

7. Affected Environment

This section describes the affected environment across Hawai‘i in general, followed by a detailed description of the affected environment at specific locations proposed for incorporation into the sanctuary. The region of interest (ROI) or area of potential affect includes all lands and waters within and adjacent to the sanctuary in the populated Hawaiian Islands. There are currently sanctuary areas that border Hawai‘i, Kaho‘olawe, Maui, Lāna‘i, Moloka‘i, O‘ahu, and Kaua‘i. The sanctuary is proposing boundary changes on the north shores of O‘ahu and Kaua‘i, as well as the inclusion of new sanctuary boundary around Ni‘ihau.

7.1. Biophysical Environment

7.1.1. Habitats

The current and proposed sanctuary boundaries include a wide range of sub-tropical marine habitat types including coastal and shoreline areas, estuaries, seagrass, sandy, hard and rubble habitat, coral reefs, and deep ocean. These habitats support diverse marine species, which are presented in more detail in the next section. This section provides an overview of the primary habitat types within the current and proposed sanctuary boundaries. The primary threats to habitats are discussed in Section 6.1.4., such as coral bleaching, coral disease, vessel grounding, and pollution.

For the populated Hawaiian Islands, NOAA mapped 32 distinct habitat types (i.e., 4 major and 14 detailed geomorphological structure classes; 7 major and 3 detailed biological cover types) within 13 nearshore zones using satellite imagery (Battista et al. 2007). Total coral reef and hard bottom and total “other” substrate (e.g. sand, mud, artificial) are shown in Table 11.

Coral Reef Structure Type	Major and Detailed Habitat Area (square miles)							
	Ni‘ihau/ Ka‘ula	Kaua‘i	O‘ahu	Moloka‘i	Maui	Lāna‘i	Kaho‘olawe	Hawai‘i
Total Coral/Hard Bottom	38.1	64.6	110.3	45.0	39.7	10.2	5.1	40.5
Sand	5.6	21.5	24.7	19.7	38.2	5.4	2.4	7.8
Mud	0.0	0.6	19.1	2.4	0.3	0.0	0.0	2.0
Artificial	0.0	0.2	1.8	0.8	0.1	0.0	0.0	0.1
Total Coral Reef Area	43.7	86.9	155.9	68.0	78.2	15.7	8.2	50.4

Table 11. Coral reef habitat classes in Hawai‘i.

Source: Adapted from http://ccma.nos.noaa.gov/products/biogeography/Hawai‘i_cd_07/

Table 12 describes the major habitat types on each of the populated Hawaiian Islands. The major biological cover types in the nearshore environment include coral, macroalgae, coralline algae, seagrass, turf, emergent vegetation or uncolonized cover (Battista et al. 2007). The area in which each biological cover type constitutes the major cover type (with at least 10% the cover type present) is shown. Uncolonized habitat has less than 10% of any biological cover type and is usually sand or mud structures. Figure 13 and Figure 14 illustrates examples of habitat types throughout the populated Hawaiian Islands.

Major Biological Cover Type	Major and Detailed Habitat Class Area (square miles)							
	Ni'ihau/ Ka'ula	Kaua'i	O'ahu	Moloka'i	Maui	Lāna'i	Kaho'olawe	Hawai'i
Coral	1.90	25.90	21.89	12.51	21.58	5.79	4.02	28.84
Macroalgae	0.08	19.22	38.15	22.39	27.72	4.63	0.00	0.77
Coralline Algae	0.23	0.35	1.85	0.04	0.27	0.04	0.00	0.58
Seagrass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Turf	92.80	19.42	51.27	18.46	12.12	2.01	1.70	10.04
Emergent Vegetation	0.00	0.11	0.69	1.74	0.00	0.00	0.00	0.00
Uncolonized	5.60	21.74	40.27	11.78	16.25	3.28	2.47	9.69
Total Cover by Island	100.61	86.74	154.13	66.91	77.95	15.75	8.19	49.92

Table 12. Coral reef biological cover classes.

Source: Adapted from http://ccma.nos.noaa.gov/products/biogeography/Hawai'i_cd_07/

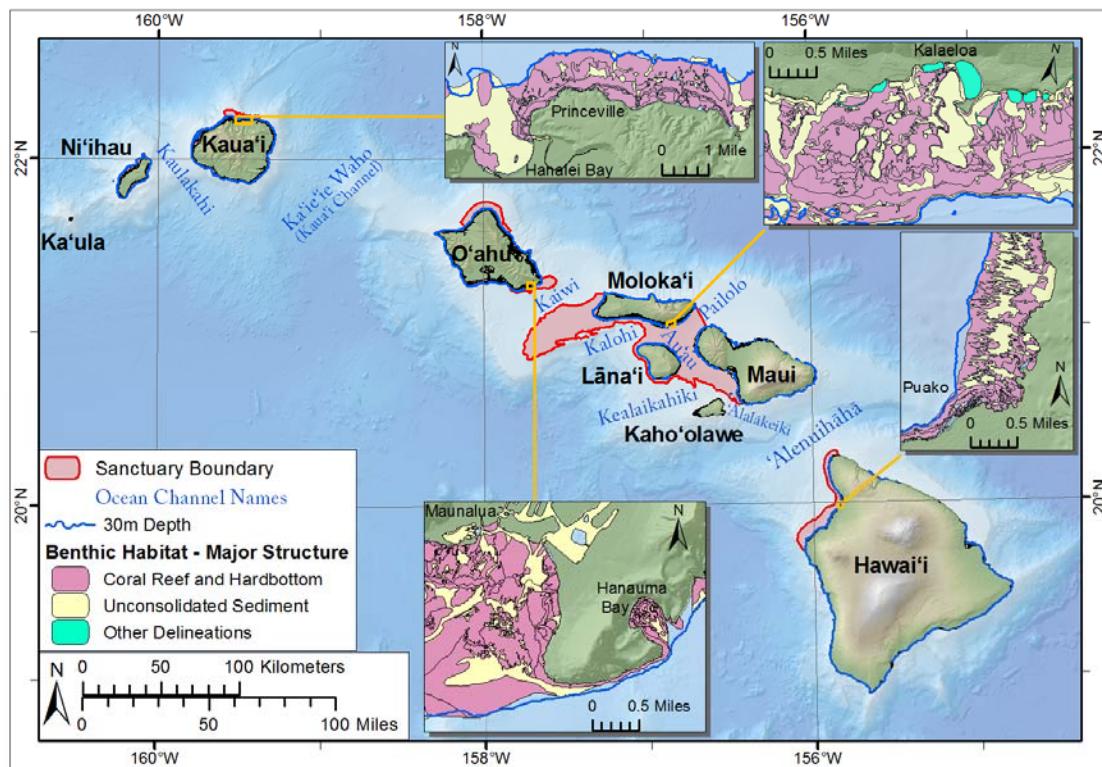


Figure 13. Examples of nearshore benthic habitat structure.

Source: Hawaiian Islands Humpback Whale National Marine Sanctuary 2013.

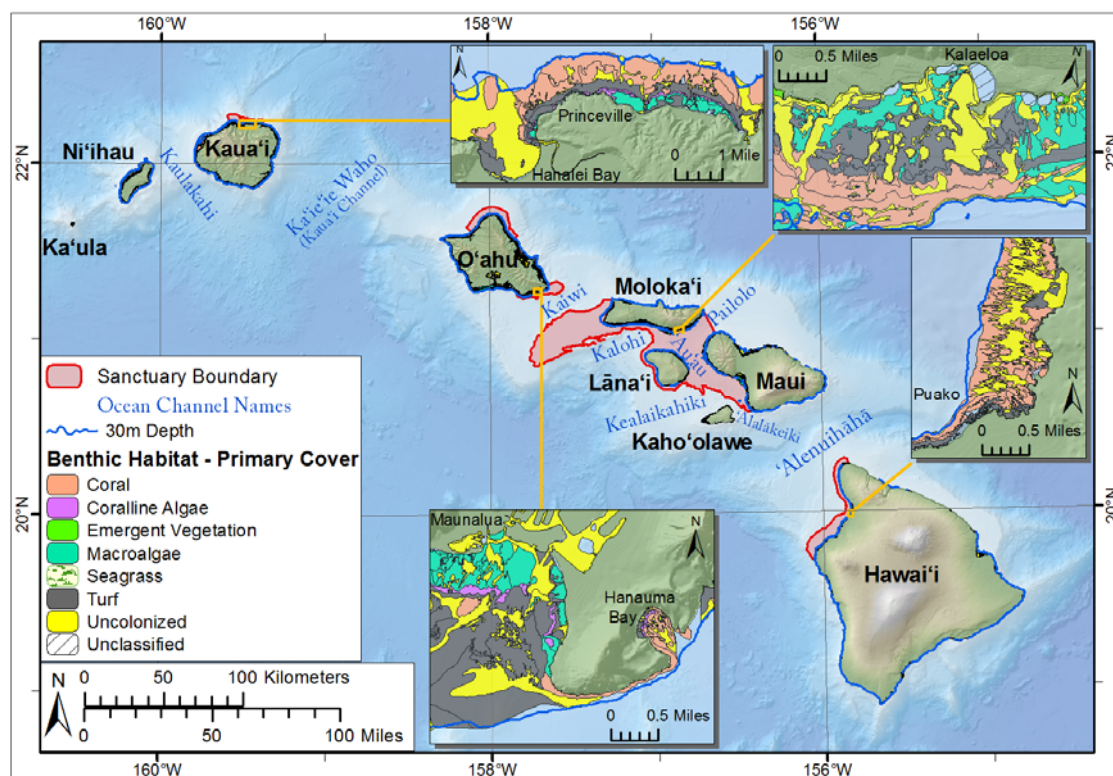


Figure 14. Examples of major and detailed nearshore habitat classes.

Source: *Hawaiian Islands Humpback Whale National Marine Sanctuary* 2013.

7.1.1.1. Coastal and Shoreline Areas

Intertidal zones found along the shoreline are the physical areas along the shoreline that are covered by water during high tide and waves. The tidal range in the populated Hawaiian Islands is relatively small and can vary by the bathymetry of the location. While extreme tides can reach 3 feet, on average the tides don't fluctuate more than 2 feet. In spring when extreme low tides are observed, intertidal habitats and some shallow



reefs and rocks can be exposed to the air and direct solar effects for periods of hours. In addition, wave action can splash seawater above the upper tidal limits and create a habitat called the splash zone. This zone provides unique habitat because any plants or animals that live in this zone must

be able to tolerate periodic exposure to air and direct sunlight and variations in temperature. Many organisms live in the intertidal and splash zones including species of red, brown, and green algae, species of fish including gobies, and benthic invertebrates such as Nerite snails (Pipipi), limpets ('Opihi), barnacles, tube snails, crabs, and sea slugs. The specific range of sedentary and mobile invertebrates in the intertidal area may be controlled by the ranges of predators, competing species, and their physiological limits and varying temperature and desiccation tolerances. Fish in intertidal habitats are limited to tide pools or passing through the intertidal zone at high tide. Additionally, shorebirds forage in the intertidal at low tide, while some roost in aggregations on cliffs just above the shore. Hawaiian monk seals as well as sea turtles often haul out to rest or bask in shoreline areas.

