*Bird*	*Coral*	*Fish*	*Marine Mammal*	*Non-Coral Invertebrates*	*Plant*	*Reptile*	*Terrestrial Mammal*	*Terrestrial Mollusk*
29	I. b; III. g, i	N/A	Outreach program with DAR/MWR/Security	CWA, CZMA, Sikes, CRCA, DoDI 4751.3, DoDI 5525.ee, ESA, EO 11990, EO 13089, EO 13186, EO 13751/13112, MBTA, MSFCMA, OPNAV 5090.1	2	Outside Agency	Air Ops, Amphib Ops, Comm, E&T, Ground, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, MNS, PEL			x	x	x	x		x		
30	I. b; II. c-d; III. g	6144914R01	White tern monitoring and mapping	Sikes, DoDI 4715.3, EO 13186, MBTA, OPNAV 5090.1	2	CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops	ESW, HLF, HLS, HRF, MNS, SSW		x								
31	I. b; II. d-e; III. h-i	6144914R01	Implement wildlife friendly lighting practices	CZMA, Sikes, DoDI 4715.3; ESA, MBTA, OPNAV 5090.1	2	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW		x			x			x		
32	I. a; II. c; III. i	6144914R05	Hawaiian hoary bat fenceline monitoring	ESA, NEPA, 2020 West Loch BO	4	CNIC	Air Ops, Log, MILCON	HLF, HLS, SSW, USB									x	
33	I. a-b; II. c-e	6281317R02	Marine species assessment and monitoring	CWA, CRCA, DoDI 4715.3, ESA, EO 13089, EO 13751/13112, MSFCMA, MBTA, MMPA, OPNAV 5090.1	2	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, MNS, PEL			x	x	x	x		x		
34	I. a-b; II. c-f; III. g, i	B526009R03	Wetland delineation	CZMA, CWA, Sikes, DoDI 4715.3, ESA, EO 13186, MBTA, MSFCMA, OPNAV 5090.1	2	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW	x	x	x	x	x	x	x	x	x	x
35	I. a-b; II. c-e	6281317R02	Creel Survey	CWA, CRCA, DoDI 4715.3, ESA, EO 13089, EO 13751/13112, MSFCMA, MBTA, MMPA, OPNAV 5090.1	2	CNIC	Air Ops, Amphib Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, R&D, Spec Ops, Sub Ops	CRS, ESW, FRF, HLF, HLS, HRF, MNS, PEL, SSW		x	x	x	x	x		x		

Unique Identifier	*Goals and Objectives*	*EPR Number*	*Project Description*	*Reference/ Driver (ESA/Sikes Act etc.)*	*ERL Priority*	*Funding Source*	*Missions Supported*	*Ecosystem Supported*[1]	*Species Supported*									
									Arthropod	*Bird*	*Coral*	*Fish*	*Marine Mammal*	*Non-Coral Invertebrates*	*Plant*	*Reptile*	*Terrestrial Mammal*	*Terrestrial Mollusk*
36	I. a; II. e-f; II. g, i	N/A	Wildland Fire Mgt.	Addendum 2012, Sikes, DoDI 4715.3, ESA, EO 13751/13112. OPNAV 5090.1, PPA7701, SWCA590A	2	CNIC	Air Ops, Comm, E&T, Ground Ops, Helo Ops, Shore Ops, Log, MILCON, Housing, Ord Ops, Spec Ops	ESW, HLF, HLS, HRF, MNS, SSW, USB		x							x	x

Notes: ADCA = Animal Damage Control Act of 1931; Air = Aircraft; Amphib = Amphibious; BO = Biological Opinion; BTSA = Brown Tree Snake Control and Eradication Act of 2004; CLEP = Conservation Law Enforcement Program; CNIC = Commander, Navy Installations Command; CNRH = Commander, Navy Region Hawaii; Comm = Communication; CRB = Coconut rhinoceros beetle; CRCA = Coral Reef Conservation Act; CRS = Coral Reef Substrate; CWA = Clean Water Act; CZMA = Coastal Zone Management Act; DoDI = Department of Defense Instruction; E&T = Education & Training; EFH = Essential Fish Habitat; EO = Executive Order; ESA = Endangered Species Act; ESW = Estuarine Shallow Water; FRF = Faunal Reef; FWCA = Fish and Wildlife Coordination Act; GIS = Geographic Information System; Helo = Helicopter; HLF = Hawaiʻi Lowland Mesic Forest; HLS = Hawaiʻi Lowland Dry Shrubland; HRF = Hawaiian Riparian Forest & Shrubland; INRMP = Integrated Natural Resources Management Plan; JBPHH = Joint Base Pearl Harbor-Hickam; LLL = Lualualei; MBTA = Migratory Bird Treaty Act; MILCON = Military Construction; MMPA = Marine Mammal Protection Act; MNS = Marine Nearshore; MRR = Military Readiness Rule; MSFCMA = Magnuson-Stevens Fishery Conservation and Management Act; NAVFAC = Naval Facilities Engineering Systems Command; NCTAMSPAC = Naval Computer and Telecommunications Area Master Station, Pacific; NEPA = National Environmental Policy Act; NISA = National Invasive Species Act; NRTF = Naval Radio Transmitter Facility; OPNAV = Office of the Chief of Naval Operations; OPNAVINST = Office of the Chief of Naval Operations Instruction; OPEO = [OP] Executive Order; Ops = Operations; Ord = Ordnance; PEL = Pelagic; PPA = plant protect act; R&D = Research & Development; Spec = Special; SSW = Scrub-Shrub Wetland; Sub = Submarine; SWCA = soil and water conservation act; USB = Unconsolidated substrate; USFWS = United States Fish and Wildlife Service.

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8.2.5 ESA Requirements

Section 7 of the ESA requires federal agencies to consult if an action may affect a federally-listed species. Tables 8-9 and 8-10 discuss the conservation measures and terms and conditions for terrestrial and marine species, respectively.

In accordance with OPNAV M-5090.1, compensatory mitigation measures must have at the very least, some reasonable expectation of success based on prior practice or best available commercial or scientific information. See Chapter 4, Section 4.5.1 for more information on ESA and the INRMP actions.

8.2.5.1 National Environmental Policy Act

The applicability of NEPA to the INRMP is detailed in Section 1.6.2 of the INRMP. Because implementation of the INRMP is considered a major federal action and therefore subject to NEPA analysis, and it provides guidance on the implementation of other federal actions, a list of BMP measures has been developed to reduce impacts associated with implementing actions covered or otherwise guided by the INRMP (Appendix N). Many of the BMPs were developed during consultation with resource agencies and memorialized during issued Biological Opinions. There are three Biological Opinions that apply to work on JBPHH and Surrounding Areas

This list is meant to help ensure that BMP guidance is analogous between projects. It can be used as a starting point to discuss how projects can avoid and minimize impacts. These BMPs are not meant to replace or avoid consultation. In many cases, this language can and will be incorporated into consultation documents. Additionally, each individual project will still need to be reviewed by a SME for natural resource compliance and the applicability and appropriateness of suggested BMPs.

There will be a separate EA to address implementation of actions and projects described in this INRMP.

Table 8-9 Marine EFH/ESA Requirements

Driver/ Reference Document	*Requirement*	*Species Benefited*	*Completed/ Ongoing/ New, Target Date*	*Cost, if Recurring*	*Funding Entity*	*Programmed No/Yes, Year*	*EPR#/title (if applicable)*	*Notes*
USFWS Biological Opinion for Activities and Operations at Hickam Air Force Base, August 2009	Maintain Āhua wetland with open water (1-6 inch in depth) and mudflat (saturated and dry).	Hawaiian stilt (primary), Hawaiian duck, Hawaiian coot, Hawaiian gallinule	Ongoing	72,000/yr	CNIC	Yes, ~2012-current	B526009R03 2 BO CNRH JBPHH - Hickam Āhua Reef Wetland Habitat Restoration	Exposed mudflat and open water present year-round.
	Āhua wetland interspersed with less than 25% cover of pest plants (pickleweed & red mangrove).	Hawaiian stilt (primary), Hawaiian duck, Hawaiian coot, Hawaiian gallinule	Ongoing		CNIC	Yes, ~2012-current		January 2021: 4.25 acres cleared/6.6 total area = approx 36% invasive plant cover.
	Minimize predation of waterbirds by feral mammalian predators (cats, dogs) through year-round predator trapping at Āhua wetland.	Hawaiian stilt (primary), Hawaiian duck, Hawaiian coot, Hawaiian gallinule	Ongoing	31,000/yr	CNIC	Yes, ~2012-current	6144914R10 2 BO CNRH JBPHH – ESA-Listed Species Predator/Feral Animal Control	Predator control contract in place.