7.1.1.2. Estuaries

An estuary is an area of brackish water between a body of coastal freshwater and the open ocean. Freshwater inputs into estuaries are major sources of sediment and nutrients to the open ocean and therefore can be very productive ecosystems. Only distinct groups of species can tolerate these variable conditions and use estuaries as a habitat. Some species that commonly live in freshwater and saltwater may also live in estuaries depending on whether the conditions are suitable for the species. Species of endemic and indigenous freshwater fish (such as gobies) and invertebrates (such as shrimp and snails) have lifecycles in freshwater bodies, estuaries and the open ocean. In addition, estuaries are habitat for many endemic and indigenous marsh and shore birds. Many Native Hawaiian fishponds were originally built in estuary habitats.

7.1.1.3. Seagrass

There are two species of seagrass in Hawai'i, *Halophila hawaiiiana* and *Halophila decipiens*. *Halophila hawaiiiana* is an endemic species of seagrass that is only found in Hawai'i in soft



bottom or sandy habitats. The blades of *Halophila* are generally 1-2 inches (2-5 cm) length so meadows of these sea grasses do not create the same kind of habitat that many other seagrass species do in other parts of the world. However *Halophila* do provide microhabitats for many species of algae and invertebrates (McDermid et al. 2003). The Hawaiian green sea turtle (*Chelonia mydas*) is known to feed on seagrass in Hawai'i and the endemic snail *Smaragdia bryanae* is a

specialist herbivore on *Halophila hawaiiiana* (Unabia 2011). Seagrass provides many ecological services including stabilizing bottom sediments and particulate matter, providing food for grazers and detritivores, serving as shelter for small invertebrates and processing nutrients.

7.1.1.4. Sandy, Hard and Rubble Subtidal Habitat

Subtidal habitat generally ranges between 0-100 feet (0-30 m) and includes softbottom, rubble and hard substrate. Each substrate type supports different communities of species. Softbottom habitats in Hawai'i are generally composed of calcium carbonate sand, volcanic sand or other land sourced soils or mud. Softbottom habitats support two species of seagrass, *Halophila hawaiiiana* (endemic) and *Halophila decipiens*, as well as native and introduced macroalgae. Halimeda spp. green macroalgae are a typical component of sandy habitats (Macintyre et al. 1987). The introduced green macroalgal species *Avrainvillea amadelpha* grows in sandy habitats and competes with native algae and seagrass for space and resources (Peyton 2009). Sand dwelling species include crabs, goby fish, bonefish, flounder, scorpion fish, sting rays, and sea cucumbers.

Hard bottom substrate is generally composed of volcanic basalt or calcium carbonate biologically derived material. Coral reef organisms such as coral, crustose coralline algae and other calcifiers are the major contributors of hard bottom material. Hard bottom substrates provide the relatively stable structure that many species need to attach and become established on the bottom of the ocean. Coral, crustose coralline algae as well as other kinds of algae, many invertebrates and fish species are all associated with hard bottom substrate. Rubble habitats generally consist of pieces of volcanic or calcium carbonate rock that can be either or both permanently fixed or perpetually moved by waves and currents overlying soft or hard bottom substrate. Many of the same species from soft and hard bottom habitats also live within rubble habitats. However the motion of rubble can damage and thus reduce the number of hard bottom specific species. The shallow subtidal zone includes many coral reef habitats and provides major habitat for photosynthetic coral reef organisms as well as fish and other invertebrates in Hawai'i.

7.1.1.5. Shallow Coral Reefs and Reef Slope

Reef flats are generally nearshore and relatively shallow (0-100 feet or 0-30 m). They are mainly constructed of calcium carbonate skeletons of coral and coralline algae and support a diversity of algae, fish, coral and other invertebrates. Reefs generally slope down from the reef flat and reef crest to depths about 80-100 feet (25-30 m). The reef slope (fore reef) provides habitat for a variety of communities because light, currents and other physical parameters vary by depth, and are often more or less optimal for different benthic communities. The most common coral species in Hawai'i are the endemic Finger coral (*Porites compressa*), Rice coral (*Montipora capitata*), Lobe coral (*Porites lobata*), and Cauliflower Coral (*Pocillopora meandrina*; Friedlander et al. 2008).

7.1.1.6. Banks, Drowned Reefs, and Seamounts

Banks, drowned reefs, and seamounts are generally found at depths of 100-500 feet (30-150 m) and provide a variety of fish habitats, sustain ecological communities, and enhance ocean mixing. Banks are undersea hills, separated from the major land masses, like islands during rifting, compression, and other geological events. Drowned reefs are coral reefs that could not maintain vertical growth to keep up with rising sea levels, and die as a result of lack of sunlight. Seamounts are underwater volcanic mountains, rising from submerged lands, and occur throughout all ocean basins (Wessel et al. 2010).

Fish distribution across these habitats is affected by depth, substrate type, and composition. Deep-slope fisheries typically occur between 328 feet (100 m) and 1640 feet (500 m), with a rapid decrease in species richness typically occurring between 656 feet (200 m) and 1312 feet (400 m). Most bottomfish are associated with hard substrates, holes, ledges, or caves (Chave and Mundy 1994) and are not believed to migrate between isolated seamounts. Taylor column eddies (eddies that form above seamounts) are believed to retain pelagic larvae, though seamount populations of snappers and groupers apparently rely on inputs of larvae from external sources (WPFMC 2009).

Surface irradiance is much reduced at these depths but the small amount of sunlight is sufficient to support some photosynthetic organisms. While most reef-building corals live within 100 feet (30 m) of depth, some assemblages of reef-building coral species are known to thrive at mesophotic depths of generally 100-500 feet (30-150 m). The coral that grows at these depths can form extensive reef ecosystems such as in the Au‘au Channel and at Penguin Bank in the populated Hawaiian Islands. In addition black and precious corals also grow at these depths. In the ‘Au‘au Channel area there are also extensive meadows of green seaweed (*Halimeda sp.*) which serve as habitat for small fish (Friedlander et al. 2008). These habitats are just starting to be explored within the mesophotic waters of the Hawaiian Islands.

7.1.1.7. Pelagic and Deep Ocean

Deep water habitats (>500 feet or 150 m) are generally too deep for light to penetrate and have either basalt or carbonate hard bottom substrate on slopes and assemblages of sediment on flat surfaces. There are few or no plants other than phytoplankton in deep ocean habitats. Deep sea animals include zooplankton, fish, squid, precious coral and other invertebrates. Pelagic organisms include phytoplankton, zooplankton, fish, squid, marine mammals, and sea turtles. While humpback whales may explore these depths, they are generally found in waters less than 600 feet (200 m) deep.

7.1.2. Marine Species

The sanctuary is home to a variety of marine species including invertebrates, fishes, turtles, and marine mammals. Although the sanctuary currently only protects humpback whales and their habitat, the sanctuary is proposing an ecosystem-based management approach that would seek to support and conserve all marine species and their habitats. The following section provides an overview of some of the marine species that could benefit from additional protection either through sanctuary management actions or additional regulations under the National Marine Sanctuaries Act (NMSA).

7.1.2.1. Protected Marine Species

Protected marine species include those afforded special protection by the state and federal governments. Federal protection for protected marine species is afforded primarily through the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA). The ESA provides measures to conserve and recover a designated list of species. NOAA’s National Marine Fisheries Service (NOAA Fisheries) is charged with implementation of the ESA for all marine animals in Hawai‘i, and shares responsibility with the U.S. Fish & Wildlife Service (USFWS) for sea turtles. The ESA defines endangered species as “any species which is in danger of extinction throughout all or a significant portion of its range” and threatened species as “any

species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range” (ESA; 7 U.S.C. § 136, 16 U.S.C. § 1531 *et seq.*).

The State of Hawai‘i automatically lists any species that is listed on the federal Endangered Species List on the State Endangered Species List and provides these species with state protection in addition to federal protection (ESA; 7 U.S.C. § 136, 16 U.S.C. § 1531 *et seq.*). Currently there are no additional species protected under state law. The ranges of 13 threatened and endangered marine species overlap with the Hawaiian Islands Exclusive Economic Zone (EEZ), which extends to 200 nautical miles offshore. These include the endangered Hawaiian monk seal (‘Īlioiloikaua, *Neomonachus schauinslandi*), five endangered baleen whale species (blue-*Balaenoptera musculus*, fin-*Balaenoptera physalus*, humpback, sei-*Balaenoptera borealis*, right-*Eubalaena japonica*), two endangered toothed whale species (insular false killer and sperm whale), three endangered turtle species (hawksbill-*Eretmochelys imbricata*, leatherback-*Dermochelys coriacea*, and olive ridley-*Lepidochelys Belolivacea*), and two threatened turtle species (green- *Chelonia mydas*, and loggerhead-*Caretta caretta*).

Three coral species with ranges overlapping the Hawaiian Islands EEZ have been proposed for “threatened” status under the ESA. Two of the three species are found in the Hawaiian Islands Humpback Whale National Marine Sanctuary: ringed rice coral (puna kea) and Hawaiian reef coral. These are groupings of several previously recognized species including *Montipora patula/verrili* and *Montipora dilitata/flabellata/turgescens* respectively. The third species proposed for listing, staghorn coral (*Acropora paniculata*), is found only at French Frigate Shoals, in the northwestern Hawaiian Islands.



Additional ESA petitions are at various stages of review by NOAA, including petitions to list scalloped hammerhead sharks (mano kihikihi, *Sphyrna lewini*), great white sharks (*Carcharodon carcharias*, blue-green damselfish (*Chromis viridis*), and Hawaiian damselfish (*Dascyllus albisella*). These are candidate species whose range also overlaps the Hawaiian Islands EEZ. The ESA defines a candidate species as “any species being considered by the Secretary for listing as an endangered or threatened species, but not yet the subject of a proposed rule” (ESA; 7 U.S.C. § 136, 16 U.S.C. § 1531 *et seq.*). Petitions are also under review to delist the green sea turtle and the humpback whale.

All marine mammals are protected under the Marine Mammal Protection Act (MMPA) administered by NOAA Fisheries and USFWS (see Appendix A). The MMPA exempts incidental take of marine mammals for commercial fisheries operations except when fisheries are

regulated by Take Reduction Team or take ESA-listed marine mammals. Fisheries regulated by Take Reduction Team must follow the applicable Take Reduction Plan regulations. Fishermen must also report any incidental take of marine mammals and accommodate any required observers. NOAA Fisheries issues permits to take ESA-listed marine mammals for commercial fisheries interacting with ESA-listed marine mammals. NOAA Fisheries also issues scientific research permits and certain exemptions under the MMPA.