Driver/ Reference Document	***Requirement***	***Species Benefited***	***Completed/ Ongoing/ New, Target Date***	***Cost, if Recurring***	***Funding Entity***	***Programmed No/Yes, Year***	***EPR#/title (if applicable)***	***Notes***
	Air Force shall enforce their policy to restrict pets from Āhua wetland area for the protection of listed waterbirds.	Hawaiian stilt (primary), Hawaiian duck, Hawaiian coot, Hawaiian gallinule	Ongoing	N/A (coord. only)	CNIC	N/A	N/A	Implementation of no-pet policy is ongoing; dogs are documented during surveys and reported to security, who sometimes lack resources to respond. Outreach campaigns are conducted periodically to maintain awareness of policy, and signs are posted.

Driver/ Reference Document	*Requirement*	*Species Benefited*	*Completed/ Ongoing/ New, Target Date*	*Cost, if Recurring*	*Funding Entity*	*Programmed No/Yes, Year*	*EPR#/title (if applicable)*	*Notes*
USFWS Biological Opinion for Construction of Magazines for Munitions and Associated Improvements at JBPHH West Loch Annex, June 2020	Monitor newly-installed barbed wire fencing for Hawaiian hoary bat mortalities using plan previously implemented at PMRF (Herring 2017).	Hawaiian hoary bat	New, FY 2022	18,000/yr	CNIC	Yes, 2021	6144914R05 1 S CNRH JBPHH Hawaiian Hoary Bat Acoustic Surveys (name revised for POM 23)	It is expected that a minimum of one survey per week will be required to detect mortalities, but this survey interval may be shortened or lengthened based on results of carcass search trials. Generally, these mortality surveys will occur in the fall, when bats are thought to inhabit lower elevations (Bonaccorso and Pinzari, 2011; Wolfe, 2019).

Driver/ Reference Document	*Requirement*	*Species Benefited*	*Completed/ Ongoing/ New, Target Date*	*Cost, if Recurring*	*Funding Entity*	*Programmed No/Yes, Year*	*EPR#/title (if applicable)*	*Notes*
	Conduct carcass-scavenging and searcher efficiency trials 1 month prior to bat mortality surveys; use results to inform frequency and duration of mortality surveys	Hawaiian hoary bat	New, FY 2021-2022		CNIC	Yes, 2021		Carcasses (mice or rat) will be placed randomly along the barbed wire fence line, which will be checked regularly for 30 days. Searcher efficiency trials, in conjunction with the carcass searches, will be conducted in order to estimate the percentage of bat mortalities searchers are able to find. These two trials will be conducted simultaneously, at least one month prior to the bat mortality surveys, in order to avoid artificially increasing predator traffic along the fence line.

Driver/ Reference Document	*Requirement*	*Species Benefited*	*Completed/ Ongoing/ New, Target Date*	*Cost, if Recurring*	*Funding Entity*	*Programmed No/Yes, Year*	*EPR#/title (if applicable)*	*Notes*
	Provide the results of carcass and searcher efficiency trials and the protocol for bat mortality surveys along the fence line, including frequency and duration of the surveys, to USFWS.	Hawaiian hoary bat	New, FY 2021 - 2022		CNIC	Yes, 2021		None

Driver/ Reference Document	*Requirement*	*Species Benefited*	*Completed/ Ongoing/ New, Target Date*	*Cost, if Recurring*	*Funding Entity*	*Programmed No/Yes, Year*	*EPR#/title (if applicable)*	*Notes*
USFWS Biological Opinion for West Loch Oxidation Pond Operations and Maintenance, Joint Base Pearl Harbor-Hickam, Oahu, August 2021	Monitor for waterbird presence once every two weeks during the months of September through January and once per week during the months of February through August for behavioral observations, use of the site over time, and signs of avian botulism. Any nests observed will be communicated to facilities staff and additional measures will be taken to ensure operations do not disturb actives nests and broods.	Hawaiian stilt (primary), Hawaiian coot, Hawaiian gallinule	Ongoing	12,000/yr	CNIC	Yes, ~2012-current	6281314R02 2 BO CNRH JBPHH Hawaiian Waterbirds Tracking	None