In addition to the ESA-listed marine mammal species listed in Appendix A, additional species of marine mammals may occur within the Hawaiian Islands EEZ and are protected under the MMPA including Bryde's whale (*Balaenoptera edeni*), Minke Whale (*Balaenoptera acutorostrata*), Blainville beaked whale (*Mesoplodon densirostris*), Common bottlenose dolphin (*Tursiops truncatus*), Cuvier's beaked whale (*Ziphius cavirostris*), Fraser's dolphin (*Lagenodelphis hosei*), Longman's beaked whale (*Indopacetus pacificus*), Melon-headed whale (*Peponocephala electra*), Pygmy sperm whale (*Kogia breviceps*), Dwarf sperm whale (*Kogia sima*), Risso's dolphin (*Grampus griseus*), Rough-toothed dolphin (*Steno bredanensis*), Short-finned pilot whale (*Globicephala macrorhynchus*), Spinner dolphin, Pantropical spotted dolphin, Pygmy killer whale (*Feresa attenuata*), Killer whale (*Orcinus orcus*), and the Striped dolphin (*Stenella coeruleoalba*).

The Migratory Bird Treaty Act (MBTA) prohibits the killing or taking of migratory birds. USFWS is responsible for implementing this federal prohibition, which protects seabirds, their eggs, and their nests. However, NOAA's National Marine Fisheries Service also has statutory authority and responsibilities to reduce the effects of fisheries bycatch and manage seabird habitat within the U.S. EEZ (Rivera et al. 2009).

7.1.2.2. Humpback Whales (koholā, koholā kuapi'o, palaoa)

Sanctuary management has always focused on the protection of humpback whales. Under the proposed ecosystem-based management approach, humpback whales would continue to be a focus of sanctuary conservation and management activities. Humpback whales occur throughout the world in both coastal and open ocean areas. They typically migrate between tropical and subtropical latitudes to temperate and polar latitudes. Tropical areas are occupied during winter

months when the humpback whales engage in mating and the females bear their young. Humpback whales are not known to extensively feed in wintering grounds, although opportunistic feeding has been observed (*e.g.* Salden 1990). Polar areas are occupied in the spring, summer, and fall months when feeding occurs.

Prior to commercial whaling, the worldwide population of humpback whales is thought to have been in excess of 125,000 (US DOC NOAA 1991). Between 1905 and 1960, intense commercial whaling operations targeted humpback whales worldwide. In 1966, treaties under the International Whaling Commission protected humpback whales from further harvesting by whaling operations. Based on whaling records, Rice (1977) estimated that abundance of humpback whales in the North Pacific was approximately 15,000 prior to 1905. However, the Russian President for Ecology and Health confirmed that the Soviet Union was illegally killing thousands of endangered humpback whales and other great whales in the southern Hemisphere and perhaps the North Pacific and North Atlantic during the 1960's after the ban had been in effect (Yablokov 1994).

Humpback whale abundance near the Hawaiian Islands was estimated to be as low as 895 in 1977-1979 (Darling et al. 1983). Abundance estimates continued to increase in additional studies over time to the most recent 2004-2006 estimate of 10,000 humpback whales breeding near the Hawaiian Islands (Barlow et al. 2011). The current population of humpback whales (central North Pacific stock) that use Hawai'i's waters as their principle wintering ground currently likely lies between 10,000 and 15,000 animals, although not all of these animals are in Hawai'i at the

History and Culture of Koholā (whale)

The Koholā (whale) was well known to the early Hawaiians. In the Kumulipo chant, the Hawaiian chant of creation, the Second Era speaks of the birth of the whale:

Hanau ka palaoa noho I kai
Born is the whale living in the ocean

The pauku, or poetic passages, address the familiar scene in native Hawaiian culture of whales travelling through the 'Alalakeiki Channel between Maui and Kaho'olawe. The whale is the largest ocean form, and a majestic manifestation of Kanaloa. From the ivory of this creature, the highly prized niho palaoa was worn by the ali'i (chiefs) of high rank. The scarcity and beauty of the niho lei palaoa and its connection to Kanaloa brought mana (spiritual power) to the carver, to the pendant itself, and eventually to the wearer of the pendant. The Ali'i who possessed this kinolau or body form of the great god, would themselves acquire the characteristics, intelligence, and knowledge of the god. Therefore, it would be advantageous for any Ali'i to secure the ivory whale tooth of this Kanaloa body form (Maxwell 1996).

Koholā (whale)

The people of Hawai'i had many names for different rains, oceans, environments, and animals. One traditional name for whale is "palaoa", but it is not the only name given to whales. The Hawaiian language is very descriptive and over time, new names can arise through different descriptions. The word "kohola" is used to describe reef flats. The wave action on reef flats is similar to a whale's blow, so "kohola" or "koholā" also means whale. Recently, an additional descriptive word "kuapi'o" has been identified to mean humpback or arched back, so "koholā kuapi'o" is another name for humpback whales (Komike Hua'olelo 1998).

same time during the season. Although collecting scientific information about abundance, distribution, and trends can be expensive and difficult, new studies are beginning to find ways to use citizen monitoring and other methods to address these kinds of questions while accounting for the biases inherent in such approaches (*e.g.* Tonachella et al. 2013).

NOAA Fisheries is currently conducting a world-wide status review of humpback whales to evaluate abundance and potential for downlisting or delisting under the Endangered Species Act. Downlisting or delisting humpback whales would not impact their protection under the Marine Mammal Protection Act or in the Hawaiian Islands Humpback Whale National Marine Sanctuary.

7.1.2.3. Hawaiian Spinner Dolphins (nai'a)

The spinner dolphin (*Stenella longirostris*) is a small cetacean species found in tropical waters

History & Culture of Nai'a (dolphins)

Nai'a appear in the Hawaiian cosmology, specifically in a mele (song) recounting the genealogy of the main Hawaiian Islands. In this cosmology, the first nai'a (dolphin) resulted from a mating between Papa, or Papahānaumoku (Earth Mother) and Kanaloa, the god of the ocean (Ka Hae Hawaii 1860):

Kahea o Papa ia Kanaloa,
Papa calls upon Kanaloa
 I hanau ia he punua he naia,
Born is a fledgling, a porpoise
 He keiki ia na Papa i hahanau,
A child indeed given birth by Papa
 Haalele o Papa, hoi i Kahiki,
Papa departs, returning to the ancient homelands of Kahiki
 Hoowawa, wawaka, nihoniho,
The murmuring and chatter about her departure prevail, they
 Hoia Kahiki, hoia Kahiki, Kapakapa kaua,
chide and chastise Papa
 Moe o Wakea, Moe ia Kaulawahine,
She returns to Kahiki, Kahiki in the unceasing patter of the rain
 Hanau o Lāna'i, Keiki makahiapo a ia wahine,
Wakea continues his quest and sleeps with Kaulawahine
 Hoi ae o Wakea, Loaa o Hina,
Born is Lāna'i, firstborn of this woman (Kaulawahine)
 He wahine moe na Wakea,
Wakea retreats momentarily, until Hina is found
 Hapai o Hina ia Molokai, he moku,
She is for the pleasure of Wakea
 O Molokai a Hina ke keiki moku,
Hina conceives Molokai, an island

worldwide. Named for their impressive aerial acrobatics, adult spinner dolphins generally grow to 6-7 feet in length and weigh approximately 120-170 pounds (NMFS Office of Protected Resources 2010). Throughout tropical waters, spinner dolphins are associated with inshore waters, islands, or banks (Hammond et al. 2008). The Hawaiian spinner dolphin is recognized within the subspecies *Stenella longirostris longirostris* and is considered a separate race of spinner dolphins (Perrin 1998).

Hawaiian spinner dolphins are common throughout the Hawaiian Archipelago and within the Hawaiian Islands Humpback Whale National Marine Sanctuary waters. High density areas of Hawaiian spinner dolphins include the waters along the Kona coast of the island of Hawai'i and the southern and western shores of O'ahu (Lammers 2004). During the day, Hawaiian spinner dolphins are typically found close to shore in shallow wind-sheltered coves and bays. Shallow coves and bays near the shore provide safe habitat for

spinner dolphins to rest during the day. Hawaiian spinner dolphins feed primarily at night by foraging on small mesopelagic fish, shrimp, and squid (Lammers 2004).

There are approximately 1,500 Hawaiian spinner dolphins in the populated Hawaiian Islands and an estimated 3,350 in Hawaiian waters (Barlow 2006). Research suggests that Hawaiian spinner dolphins may consist of smaller subpopulations associated with different islands. In particular, a population genetics study suggests that limited exchange occurs between the spinner dolphin populations that inhabit the waters of each of the populated Hawaiian Islands (Andrews et al.

2006). The study demonstrates that there is little gene flow between spinner dolphin populations associated with each island, which allows for the possibility to divide the Hawaiian spinner dolphin population into distinct population segments. Further support for this distinction of populations comes from a study that demonstrates great site fidelity for at least some Hawaiian spinner dolphins in nearshore habitats (Marten et al. 2006) and a study that demonstrates different social behaviors in different regions in the Hawaiian Archipelago (Andrews et al. 2010).

Spinner dolphins, as a species, are not considered endangered or threatened under the Endangered Species Act and are not considered depleted under the Marine Mammal Protection Act. One exception, however, is the subspecies of eastern spinner dolphins (*Stenella longirostris orientalis*), which is considered a depleted stock under the MMPA due to frequent takes by the eastern tropical Pacific purse-seine tuna fishing industry (Southwest Fisheries Science Center 2002). While Hawaiian spinner dolphins, like most spinner dolphins, are not considered endangered, threatened, or depleted, it may be the case that one or more of the island-associated subpopulations of Hawaiian spinner dolphins suffer greater threats than the entire population of Hawaiian spinner dolphins (e.g. from wildlife viewing tours).



7.1.2.4. Hawaiian Monk Seal (‘Īlioḥoloikauaaua)

The Hawaiian monk seal (‘Īlioḥoloikauaaua, *Neomonachus schauinslandi*) is a critically endangered species that is endemic to the Hawaiian Islands. Only one other species of monk seal still exists today, the Mediterranean monk seal. The Caribbean monk seal was last sighted in 1952 and is believed to be extinct. Hawaiian monk seals are pinnipeds that typically grow to 7 feet in length and weigh 400-600 pounds. Individuals generally live between 20 and 25 years and consume a diet consisting of bottom-dwelling and reef fish, eels, octopus, squid and crustaceans (HIHWNMS 2010).