Driver/ Reference Document	*Requirement*	*Species Benefited*	*Completed/ Ongoing/ New, Target Date*	*Cost, if Recurring*	*Funding Entity*	*Programmed No/Yes, Year*	*EPR#/title (if applicable)*	*Notes*
	Minimize predation of waterbirds by feral mammalian predators (cats, mongoose) through year-round predator trapping at West Loch Oxidation Pond.	Hawaiian stilt (primary), Hawaiian coot, Hawaiian gallinule	Ongoing	20,000/yr	CNIC	Yes, ~2012-current	6144914R10 2 BO CNRH JBPHH – ESA-listed Species Predator/Feral Animal Control	Predator control contract in place.
	Natural Resources staff will work closely with facilities to ensure maintenance activities occur outside of nesting season and pond is less attractive to nesting birds during nesting season (i.e., high water level, liner is free of debris, passive hazing during high-volume use of the pond).	Hawaiian stilt (primary), Hawaiian coot, Hawaiian gallinule	Ongoing	N/A (coordination only)	Labor	N/A	N/A	None

Driver/ Reference Document	*Requirement*	*Species Benefited*	*Completed/ Ongoing/ New, Target Date*	*Cost, if Recurring*	*Funding Entity*	*Programmed No/Yes, Year*	*EPR#/title (if applicable)*	*Notes*
Addendum to the Integrated Natural Resource Management Plan June 2012	Survey documenting numbers and locations of plant species. Create and implement a Snail and Plant Management Plan.	Plant Species	Ongoing	600,000/yr	CNIC	Yes, ~2012-current	EPR# 682973N001 1 CP CNRH JBPHH Lualualei Endangered Plant and Snail Management	
	Identification of an additional population of *Marsilea villosa* in the Radio Transmitting Facility.	Plant Species	Complete		CNIC	Yes, ~2012-current	EPR# 682973N001 1 CP CNRH JBPHH Lualualei Endangered Plant and Snail Management	
	Development of a *M. villosa* management plan based on recommendation strategies outlined in a dissertation, partly funded by the DON.	Plant Species	Ongoing		CNIC	Yes, ~2012-current	EPR# 682973N001 1 CP CNRH JBPHH Lualualei Endangered Plant and Snail Management	

Driver/ Reference Document	*Requirement*	*Species Benefited*	*Completed/ Ongoing/ New, Target Date*	*Cost, if Recurring*	*Funding Entity*	*Programmed No/Yes, Year*	*EPR#/title (if applicable)*	*Notes*
	Expansion of funding for a fencing plan and fence construction for ungulate control with specified timeline.	Plant Species	Ongoing		CNIC	Yes, ~2012-current	EPR# 6829714R30 1 CP CNRH JBPHH Lualualei Ungulate Fencing	
	Completion of aerial surveys for feral goats, with plans for their removal beginning in 2013.	Plant Species	Ongoing		CNIC	Yes, ~2012-current	EPR# 6829714R30 1 CP CNRH JBPHH Lualualei Ungulate Fencing	
	Non-native plant removal within exclosures at Hālona and Mikiula management areas.	Plant Species	Ongoing		CNIC	Yes, ~2012-current	EPR# 682973N001 1 CP CNRH JBPHH Lualualei Endangered Plant and Snail Management	

Driver/ Reference Document	*Requirement*	*Species Benefited*	*Completed/ Ongoing/ New, Target Date*	*Cost, if Recurring*	*Funding Entity*	*Programmed No/Yes, Year*	*EPR#/title (if applicable)*	*Notes*
	Commitment to address outplanting needs for threatened and endangered species to augment and stabilize populations with U.S. Navy property at Lualualei Annex.	Plant Species	Ongoing		CNIC	Yes, ~2012-current	EPR #6829713R05 1 CP CNRH JBPHH Lualualei Endangered Plant Species Outplanting	
	Allocation of funding for research on Black Twig Borer control methods.	Plant Species	Ongoing	80,000	CNIC	Yes, ~2012-current	6281314R20 CHE/S and SIKES CNRH JBPHH - Flora Fauna Surveys	
	Commitment to prioritize the production of a wildfire management plan	Plant Species	Ongoing	N/A (coordination only)	Labor	N/A	N/A	

Notes: BO = Biological Opinion; CNIC = Commander, Navy Installations Command; CNRH = Commander, Navy Region Hawaii; ESA = Endangered Species Act; FY = Fiscal Year; JBPHH = Joint Base Pearl Harbor-Hickam; Pacific Missile Range Facility (PMRF) = Pacific Missile Range Facility; USFWS = United States Fish and Wildlife Service.