According to studies on the diet of Hawaiian monk seals in the Northwestern Hawaiian Islands, Hawaiian monk seals are opportunistic predators that feed on a variety of prey, including coastal, benthic, and offshore-mesopelagic species (Goodman-Lowe 1998). Hawaiian monk seals inhabit the waters and beaches of the populated Hawaiian Islands and the Northwestern Hawaiian Islands. In total, the population is estimated to be only 1100-1200 individuals with a little over 10% of individuals inhabiting the populated Hawaiian Islands. The overall species decline is being driven by extremely poor juvenile survival in the Northwestern Hawaiian Islands due to food competition with large apex predatory fish (e.g., sharks and ulua), entanglement in marine debris, unusual shark predation at one sub-population, and other factors. However, a small population of Hawaiian monk seals has been slowly increasing in the main Hawaiian Islands,

including in the waters of the Hawaiian Islands Humpback Whale National Marine Sanctuary, especially the islands of Kaua‘i, Moloka‘i and O‘ahu. Less competition with large predatory fish, like sharks and ulua (both hunted down by humans), and a higher survival rate of pups make the shores of the populated Hawaiian Islands ideal habitat for monk seals, with some terrestrial and



marine areas likely to be designated as critical habitat for monk seals in the near future (Endangered and Threatened Species 2009). However, habitats in the populated Hawaiian Islands may also pose several threats to Hawaiian monk seals, particularly disease transmission from humans, pets, livestock, and feral animals (Littnan et al. 2006).

As a critically endangered species, the Hawaiian monk seal suffers from a variety of threats that have collectively undermined population recovery efforts. The major threats to Hawaiian monk seals include entanglement in marine debris,

effects from human interaction, death or injury from vessel strikes, death from infectious disease, genetic effects of small population size, fitness loss due to food limitation, death by predators, and effects of climate change.

7.1.2.5. Sea Turtles (honu, ea)

Sea turtles are commonly found in the waters surrounding the populated Hawaiian Islands as well as the Northwestern Hawaiian Islands. The most commonly found species of sea turtles are the green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricate*), leatherback turtle (*Dermochelys coriacea*), loggerhead turtle (*Caretta caretta*), and olive ridley turtle (*Lepidochelys olivacea*). Of these species that inhabit the populated Hawaiian Islands, the loggerhead turtle, leatherback turtle, and hawksbill turtle are endangered while the green turtle and olive ridley turtle are listed as threatened under the Endangered Species Act.

Green turtles are the most common of the sea turtles that inhabit the populated Hawaiian Islands. The

History and Culture of Honu (sea turtles)

When exploring the role of sea turtles in Hawaiian culture, we find Hawaiians possessed significant knowledge of the varieties of sea turtles that are found in Hawai‘i, including native and foreign species. Sea turtles are mentioned in the fourth wā, the fourth era of the Kumulipo.

Hānau ka pō

The darkness of the sea gives birth

Hānau ka pō ia mili nanea

The darkness of the sea gives birth to the cherished ones

Kuka‘a ka pō ia ki‘i nana‘a

The darkness of the sea is swollen as if a protruding statue

Hānau ka pōia honu kua nanaka

The darkness of the sea gives birth to the green sea turtle

Kūlia ka pō ia ‘ea kua neneke

The darkness of the sea sets forth the hawksbill turtle

Honu or Hawaiian sea turtles played many roles in traditional Hawaiian culture. Hawaiian language resources reveal that turtles were used as a source for food and medicine. Sea turtles also influenced social behavior and cultural activities. References to honu appear in hula, traditional dance, and recreation activities.

green turtle inhabits the nearshore waters of the populated Hawaiian Islands with important foraging areas along the coastlines of O‘ahu, Moloka‘i, Maui, Lāna‘i, and Hawai‘i Island (HIHWNMS 2007). Green turtles occur in the coastal waters surrounding the populated Hawaiian Islands, primarily from shore to the 55-fathom isobaths. They are found here throughout the year and also migrate seasonally to the Northwestern Hawaiian Islands to reproduce. Specific habitat includes convergence zones in the ocean, oceanic beaches for nesting, and benthic feeding grounds in coastal areas.

The green turtle feeds primarily on macroalgae and sea grasses, though specific diet varies depending on an individual turtle’s life history stage (Arthur et al. 2008). The coastlines of O‘ahu, Moloka‘i, Maui, Lāna‘i, and Hawai‘i Island and the Johnston Atoll in the Northwestern Hawaiian Islands are especially important foraging areas for green sea turtles, as these areas are



rich in algae pastures (HIHWNMS 2007). Specific foraging grounds in the populated Hawaiian Islands include Kāne‘ohe Bay, Pala‘au, Kiholo Bay, and Punalu‘u Bay (Dutton et al. 2008).

Research of green sea turtles in the populated Hawaiian Islands suggests that Hawaiian green sea turtles are genetically distinct from other populations of green sea turtles in the Pacific Ocean. Green sea turtles that forage in the Hawaiian

Archipelago comprise one genetic stock primarily derived from the nesting population at French Frigate Shoals. Only three of the turtles sampled from the French Frigate Shoals contained unique haplotypes, which indicates that the Hawaiian population is rarely visited by turtles from rookeries outside the Hawaiian Archipelago.

The hawksbill turtle is less commonly sighted in the populated Hawaiian Islands, as it is a highly migratory species and nesting areas are widely distributed. Hawksbill turtles are small to medium-sized compared to other sea turtle species, but can weigh up to 200 pounds. The diet of hawksbill turtles consists of a combination of plant and animal material, including primarily sponges and other invertebrates. Hawksbill turtles typically find their food by foraging at or near the sea floor and in coral reefs.

Hawksbill turtles may have important habitat in the populated Hawaiian Islands even they are not commonly sighted there. Hawksbill turtles are not known to inhabit the Northwestern Hawaiian Islands. Hawksbill turtles typically inhabit healthy coral reefs, though their main habitat depends on their life history stage. Over the life history of a hawksbill turtle, individuals occupy a range of habitats including coral reefs, hard bottom habitats, sea grass, and algal beds. Kamehame, a small island on the southeastern coast of the island of Hawai‘i, is an important nesting habitat for hawksbill turtles and hosts a major portion of all hawksbill nesting in the Hawaiian Archipelago (Balazs et al. 1996). Other nesting areas on the islands of Hawai‘i, Maui, Moloka‘i, and O‘ahu have been identified (HIHWNMS 2007).

The leatherback, loggerhead, and olive ridley turtles are less commonly sighted in the populated Hawaiian Islands but still inhabit the offshore areas. The leatherback turtle is an offshore species of turtle that is typically found in deep waters off the Hawaiian Islands. As individuals can weigh up to 2,000 lbs., the leatherback turtle is the world's largest turtle. Leatherback turtles do not nest in the Hawaiian Archipelago, but individuals inhabit the offshore waters of the populated Hawaiian Islands (HIHWNMS 2007).

Loggerhead turtles characteristically have large heads and powerful jaws. The habitat of loggerhead turtles depends on its life history stage, as loggerhead turtles occupy the terrestrial, oceanic, and neritic zones at different points during their lives. Loggerhead turtles do not nest in the Hawaiian Islands, but frequent the waters surrounding the populated Hawaiian Islands. Significant numbers of loggerhead turtles have been caught by the Hawai'i-based longline fishery (FWS and NOAA 2010).

Olive ridley turtles are a highly migratory species of sea turtle that are rarely found in Hawaiian coastal waters. However, olive ridley turtles are the most commonly caught turtle species in offshore fishing operations in the Hawaiian Archipelago (NMFS 2007). The olive ridley turtle is relatively small and is considered the most abundant sea turtle in the world. Despite its abundance, all populations of the olive ridley turtle are either threatened or endangered under the Endangered Species Act. Olive ridley turtles are omnivores and typically consume algae, lobster, crabs, mollusks, and fish. Research on olive ridley turtles caught in the Hawai'i-based longline fishery indicates that their most common prey are pyrosomes and salps (Polovina et al. 2004).

7.1.2.6. Seabirds

While not always considered part of the ocean environment, seabirds are true marine organisms, as they are completely reliant on the sea for food and only come to land to breed. As the most visible marine species, seabirds are ideal ecosystem indicators because they are easy to monitor and indicate oceanographic variability at multiple spatial and temporal scales (Ballance 2007, Piatt et al. 2007). Seabirds are an established component of NOAA's ecosystem-based management approach because they reflect changes in ecosystem structure and function (Rivera et al. 2014).



In the populated Hawaiian Islands, there are 22 species of breeding seabirds (Harrison 1990). Tropical seabirds are opportunistic and feed on a wide variety of fish, squid, and crustaceans (Harrison 1990). Hawaiian seabirds are comprised of a diverse group of families including albatrosses, shearwaters, petrels, storm-petrels, frigatebirds, boobies, tropicbirds, terns, and noddies. They vary greatly in terms of abundance, with some species such as sooty terns being very numerous and widely distributed, whereas the listed species exhibit low numbers and limited distributions. The

Hawaiian petrel (also known as dark-rumped petrel) (*Pterodroma sandwichensis*), was once the most abundant seabird on the populated Hawaiian Islands, and is now listed as endangered under

the Endangered Species Act (USFWS 2005). The other listed breeding seabird is the threatened Newell's shearwater (*Puffinus newelli*). Additionally, the short-tailed albatross is endangered, although it does not nest in the populated Hawaiian Islands, this species occurs within Hawaiian waters. A complete list of seabirds protected under the ESA and the MBTA can be found in Appendix A.

7.1.3. Water Quality

While water offshore around Hawai'i is remarkably clean, nearshore localized concentrations of pollutants occur near populated areas due to storm water discharges and permitted sanitary



outfalls. A report on water quality monitoring and assessment is prepared annually by the Hawai'i Department of Health. In the 2012 report, a total of 225 impaired marine segments were listed. For these 225 marine segments, the breakdown per island (and the percent listed waters per island/per total number listed waters) is: Kaua'i 23 (10%), O'ahu 73 (32%), Moloka'i 3 (1%), Lāna'i 7 (3%), Maui 76 (34%), and Hawai'i 43 (19%) (Hawai'i Department of Health 2012). With 150 occurrences in the 2012 Integrated Report, turbidity is the most common

pollutant in triggering a marine water listing for impairment, possibly due to polluted runoff. The Hawai'i Department of Health aims to make measurable improvements to its polluted runoff control program by focusing on selected watersheds (Hawai'i Department of Health 2012).

Hawaii's overall coastal water quality is rated "good" through the Water Quality Index (Environmental Protection Agency 2012) and Sediment Quality Index is rated "poor" by 2006 surveys. Overall the condition of waters including water quality and sediment quality is rated "fair." Overall there has been a decline in "good" water quality between 2002 and 2008 (Environmental Protection Agency 2012).