Table 8-10 Marine ESA Requirements

Driver/ Reference Document	*Requirement*	*Species Benefited*	*Completed/ Ongoing/ New, Target Date*	*Cost, if Recurring*	*Funding Entity*	*Programmed No/Yes, Year*	*EPR#/title (if applicable)*	*Notes*
EFH Consultation for Pearl Harbor Maintenance Dredge (FY14 Southeast Loch; FY17 Upper Middle Loch)	Establishment of at least 17,000 oysters for bioremediation.	EFH, ESA	Ongoing	NA	NA	No	N/A	Oyster pilot study on success of colony establishment is ongoing. A study in 2017 found such bioremediation to be successful (Bienfang, 2017). No funding secured for bioremediation from the action proponent.
	Stabilization and restoration of 242.2 m and 3,995 m^2 of Hickam shoreline.	EFH, ESA	Ongoing	NA	NA	No	N/A	Hickam shoreline stabilization study conducted, however no funding secured for bioremediation from the action proponent.
	Completion of a desktop study on the Pearl Harbor area watershed.	EFH, ESA	Complete	-	-	No	N/A	None
	Revision of fishing regulations in Pearl Harbor.	EFH	Ongoing	$120,258	CNIC	Yes	6281317R02 CHE/S CHRH JBPHH Marine Resources and Fisheries Surveys	Target completion date: FY 2023

Driver/ Reference Document	*Requirement*	*Species Benefited*	*Completed/ Ongoing/ New, Target Date*	*Cost, if Recurring*	*Funding Entity*	*Programmed No/Yes, Year*	*EPR#/title (if applicable)*	*Notes*
	Establishment of a Conservation Law Officer at JBPHH.	EFH, ESA	Ongoing	$169,793	CNIC	Yes	6281317R01 CHE/S CNRH JBPHH Conservation Law Enforcement (REPACKAGED)	None
EFH Consultation for COMPACFLT Boathouse Repair	Removal and relocation of marine growth with important ecological functions, such as oysters, to an area nearby with similar environmental conditions where no future impacts are predicted. Monitoring of the survival of the relocated organisms.	EFH, ESA	Ongoing	-	Customer	NO	N/A	None

Notes: CNIC = Commander, Navy Installations Command; COMPACFLT = Commander United States Pacific Fleet; EFH = Essential Fish Habitat; ESA = Endangered Species Act; FY = Fiscal Year; JBPHH = Joint Base Pearl Harbor-Hickam; USFWS = United States Fish and Wildlife Service.

8.2.6 Implementation Process

This INRMP is effective upon the acceptance and signatory release by the INRMP's responsible parties and cooperating agencies.

8.2.6.1 Responsibility for Implementation

NAVFAC HI is responsible for the preparation, revision, and implementation of INRMPs. SECNAV Instruction 6240.6E assigns responsibility for establishing, implementing, and maintaining the natural resources programs under the jurisdiction of SECNAV to the CNO/Commander, Navy Installations Command (CNIC). These entities ensure the programming of resources necessary to establish and support an integrated natural resources program throughout the DON that is consistent with legislative requirements, DoD policy, and stewardship requirements. JBPHH maintains natural resources program information needed to satisfy reporting requirements and legislative information requests, and to support project requests. In accordance with OPNAVINST 5090.1 and pending further guidance, for joint bases where the DON provides facility services (e.g., to Hickam AFB), the DON will coordinate with tenant commands to ensure that environmental requirements are met.

NAVFAC HI, under the direction of JBPHH, coordinates natural resources requirements with other agencies, including the acquisition of INRMP mutual agreements between the DON, USFWS, NOAA NMFS, and SOH fish and wildlife agencies.

The JBPHH Commander is responsible for and oversees INRMP implementation throughout the installation. The Installation Commanding Officer delegates the day-to-day management responsibility to the installation's professional environmental staff. It is imperative that the natural resources managers are familiar with the activities conducted on the installation by commands and tenants (including other military services). Managers must also understand the overall conservation efforts taking place within their respective geographic region and be able to identify the support needed for those missions in the form of natural resources management.