7.1.4. Threats to the Biological Environment

7.1.4.1. Coral Bleaching

When corals are stressed by changes in conditions such as temperature, light, or nutrients, they expel the symbiotic algae living in their tissues, causing them to turn white. This phenomenon is referred to as coral bleaching. When a coral bleaches, it is not dead. Corals can survive a bleaching event, but when they are highly impacted by other stressors, in addition to bleaching, they are subject to potential mortality. Usually, mass bleaching is associated with increased sea surface temperature (State of Hawai'i 2010). The first large-scale coral bleaching in the Hawai'i region occurred in 1996 predominantly in Kāne'ohe Bay on



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the island of O‘ahu (Jokiel and Brown 2004). This bleaching event was attributed to increases in sea-surface temperature and high light during a cloudless period (Jokiel and Brown 2004). Mass bleaching was also documented in the Northwestern Hawaiian Islands in both 2002 and 2004 (Kenyon and Brainard 2006).

7.1.4.2. Coral Disease

Infectious disease in coral, observed in the field as lesions or distinct bands of tissue loss, can be caused by bacteria, viruses, protozoa, or fungi (Harvell et al. 2007). Outbreaks of disease in corals may be aggravated or caused by the introduction of novel pathogens to an environment or shifts in environmental conditions. Water quality and habitat deterioration have also been identified as potential environmental drivers of coral disease (Harvell et al. 2007). As a natural aspect of populations, background levels of disease exist in all healthy reef ecosystems (Barnard and Scheske 2010).

Coral disease outbreaks have been documented in the Northwestern Hawaiian Islands (*e.g.* Aeby 2005). Variation in antibacterial activity in Hawaiian coral reefs may partly explain differences in disease susceptibility (Gochfeld and Aeby 2008). In a study of factors that may affect coral disease in Hawai‘i, Williams et al. (2010) found that environmental predictors showing the strongest overall associations with four coral diseases were both biotic and abiotic, including turbidity, declines in butterfly fish and juvenile parrotfish, and coral host cover. Different factors were predictive of different diseases, suggesting diseases need to be considered independently of one another. Aeby et al. (2011) conducted disease surveys at 78 sites near five of the populated Hawaiian Islands in 2004 and 2005. They found eight diseases in two genera (*Porites* and *Montipora*). Overall prevalence of disease in each coral genus was less than 2%.

A disease outbreak at Makua and Anini near Kaua‘i was reported in 2012. In investigating this outbreak, Work (2012a) reported that the reef at Anini had unusually low coral cover compared to a healthy reef, and 10-80% of *Montipora capitata* colonies included disease infected corals. The disease was co-incident with indicators of chronic stress, and cyanobacteria were commonly associated with lesions, with some corals suffering fungal infection. According to the Work (2012a) report, this was the first time a cyanobacterial/fungal disease on this scale has been documented in Hawaiian corals. Work (2012b) reported that, at the area on North Kaua‘i referred to as Tunnels, the same disease was found in both *Montipora capitata* and *Montipora patula* with cyanobacteria and fungus again associated with the disease. Work (2012b) goes on to state that understanding the factors precipitating this disease outbreak would require longitudinal studies and more systematic sampling over time.

7.1.4.3. Vessel Grounding

The nature and degree of the impacts and subsequent recovery of vessels grounded on coral reefs are not well understood (Schroeder et al. 2008). They can break and crush reef structure, reduce habitat complexity, kill corals and other benthic organisms, provide bare surfaces for colonization and can lead to discharge of oil, debris, and other point source pollutants (Precht et al. 2001). Benthic and associated fish assemblages may take years to decades to recover from groundings (Schroeder et al. 2008). Groundings at archaeological sites can destroy or bury historical and cultural artifacts under tons of steel and debris. Vessel fuel can smother and damage resources.

In 2000, the U.S. Coral Reef Task Force (CRTF) issued Resolution 5-1, recommending several actions including (1) requiring bonds from fishing vessels that transact business at U.S. ports adjacent to coral reefs; (2) developing legislation and a funding mechanism for vessel removal; (3) establishing national legislation for coral reef damage assessment to serve as a guideline for fines and restoration costs; and (4) developing federal assistance protocols for vessel damage assessment and removal. NOAA initiated several actions in response to this resolution, including collaborating with the U.S. Department of Justice, the USCG and Pacific Island jurisdiction through a Grounded and Abandoned Vessel Working Group to review legal and financial mechanisms for vessel removal from coral reef ecosystems, conducting two workshops on vessel grounding issues in U.S. Flag Pacific Islands and developing a database of grounded and abandoned vessels in coral reef ecosystems. Similar to impacts from grounding events, hazardous cargos, fuel, and possible unexploded ordinance inside metal hulls of slowly deteriorating shipwrecks may threaten marine resources.



An example of a serious grounding event in Hawai'i was the grounding of the USS Port Royal Navy vessel near O'ahu in 2009. Laura Thielen, chairwoman of the Hawai'i State Board of Land and Natural Resources at that time, informed the United States Navy in a letter in April 2009 that the grounding had damaged six to ten acres (4.0 ha) of the reef and that the "main injury scar" covered about 9,600 square feet (890 m²). Much smaller boats have also run aground on Hawai'i's reefs. For example, a 65 foot catamaran ran aground during a dinner cruise near Lahaina, Maui in December 2010. It is difficult to assess the full impact of these and other grounded vessels on Hawaii's coral reef habitats. Approximately 160 groundings (including self-extractions and sunken vessels) are reported annually island-wide, and this is likely an underestimate because groundings for which boat operators are able to get the vessel free at high tide or with mechanical assistance often go unreported.

7.1.4.4. Climate Change

Climate change refers to variability in the climate of the earth. While climate change has occurred naturally for thousands of years, recent changes have been attributed to observed increases in human induced greenhouse gas concentrations (Crowley 2000). Global and regional changes to the marine environment may have significant consequences for biological and cultural resources. For example, Hawai'i is expected to experience sea-level rise of one foot by 2050 and three feet by the end of the century, which poses significant economic, social, and environmental challenges (Codiga and Wager 2011). Increased sea level, extreme weather, changes in ocean salinity and oxygen levels, changes in precipitation, and marine organism range shifts are all potential effects of climate change (Bernstein et al. 2007). Increased greenhouse gases induce ocean acidification, which may negatively impact calcifying species, such as coral and coralline algae (Jokiel et al. 2008). Changing ocean temperature and ocean acidification are expected to have significant impacts on many marine species, food webs, and ocean ecosystem structure and function, and the many benefits they provide (National Ocean Council 2011). Sea-level rise, increased severe storm events, rapid erosion, changing ocean temperature, and saltwater intrusion present serious and growing threats (National Ocean Council 2011).

In the Hawaiian Islands, climate change has been identified as an important area of research and policy making. In July 2012, the Governor of Hawai‘i signed Act 286 that states that there is a significant need for sustained and enhanced climate monitoring and assessment. At the University of Hawai‘i, the Center for Island Climate Adaptation and Policy (ICAP) was formed to facilitate a sustainable, climate-conscious future for Hawai‘i, the Pacific, and global island communities (Codiga and Wager 2011). There are a wide variety of policy documents at federal, state, and local levels to address climate change adaptation, resiliency, and mitigation (e.g. Ocean Resources Management Plan Working Group 2009, Office of Environmental Quality 2010, U.S. Department of Commerce. National Oceanic and Atmospheric Administration 2010, Codiga and Wager 2011).

In Hawai‘i, climate change has begun to cause air temperatures to rise, sea level and sea surface temperatures to increase, and the ocean to become more acidic (Fletcher 2010). Overall rainfall has decreased resulting in a decrease of stream flow; however the intensity of individual rainfall events has increased which can result in flooding in some areas. Because these trends are likely to continue, scientists anticipate growing impacts to Hawai‘i’s water resources and forests, coastal communities, and marine ecology (Fletcher 2010). Carpenter et al. (2008) report that one-third of reef building corals worldwide face an elevated extinction risk from climate change and other impacts today, but they also state that Hawai‘i’s coral reefs have been less impacted by disease and bleaching than in many other areas. They point out that Hawai‘i is a very isolated archipelago with many rare and endemic coral species with potentially varying levels of adaptability and resilience. Pandolfi et al. (2011) suggest that although coral response to climate change thus far has been interpreted as indicating the extinction of coral reefs as we know them, there is variability in response and adaptability to climate change. They predict that reef degradation will occur with temporal and spatial heterogeneity, creating opportunity for building resiliency for reefs in the face of climate change by reducing other stressors.

The effect of climate change on the marine environment may also include changes in abundance, distribution, timing and range of migration, community structure, the presence and species composition of competitors and/or predators, prey availability and distribution, timing of breeding, reproductive success and, ultimately, survival of a variety of species (e.g. Heide-Jørgensen et al. 2011).

7.1.4.5. Entanglement



Marine mammals and sea turtles can become entangled in fishing gear and other marine debris, which can result in injury and even death (Mazzuca et al. 1998). From 2003 to 2007, there were 86 reports of human-related mortalities or injuries of humpback whales in the Central North Pacific stock that includes the approximately 10,000 humpback whales that breed in the Hawaiian Islands (Allen and Angliss 2012). Of these, 54 involved commercial fishing gear and 23 were considered lethal or likely to be lethal. The sanctuary participates in a collaborative

effort to study and respond to humpback whale entanglement. This effort, the Hawaiian Islands Large Whale Entanglement Response Network, includes state, federal, and local agencies, as well as whale researchers, tour operators, fishermen, and other citizens. The network was established in the 2001-2002 humpback whale season and has grown to over 230 members with various levels of training. Over 11 seasons, the network received 109 confirmed reports of humpback whales entangled in gear and three reports of other entangled large whales. This represents as many as 70 different animals (Lyman 2012).

7.1.4.6. Wildlife Approach & Interaction

Wildlife approach and interaction can lead to behavioral harassment or physical injury.

Behavioral harassment refers to human activities that can affect the behavior of wildlife, thereby potentially affecting energy budgets and habitat use patterns, cause displacement from preferred habitats, and affect individual and population health and fitness. For example, swimmers and vessels have been documented harassing spinner dolphins in bays in Hawai‘i while dolphins are attempting to rest during the day (*e.g.*

Danil et al. 2005, Courbis 2007, Courbis and Timmel 2009). The potential impacts of spinner dolphin harassment are considered serious enough that NOAA Fisheries published an intent to make regulations to reduce these impacts (US DOC NOAA 2005). It can be difficult to document physiological and population level responses to harassment that does not result in immediate or obvious injury.



However, increases in human contact with dolphins has been shown to lead to habituation that can cause changes in dolphin behavior that potentially results in death (*e.g.* Stone and Yoshinaga 2000), and causes as much as double the normal rate of calf mortality in the first year of life (*e.g.* Mann et al. 2000). In the Hawaiian Islands, studies indicate that spinner dolphin behavior patterns may have changed over time as a result of increased swimmer and vessel activity in bays (Courbis and Timmel 2009). As a response to concern regarding harassment, the federal government prohibits approaching within 100 yards of humpback whales, but no such regulations are in effect for spinner dolphins and other Hawaiian wildlife.

Feeding wildlife is a type of harassment. Feeding can habituate animals, increase aggressive behavior, provide poor quality food compared to natural foraging foods, and make animals vulnerable to being fed inedible objects or approaching dangerous objects (like boat propellers). As a result of such concerns, shark feeding as part of commercial operations has been prohibited by the State of Hawai‘i (Haw. Rev. Stat. §188-40.6). Fish feeding for purposes other than fishing is prohibited in Marine Life Conservation Districts in the State of Hawai‘i (Haw. Adm. Rul. §13.4-60.3).

Attitudes toward wildlife can impact human behavior with respect to approach and interactions. Wiener et al. (2009) found that many visitors and commercial tour boat operators in the Hawaiian Islands dump food scraps, feed fish, trample coral, and harass marine life. However, Needham (2010) concluded that, based on surveys of 2,821 reef users in the Hawaiian Islands,

most reef users have a protectionist attitude toward reefs and want to conserve these ecosystems. Another recent survey conducted collaboratively by Honua Consulting, Department of Land & Natural Resources, and University of Hawai‘i indicated that visitors who want to experience the closest approaches to wildlife consider themselves to be the most environmentally oriented, suggesting that positive attitudes toward wildlife and the environment may actually encourage harassment (Jennifer Bernstein, University of Hawai‘i pers. comm.). In some cases, people consider harassment to be acceptable if animals have a “choice” to avoid harassment. This assumes that animals always make good “choices” with respect to their health and fitness, which is likely not the case, as evidenced by studies such as the ones described above indicating instances of increased dolphin calf mortality, as well as injury and adult death associated with interactions with humans. Although ecotourism and resident enjoyment of wildlife in the Hawaiian Islands is a valuable ecosystem service that provides aesthetic, cultural, and economic benefit, it is important to consider the impacts of these uses. As wildlife in Hawai‘i is one of the attractions for a large number of visitors, as well as Hawai‘i’s residents, it is important to develop sustainable wildlife viewing practices to minimize wildlife harassment.

7.1.4.7. Vessel Strike

Historical records indicate ship strikes fatal to whales first occurred in the late 1800’s as ships began to reach speeds of 13-15 kn (Laist et al. 2001). As number and speed of ships increased, so did the frequency of lethal ship strikes. They stated that humpback whales are commonly struck by vessels. From reviewing the literature on ship strikes, Laist et al. (2001) concluded that most lethal or severe ship strike injuries to large whales are caused by ships 80 m or longer and



travelling 14 kn or faster. Based on literature review and modeling, Vanderlaan and Taggart (2007) found the greatest rate of change in probability of lethal injury to a large whale is at vessel speeds between 8.6 and 15 kn. The probability of a lethal injury drops to below 0.5 at 11.8kn and asymptotically approaches one at above 15 kn. A study conducted in the Stellwagen Bank National Marine Sanctuary indicated that vessel speed restriction

would reduce lethality of right whale collisions with vessels (Wiley et al. 2011). Modeling indicated that speed limits of 12kn would reduce lethality by 29.4% and of 10kn would reduce lethality by 56.7%. Likewise, Conn & Silber (2013) found that reduced vessel speeds of commercial vessels reduced the risk of mortality in North Atlantic right whale vessel strikes. Lammers et al. (2013) found that most whale-vessel collisions in Hawaii were from boats that ranged between 7.9m and 19.8m in length. This size is typical of touring vessels which also suggests that incidents occur more frequently based on the vessels interactions with the whales and increased traffic in known whale environments (Lammers et al. 2013).

Gende et al. (2011) studied the distance between cruise ships and humpback whales in Alaska with respect to ship speed. They found that the relationship between whale distance and ship speed changed at 11.8 kn such that humpback whales were first encountered 114 m closer when ship speed exceeded 11.8 kn. This study shows that ship speed is linked to encounter distance, and encounter distance can affect likelihood of ship strike. Although these studies all indicate that vessel speed influences the lethality of ship strike, it should be noted that Wiley et al. (2008) found that in the Northeastern U.S., whale watching operations had a high level of non-compliance (mean 0.78) with NOAA recommended speed zone limits, with compliance diminishing with increased proximity to whales. Based on this study, this voluntary program did not achieve the goal of significantly reducing vessel speed near whales. McKenna et al. (2012) also found that voluntary speed restrictions were ineffective near the California coast. It should be noted that these voluntary programs were focused on large commercial vessels only.

In 2008, NOAA enacted a rule to implement speed restrictions to reduce the threat of collisions with North Atlantic right whales (78 FR 73726). This rule requires that vessels 65 ft and larger must travel at 10 kn or less near key port entrances and certain areas of right whale aggregation known as Seasonal Management Areas. Although this rule applies to areas within Stellwagen Bank National Marine Sanctuary, it was promulgated by NOAA Fisheries, not ONMS. With respect to humpback whales, Glacier National Park in Alaska has restrictions on vessel speed and location of transit in what are defined as “whale waters” from May 15 to September 30 (36 C.F.R. § 13.1174 & 13.1176(a)) to protect humpback whales from ship strikes. Silber and Bettridge (2012) recommend vessel speed restrictions as a means to reduce ship strikes, but also caution that strong consideration must be given to economic and other impacts to maritime communities. From 2003 to 2007, eight ship strikes that were considered lethal or likely to be lethal were recorded for whales in the Central Pacific stock in Alaska (Allen and Angliss 2012). There were a total of 44 confirmed vessel strikes to humpback whales in Hawaiian waters from 2008-2013. It should be noted that speed restrictions have been focused on large commercial vessels rather than individual boaters or tour operations.

In 2003, the Hawaiian Islands Humpback Whale National Marine Sanctuary convened a workshop to evaluate vessel strike of humpback whales in Hawai‘i (US DOC NOAA 2003). The workshop concluded that vessel strike was not a critical issue at that time but encouraged continued research and education about the issue. The International Whaling Commission held a workshop in 2010 to develop strategies to reduce the risk of collisions between cetaceans and vessels (International Whaling Commission 2011). This workshop reviewed existing information, risk assessment, and mitigation measures and made recommendations for data collection, conservation measures, and reporting. Mitigation measures for reducing risk included routing options, speed restrictions, reporting systems, observers, and technological approaches.

7.1.4.8. Introduced Species

An introduced species is any species (including but not limited to any of its biological matter capable of propagation) that is non-native to the ecosystems of the sanctuary; or any organism into which altered matter, or genetic matter from another species, has been transferred in order that the host organism acquires the genetic traits of the transferred gene. Species can be introduced to the marine ecosystem via a variety of mechanisms including vessel hulls, rudders, propellers, live-well tanks or sea chests, intake screens, ballast pumps, ballast water, and

seawater piping systems. As many as 3,000 introduced species have been transported by ships around the world (MIT Sea Grant 2004). Similarly, they may be transported by dredging and drilling equipment, dry docks, buoys, seaplanes, canals, marine debris, and recreational equipment (Carlton 2001). They may also be introduced through attachment to an intended introduced species; intended introduction for commercial and sport fishery, mariculture, or biocontrol efforts; release of unwanted organisms by aquarists or bait fishermen; intentional or accidental release during transport for research, restoration, education and aquarium activities; and natural spread from original point of introduction.



Exotic species can have a number of impacts on native coastal marine species including replacement of a functionally similar native species through competition; reduction in abundance or elimination of an entire population of a native species, which can affect native species richness; and inhibition of normal growth or increased mortality of the host and associated species. Other impacts include increased intra- or interspecies competition with native species; creation or alteration of original substrate and habitat; hybridization with native species and other genetic effects; transfer of new parasites and diseases; and direct or indirect toxicity (e.g., toxic diatoms).

7.1.4.9. Ocean Noise

Underwater sound in the ocean can come from a variety of natural and anthropogenic sources. Anthropogenic sources include shipping, general vessel traffic, tour boats, aircraft, research, energy and mineral exploration, underwater construction, seismic devices, pingers, and navy activities, such as use of sonar and underwater explosions. Potential impacts of sound on marine organisms can range from no or very little effect to various levels of behavioral reactions, physiological stress, threshold shifts, auditory masking, and direct trauma. Responses to sound generally fall into three categories: behavioral, acoustic, and physiological (Nowacek et al. 2007). Noise pollution can be intense and acute or less intense and chronic (Hildebrand 2004). Hildebrand (2004) states that estimates suggest noise levels in the ocean were at least ten times higher in the early 2000's than a few decades prior.

Commercial shipping is considered to be the major contributor to low frequency noise in the world's oceans (Hildebrand 2004). Pirota et al.(2012) investigated the effects of vessel noise on beaked whales (Ziphiidae) and found that broadband ship noise caused a significant change in beaked whale behavior up to at least 3.2 miles (5.2 km) away from the vessel. Rolland et al. (2012) found that reduction in shipping noise in the Bay of Fundy led to a significant reduction in stress-related fecal metabolites in North Atlantic right whales (*Eubalaena glacialis*). Visual observations of bowhead (*Balaena mysticetus*) and other baleen whales have indicated that individuals can be displaced when exposed to continuous industrial sound that exceeds approximately 120 dB or 1 μ Pa (microPascal; a unit of pressure; Richardson et al. 1995).

In addition to commercial shipping, smaller commercial vessels and recreational watercraft add noise to the ocean environment. Erbe (2013) reports that personal watercraft like jet skis are quieter underwater than boats but sound pressure level might not be a good indicator of bioacoustic impacts. Personal watercraft produce underwater noise between 100Hz and 1kHz

(Erbe 2013). Personal watercraft operators in Hawai‘i are required to take a safety course that includes information about protected species in Hawai‘i (Haw. Adm. Rul. § 13-256-16), and permits are required for commercial personal watercraft operation (Haw. Adm. Rul. § 13-256-18). Personal watercraft are banned in certain areas and at certain times of year in Hawai‘i to protect humpback whales and other marine wildlife (Haw. Adm. Rul. § 13-256-16).

Active sonar, as is used by the Navy in Hawai‘i’s waters, emits high-intensity acoustic energy and can be categorized as low-frequency (<1000Hz), mid-frequency (1-20kHz), and high frequency (>20kHz) (Hildebrand 2004). Hildebrand (2004) suggests that low-frequency active sonars have long ping lengths and nearly continuous duty cycles that increase the likelihood they will impact marine mammal populations. Humpback whales in the Atlantic have been found to sing longer songs during low frequency active sonar transmissions by the Navy, and it has been suggested that this indicates that whales are compensating for acoustic interference (Miller et al. 2000). Frstrup et al. (2003) found a similar result and documented a delayed response to low frequency active sonar, with humpback whales showing effects up to two hours after the final sonar signal. Humpback whales near the Hawaiian Islands displayed avoidance behavior in playback experiments to assess the effects of low-frequency sonar on whales (Maybaum 1993).