8.2.6.2 Programmatic Management

Natural resources management and implementation of INRMP policies entail an ongoing effort to integrate requirements and objectives into existing facilities and operational processes and procedures. The following are examples of ongoing facilities management activities that must conform to the INRMP policies and implementation objectives:

- landscape management and grounds maintenance
- vegetation clearing to support fire, explosives safety and security clear zones
- road and roadside maintenance for both paved and unpaved roads
- fire management actions and projects, including both pre-suppression and suppression
- facilities routine maintenance and repair
- utilities routine maintenance and repair
- normal and ongoing mission operation

Planning and implementation of facilities management activities should consider and integrate natural resource management goals and objectives. The following are examples of mission business processes and operational controls should be reviewed to ensure that natural resources programmatic requirements are fully integrated:

- installation command policies and procedures in the form of written instructions
- facilities service contracts for grounds maintenance and pest management
- facilities repair and construction contract standard specifications
- design and construction specifications, including temporary environmental controls
- recurring maintenance work orders
- SOPs for safety and security (force protection) operations

8.2.6.3 Partnerships and Project Support

The success of natural resources management and the implementation of this INRMP require a cooperative planning effort among the parties directly responsible for operating and maintaining the installation. The level of success can be enhanced by developing partnerships among other parties that have a vested interest in the responsible management of the natural resources within the installation. Cooperative planning groups often include representatives from federal, state, and local agencies, citizen groups, developers, and universities. The involvement of these agencies is based on their designation as cooperating agencies and on cooperative agreements, regulatory authority, and technical assistance, as required by federal legislation and regulation. Also, limitations to staff time at installations necessitate using contracted services or other federal agency services, cooperators, and contractors. Typically, contractors perform targeted surveys providing additional needed expertise. Opportunities for external assistance with natural resource programs at JBPHH are summarized below.

Refer to Chapter 1, *Overview* of this INRMP for additional discussions regarding teaming partners (e.g., cooperative management, and beneficial partnerships and collaborative resource planning) for project support.

8.2.6.4 Resource Partners

The NAVFAC HI Environmental staff coordinate with USFWS, NMFS, and SOH DLNR each year to discuss projects and recommendations for each project. Installation Environmental Office and NAVFAC PAC Environmental staff SMEs will continue to engage with appropriate USFWS, NMFS, and SOH DLNR SMEs to finalize projects plans and monitor implementation.

8.2.6.5 Contractors

Circular A-76 mandates the federal government to use commercial sources to supply the products and services the government needs. Contractors are able to provide a wide variety of specialties and may be hired to perform specialized management projects or provide technical knowledge about natural resources management to aid JBPHH with implementation of this INRMP. Contractors must adhere to the requirements and management strategies detailed in the INRMP. The following are examples of contractor support for implementation of natural resources management goals that may be useful at JBPHH:

- threatened and endangered species surveys
- invasive species surveys
- ungulate control

- management plans for threatened and endangered species
- vegetation surveys
- field and nursery studies relating to native plant ecology and propagation
- monitoring hydrology and soil erosion
- monitoring the terrestrial and marine resources in ecologically important areas
- wetlands and waters of the U.S. delineations
- wastewater management

Contractor-supported projects require preparation of a request for proposal and a Performance Work Statement to acquire services, which should be considered during project planning to ensure appropriate funding can be obtained in a timely manner.

8.2.6.6 Interagency Agreements

JBPHH recognizes the importance of cooperating with federal, state, and local agencies in addition to private organizations. In addition to working with the INRMP signatory partners (USFWS, NMFS, and SOH DLNR), JBPHH may enter in to multiple-year interagency agreements to implement natural resources projects.

8.2.6.7 Cooperative Agreements and Partnerships

Cooperative agreements are legal instruments that are used to enter into relationships in which substantial involvement among DON and partners such as non-governmental organizations, institutions of higher education, hospitals, non-profit organizations, and individuals. The principal purpose of these relationships is to transfer value to another recipient as authorized by a law instead of acquiring (by purchase, lease, or barter) property or services for the direct benefit or use of the U.S. Government.