There is growing evidence of a potential link between military sonar exercises and cetacean strandings, particularly with respect to beaked whales (Ziphiidae). Reports of such strandings include events in the Canary Islands, Bahamas, and Greece (Simmonds and Lopez-Jurado 1991, Frantzis 1998, Cox et al. 2006). In Hawai‘i, a mass stranding of more than 150 melon-headed whales occurred in Hanalei Bay in 2004 (ultimately resulting in one melon-headed whale death) during Rim of the Pacific Exercises, which Southall et al. (2006) considered a plausible, if not likely, contributing factor in the stranding. However, others suggested this stranding event could have been related to lunar influences (Mobley Jr. et al. 2007). Faerber and Baird (2010) conclude that a lack of mass strandings on the Hawaiian Islands cannot be considered evidence of a lack of impact from anthropogenic activities because the likelihood of finding carcasses is low as a result of factors such as local currents, scavenging sharks, deep water, and varied density of humans in areas where carcasses could wash ashore. Jepson et al. (2003) has suggested that behavioral reactions to sonar may contribute to strandings and decompression-like symptoms found in stranded cetaceans. Nowacek et al. (2007) provides an extensive overview of research on the effects of sounds on marine mammals.

7.1.4.10. Marine Debris

Marine debris is defined by NOAA as any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment (Morishige and McElwee 2012). Marine debris is an ongoing problem worldwide. In Hawai‘i, derelict fishing gear and trash may be found strewn along the beaches. Much of this debris in Hawai‘i is generated at distant sources and Hawai‘i is a hotspot for aggregation of marine debris, particularly along its windward shores. Various wildlife, including protected species, become entangled, injured, and killed as a result of marine debris (Morishige and McElwee 2012). NOAA and its partners have developed a *Hawai‘i Marine Debris Action Plan: 2012-2013* (HI-MDAP 2012) based on ongoing and past efforts. The overall purpose of the HI-MDAP is to establish a comprehensive framework for strategic action to reduce the ecological, health and safety, and economic impacts of marine debris in Hawai‘i by 2020.

Ribic et al. (2012) evaluated marine debris loads along the U.S. Pacific Coast and Hawai‘i. They found that Hawai‘i had the largest marine debris load of the regions studied and most of this debris was ocean-based (~2/3) rather than land-based or general source. In addition to other sources, the tsunami that occurred in Japan in 2011 has and is predicted to continue to result in marine debris in the Hawaiian Islands. Lebreton and Borrero (2013) modeled floating debris generated by the tsunami and predicted that the majority of debris from the tsunami will accumulate in the eastern North Pacific between Hawai‘i and California. Further, it is likely that items will accumulate as relatively isolated objects rather than as a large scale beaching of debris. This individual deposition of debris may result in as much as 1kg of material per meter of coastline in western North America and Hawai‘i. They also report that a significant proportion of this debris consists of plastics that will degrade into small particles and be eaten by marine organisms, causing organic pollutants to enter the food supply in much higher quantities than prior to the influx of this debris. As of May 2013, there were eight confirmed items of Japanese tsunami debris found near the Hawaiian Islands.

Large floating marine debris has served as a vector of introduced species (Zabin et al. 2004). Marine debris also causes physical abrasion, breakage, and shading of coral reef habitat. The few studies conducted on reefs indicate that impacts to sessile marine invertebrates include damage and death (Chiappone et al. 2005). Additionally, entanglement with derelict monofilament fishing line has been shown to cause significant coral mortality (Asoh et al. 2004). These effects have been shown to create long-lasting



changes to the reefs they impact (Precht et al. 2001). Plastics and other marine debris have been found in the gastrointestinal tracts of cetaceans, including instances in which enough debris was found that it likely caused impairment of digestive processes or even death (Simmonds 2012). Large whale entanglement can occur in derelict fishing gear. Sea turtles are particularly prone to eating plastic scraps and other buoyant marine debris and to tangle themselves in derelict lines and netting (Carr 1987). In the early 2000's, Boland and Donohue (2003) reported that marine debris was undermining population recovery efforts for the Hawaiian monk seal.

From small beach cleanups to the multi-partner *Hawai‘i Nets to Energy Program*, many activities and entities are addressing marine debris in Hawai‘i. Despite extensive efforts over the past ten years, marine debris continues to be a chronic threat to Hawai‘i's marine ecosystem as well as human health, navigation safety, and the economy (Morishige and McElwee 2012).

7.1.4.11. Pollution

Pollution can be introduced into the sanctuary via a variety of mechanisms that include point and non-point sources. Pollution can be generated in the ocean, on the ocean, nearshore and inland.

Sessile organisms (fixed in one place) can be especially vulnerable to pollution as they cannot move to avoid it. State of Hawai‘i (2010) reports that while Hawai‘i’s reefs are still in fair to good condition, many urban areas and popular destinations have suffered from land-based sources of pollution. This report goes on to state that land-based sources of pollutants, such as sediments and nutrients, threaten the quality of coral reef ecosystems. These pollutants are often transported in surface-water runoff and by groundwater seepage into coastal waters. While the complex interrelationship between land-based sources of pollution, water quality, and the health and integrity of coral reef ecosystems is not well understood, enough is known to require management policies that minimize polluted surface-water runoff (State of Hawai‘i 2010). Some significant pollutants include pesticides, petroleum hydrocarbons, pharmaceuticals, heavy metals, pathogens, and excess nutrients (State of Hawai‘i 2010). Impacts from toxic pollutants are poorly understood but potentially severe (State of Hawai‘i 2010). Persistent organic pollutants can build up in organisms, particularly apex predators. For example, false killer whales near the populated Hawaiian Islands have been found to have contaminant loads of persistent organic pollutants that could potentially affect their health (Ylitalo et al. 2009).

In addition to chemical and biological pollutants from run-off and development, sediment can pollute nearshore waters, potentially damaging coral reefs and causing stress to nearshore organisms that reduce their resiliency to other threats, such as climate change. The Department of Land & Natural Resources (2011) states in its *Rain Follows the Forest Plan* that sedimentation from erosion harms the once-pristine nearshore marine waters and coral reef ecosystems of Hawai‘i, and Friedlander et al. (2008) report that sediment is likely the leading land-based pollutant causing alteration of reef community structure.



The Clean Water Act (CWA) (33 U.S.C. §1251 *et seq.*) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained. The Hawai‘i Department of Health’s (DOH) *Water Resource Protection Plan* and *Water Quality Plan* provide the overall legal and policy framework that guides the development, conservation, and use of water resources in Hawai‘i. The DOH has also promulgated rules to reduce pollution into coastal waters (Haw. Adm. Rul. § 11-54 and Haw. Adm. Rul. § 11-55). The Division of Boating and Recreation limits the types of discharge allowed from vessels into marine waters (Haw. Adm. Rul. § 13-342D). However, pollution continues to be a concern and a threat to Hawai‘i’s marine organisms and habitats.

7.2. Human Environment

7.2.1. Human and Economic Setting

The human environment includes human socioeconomic and demographic indicators including human population size and change, along with employment, labor force, unemployment trends, and industrial earnings, to describe the economic health of the region. The protection of children and environmental justice populations are also identified.

7.2.1.1. Population

The estimated resident population of the State of Hawai‘i as of 2012 was 1,392,313 (US Census 2012).⁶ Demographic data for the State of Hawai‘i is based on the 2010 U.S. Census population when the state population was estimated to be 1,360,301. O‘ahu is the most populated island in the Hawaiian Archipelago with 953,207 residents in 2010, followed by Hawai‘i Island (185,079) and Maui (144,444). Ni‘ihau has the smallest resident population of the populated Hawaiian Islands with only 170 residents (Table 13). By county, approximately seven out of every ten residents in the State of Hawai‘i live in the City and County of Honolulu (Table 14). Kaua‘i County has the smallest population with only 69,512 residents (5.0% of the population of the State of Hawai‘i).

Island	Population (2010)	% State
State	1,360,301	
Hawai‘i	185,079	13.6%
Kaho‘olawe	-	
Maui	144,444	10.6%
Lāna‘i	3,135	0.2%
Moloka‘i	7,345	0.5%
O‘ahu	953,207	70.1%
Kaua‘i	66,921	4.9%
Ni‘ihau	170	0.0%

Table 13. Population distribution by island for the State of Hawai‘i (2010).

Source: *Hawai‘i State Data Book, 2011.*

County	Population (2013)	% State
State of Hawai‘i	1,404,054	
City and County of Honolulu	983,429	70.0%
Hawai‘i County	190,821	13.6%
Kaua‘i County	69,512	5.0%
Maui County ⁷	160,292	11.4%

Table 14. Population distribution by county for the State of Hawai‘i.

Source: *Hawai‘i State Data Book, 2013.*

⁶ The resident population is defined as the number of persons whose usual place of residence is in an area, regardless of physical location on the estimate or census date. It includes military personnel stationed or home ported in the area and residents temporarily absent, but excludes visitors present (Hawai‘i State Data Book 2011).

⁷ Maui County includes Kalawao County (Kalaupapa Settlement). Kalawao had 147 in 2000 and 90 in 2010.

The population of Hawai‘i has increased significantly since 1900. At the turn of the century, the population of the State of Hawai‘i was approximately 154,000 (Hawai‘i State Data Book 2011). Population grew steadily throughout the century but the growth rate has declined since the 1990s. Population growth has occurred primarily in the City and County of Honolulu. In 1900, only 58,504 residents lived in the county of Honolulu. By 1960, the population had boomed to over half a million. Today the population is just under one million residents and population in the county continues to grow at a steady rate. The percent of the population born in Hawai‘i grew throughout the first half of the twentieth century from 38.3% in 1900 to 71.1% in 1950. However it has steadily declined since then, dropping to 56.9% in 2000.

7.2.1.2. Employment

The average size of the civilian labor force in the State of Hawai‘i in 2013 was 648,850, of which approximately 30,900 (4.8%) were unemployed (Hawai‘i State Department of Labor & Industrial Relations 2013). The average annual wage in Hawai‘i in 2012 was \$44,767 slightly above the U.S. average annual wage of \$43,735 (Hawai‘i State Data Book 2013). Per capita annual income was highest in the City and County of Honolulu (\$48,529; Table 15), over \$15,000 higher than in Hawai‘i County, which had the lowest per capita annual income (\$33,398). It follows that the City and County of Honolulu had the lowest unemployment rate (4.3%) while Hawai‘i County had the highest unemployment rate (6.8%).

County	Civilian Labor Force	Employed	% Unemployed	Per Capita Income (2012)
State of Hawai‘i	648,850	617,950	4.8%	\$44,767
City and County of Honolulu	456,800	437,250	4.3%	\$48,529
Hawai‘i County	82,150	76,600	6.8%	\$33,398
Kaua‘i County	32,400	30,550	5.7%	\$38,392
Maui County ⁸	77,500	73,550	5.1%	\$37,909

Table 15. Employment status and per capita personal income by county (2013).