Cooperative agreements may be entered into for services such as inventories, monitoring, green sea turtle protection and monitoring, research, minor construction and maintenance, and public awareness, to provide for the maintenance and improvement of natural resources or conservation research on DoD installations (DoD,). To use a cooperative agreement, substantial involvement is expected between DON and the state, local government, or other recipient when carrying out the activity contemplated in the agreement. They provide a mutually beneficial means of acquiring, analyzing, and interpreting natural resources data, which can then be used to inform natural resources management decisions. Funded by DON, cooperative agreements produce information that can be used to help resource managers achieve project-specific compliance with environmental laws. Authorization for cooperative agreements is arranged through NAVFAC HI.

Universities are an excellent source of assistance for research, surveys, and development of monitoring programs to inform the natural resource management program. Additionally, they can provide resource-specific expertise as well as assistance with implementation of restoration activities. Collaborative investigations performed in conjunction with JBPHH biologists provide an effective source of assistance with implementation of the INRMP.

The CESU program is a working collaboration among federal agencies, universities, local government and non-governmental organizations, and other nonfederal institutional partners. The CESU National Network provides multidisciplinary research, technical assistance, and education to resource and environmental managers. The DoD is a participant in the CESU program, which is overseen by U.S.

Department of Interior. There are numerous CESU organizations throughout the U.S. and JBPHH is not limited to using a specific CESU. Often, specific localized expertise in natural resources of specific interest can be obtained through agreements with CESU organizations.

8.2.6.8 Volunteer Groups

OPNAV M-5090.1, *Environmental Readiness Program Manual* , which implements the policy set forth in OPNAVINST 5090.1, states that commands shall interact with the surrounding community to develop positive and productive community involvement, participation, and educational opportunities, and use volunteers under the supervision of professionally trained natural resources personnel, when feasible. Through support from volunteers, JBPHH is able to educate the public on the natural resources programs conducted at JBPHH sites, demonstrate environmental stewardship of natural resources, and develop and maintain partnerships with the local community.

There are numerous examples of volunteer work conducted at JBPHH in support of natural resources management, including but not limited to:

- coordination with volunteer groups to further the management and protection of the Hawaiian monk seal
- beach cleanup and marine debris reduction
- IS flora and fauna removal
- wetland restoration
- fishpond restoration

8.3 Integrated Natural Resource Management Plan Review

The INRMP review process is described in detail in Section 1.8.1 of the INRMP and includes a discussion of the revision and review process and the annual metrics review.

8.4 Critical Habitat Exemption

The 2004 amendment to the ESA (4(a)(3)(B)(i)) precludes the USFWS and NMFS from designating critical habitat on lands or other geographical areas used by DoD that are subject to an INRMP, given the INRMP provides a benefit to the species. In other words, those lands are ineligible for Critical Habitat designation. “Benefit” in this context means “conservation benefit” (i.e., in addition to addressing the species, the INRMP gives due regard to habitat-based conservation through habitat protection, maintenance, and improvement projects). To determine whether an INRMP provides the requisite benefits, USFWS and NMFS developed four criteria which are now part of the ESA regulations at 50 CFR § 424.12 and are discussed in detail in Section 1.14 of the INRMP. Species receiving impact benefit from the implementation of the INRMP are listed in Table 8-6 of the INRMP.

The Secretary shall not designate as critical habitat any lands or other geographical areas owned or controlled by the DoD, or designated for its use, which are subject to an INRMP prepared under Section 101 of the Sikes Act (16 U.S.C. 670a) , if the Secretary determines in writing that such plan provides a benefit to the species for which critical habitat is proposed for designation.

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9 References

9.1 Executive Summary

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9.2 Chapter 1

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Photo 4-2: Hawaiian Duck, provided by Richard Palmer/Division of Forestry and Wildlife (DOFAW) 2005

Photo 4-3: Hawaiian Gallinule, Natural Resources Conservation Service (NRCS)/DOFAW 2005

Photo 4-4: Hawaiian Coot, NAVFAC PAC (from Pacific Missile Range Facility)

Photo 4-5: Hawaiian Stilt, Corrina Carnes

Photo 4-6: White Tern, DOFAW/David Leonard, USFWS

Photo 4-7: Hawaiian Short-eared Owl, NRCS

Photo 4-8: Newell’s Shearwater, Bobby Brittingham

Photo 4-9: Hawaiian Hoary Bat, Jack Jeffrey

Photo 4-10: Green Sea Turtle, NAVFAC PAC

Photo 4-11: Hawaiian Monk Seal, NAVFAC PAC

Photo 4-12: Humpback Whale mother and calf, NAVFAC HI

9.6 Chapter 5

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