Source: *Hawai‘i State Data Book, 2013.*

The unemployment rate in Hawai‘i has shown no long-term trends from 1976 through 2011. The unemployment rate increased from 2.7% in 2007 to 4.1% in 2008 and 6.9% in 2009 where it remained for the next two years. The government (20%), trade, transportation and utilities sectors (18.7%), and leisure and hospitality sectors (17.8%) are the largest employers in the State of Hawai‘i (Table 16).

⁸ Maui County includes Kalawao County (Kalaupapa Settlement). Kalawao had 147 in 2000 and 90 in 2010.

Industry	State Total	% State	City & County of Honolulu	Hawai'i County	Kaua'i County	Maui County
Natural resources, mining, construction	30,800	4.9%	23,000	3,500	1,300	3,100
Manufacturing	13,500	2.2%	10,900	1,300	300	1,100
Trade, transportation & utilities	117,000	18.7%	83,500	13,300	5,800	14,400
Information	8,500	1.4%	7,100	600	200	600
Finance, Real Estate & Insurance	27,100	4.3%	20,400	2,700	1,400	2,600
Professional & business services	79,400	12.7%	64,000	6,100	2,700	6,600
Education services	15,100	2.4%	12,600	1,300	200	1,200
Health care & social assistance	63,900	10.2%	49,500	6,800	2,500	5,200
Leisure and hospitality	110,800	17.8%	66,100	13,000	9,100	22,700
Other services	26,700	4.3%	20,900	2,100	900	2,700
Federal, State & Local Government	124,800	20.0%	97,800	12,700	4,500	9,700

Table 16. Occupation by industry and county (2010).

Source: Hawai'i State Department of Labor and Industrial Relations (Hawai'i State Data Book 2013).

7.2.1.3. Ocean Economy

In 2009, the Hawai'i ocean economy supported 92,160 jobs or 15.6% of all jobs in Hawai'i.⁹ Furthermore, ocean activities generated \$5.2 billion in GDP (8.0% of the GDP produced in the Hawai'i State economy (ENOW Final Economic Report 2012). From 2005 to 2009, employment in the Hawai'i ocean economy fell 6.3%, driven largely by employment losses in the tourism and recreation, living resources, and marine transportation sectors. Employment in the overall Hawai'i state economy fell 1.9% (compared to 2.3% in the United States). However, the Hawai'i ocean economy real GDP grew by 5.8% over the same period. This growth was driven primarily by gains in ship and boat building, marine construction, and marine transportation. In 2009, wages per employee in the Hawai'i ocean economy averaged \$28,069 (32% below the state average GDP). This is largely due to the low average annual wage per employee in the tourism and recreation resources sectors. Four of the other ocean sectors (marine construction, offshore mineral extraction, ship and boat building, and marine transportation) had wages per employee above the state average in 2009 (ENOW Final Economic Report 2012).

7.2.1.4. Value of Coral Reefs

Coral reefs are considered particularly valuable in Hawai'i. A 2011 study found that individuals value coral reef ecosystems in Hawai'i both for their personal use and consumption (*direct use*) as well as for reasons that are not related to use (*passive use*). For example, many people across the United States believe that coral reefs are part of our collective legacy to future generations and therefore have value to society (Bishop 2011). Since passive uses, and many direct uses, do

⁹ Ocean economy includes tourism and recreation, offshore mineral extraction, living resources (fishing, aquaculture, and seafood processing), marine construction, ship and boat building, and marine transportation.

not involve the exchange of money, researchers conducted a nation-wide survey to determine individual willingness to pay to protect and restore coral reef ecosystems. The study considered two scenarios:

- Potential value of increasing the size of no-fishing zones around the populated Hawaiian Islands from 1% of reefs to 25% (threshold where substantial benefits to fish and the larger ecosystems would start being achieved).
- Potential value of repairing 5 acres of reefs per year damaged by ship accidents (rough, current estimate of average annual damage from ship accidents). Restoration of ship-damaged reefs would reduce recovery time by 40 years compared to natural recovery.

The results suggest that the protection and restoration of degraded ecosystems, as exemplified by increasing marine protected areas in the populated Hawaiian Islands to 25% is worth about \$224.81 per year to the average U.S. household (Table 17). Restoration of coral reefs after localized injuries, as exemplified by repairing 5 acres of reef per year after ship strikes, is worth about \$62.82 per year (Table 17). This makes the estimated value of doing both about \$34 billion per year when aggregated over the entire number of households in the United States (Table 18).

Value	Estimated Willingness to Pay (WTP)	Standard Error	95 %Confidence Interval
Ecosystem-wide protection and restoration	\$224.81	\$32.19	\$161.72 - \$287.89
Restoration after localized injuries	\$62.82	\$21.73	\$20.23 - \$105.40
Total	\$287.62	\$48.04	\$193.46 - \$381.78

Table 17. Mean willingness to pay (WTP).
Sample size (N=3,183)
 Source: *Bishop 2011*.

Value	Estimated Willingness to Pay (Billions \$)	95% Confidence Interval (Billions \$)
Ecosystem-wide protection and restoration	\$26.24	\$18.88 - \$33.60
Restoration after localized injuries	\$7.33	\$2.36 - \$12.30
Total	\$33.57	\$22.58 - \$44.56

Table 18. Estimated annual willingness to pay.
 Source: *Bishop 2011*.

7.2.2. Cultural and Historic Setting

7.2.2.1. Cultural Resources

Cultural resources include material remains of past human activities, both from historic and Pre-European contact. In addition, cultural resources include traditional cultural properties, such as areas used for ceremonies or other cultural activities that may leave no material traces, and may have on-going use important to the maintenance of cultural practices. For cultural resources qualifying as historic properties, protection is afforded under the National Historic Preservation Act (NHPA). NHPA defines a historic property as “any Pre-European contact or historic district, site, building, structure, or object included in, or eligible for listing on the National register, including artifacts, records, and material remains related to such a property or resources (46 C.F.R. § 800, as amended 2006, Title III, Section 301, #5). The criteria for evaluating eligibility for listing on the National Register of Historic Places are as follows:

The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling the association and:

- That are associated with events that have made a significant contribution to the broad patterns of our history; or
- That are associated with the lives of persons significant in our past; or
- That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
- That have yielded, or may be likely to yield, information important in prehistory or history (Monk Seal PEIS 2014; National Park Service 1997).

If a cultural resource can be demonstrated to meet the criteria for listing on NHRP, it qualifies as an historic property, and direct and indirect impacts to that historic property must be avoided and mitigated appropriately.

7.2.2.2. Cultural History and Uses

The core of Hawaiian culture, philosophy, religion and worldview is founded in ‘āina/kai dualism, the inseparable relationship between the land and sea. Kumulipo, meaning "source from the depths," is a cosmogenic genealogy and historical account of the emergence of life forms. From the first corals to the birth of man and woman, and the birth of gods that followed, each stanza brings two entities to life: one from the kai and one from the moana. It is this vast, boundless relationship between man and nature found throughout the Hawaiian culture that makes the evolution to an ecosystem based management approach consistent with Hawaiian cultural practices and traditions.

Further, within each area may be found a vast array of sites that support cultural practices, accesses, traditions and usage that support ecosystem and culturally based management. These activities also serve as the foundations of the three forms of Hawaiian cultural heritage: tangible cultural heritage, intangible cultural heritage and natural cultural heritage. The list below, based on an original list developed by the Hawai‘i State Office of Planning in 2002, is the result of a

statewide community assessment conducted in 1992. The following is a list of both tangible and natural heritage resources. Intangible heritage resources include: hula (dance), mele (song), oli (chant), mo‘olelo (stories), mo‘okū‘auhau (genealogies) and other oral histories and traditions.

Cultural Heritage Resource	Definition
Ahu	Heap, pile, collection, mound, mass; altar, shrine, cairn; a traplike stone enclosure made by fishermen for fish to enter; laid, as the earth oven.
Ana (Karst)	Cave, grotto, cavern.
Bathing pools	Areas revered for ritualistic bathing.
Heiau	Pre-Christian place of worship, shrine.
Historic Walls	Historic Walls.
Hō‘ailona	Symbol, sign, as in math.
Holua slides	Sled, especially the ancient sled used on grassy slopes; the sled course.
‘Ala Hele	Pathway, route, road, way to go, itinerary, trail, highway, means of transportation.
‘Aumakua	Family or personal gods, deified ancestors who might assume the shape of sharks, owls, hawks, ‘elepaio, ‘iwi, mudhens, octopuses, eels, mice, rats, dogs, caterpillars, rocks, cowries, clouds, or plants.
‘Auwai	Irrigation ditch.
Kahawai	Stream, creek, river; valley, ravine, gulch, whether wet or dry.
Kāheka	Pool, especially a rock basin where the sea washes in through an opening and salt forms; salt pond.
Kāhekaheka	Plural and diminutive of kāheka; small sea pool or pools; artificial salt pan.
Ki‘i Pōhaku	Stone statue; petroglyph.
Kilo i‘a	A man who observes fish movements from a high place and directs fishermen; to so act.
Ko‘a	Coral, coral head.
Kula	Plain, field, open country, pasture.
Leina	Spring, leap, bound; place to leap from.
Lo‘i	Irrigated terrace, especially for taro, but also for rice; paddy.
Loko Wai / Loko I‘a	Fresh-water pond or lake; fountain. Fishpond system.
Lua Pō	Grave.
Mala	Garden, plantation, patch, cultivated field, as māla ‘ai, māla kalo, māla kō, māla kūlina.
Mea Ulu	Native plants.
Muliwai	River, river mouth; estuary.
Omo ‘ā	Natural conduits through which lava travels beneath the surface of a lava flow.
Po‘ina Nalu	Where a wave breaks; surf break.
Po‘o Wai	Water source or head, dam.
Pu‘e One	Sand dune, sand bar.
Pu‘uhonua	Place of refuge, sanctuary, asylum, place of peace and safety.
Punawai or Waipuna	Water spring.
Uapo (bridge)	Wharf pier, quay, dock, bridge.
Wahi Kapu	Sacred place.
Wahi Lawai‘a	Place of fishing
Wahi Pana	Legendary place.
Wells	Source of water.

Table 19. List of cultural heritage resources in Hawai‘i

Soure: *McGregor et al. 2002; Honua Consulting 2014.*

Koholā, the humpback whale, is revered as a body form of Kanaloa, the supreme ocean deity. The ocean itself is a form of Kanaloa, known as kai, moana and moananuiākea (vast ocean). The current sanctuary boundaries are not known to the koholā. Wherever koholā are seen, a deity is seen. Beyond the current sanctuary zones, tradition mele (poetic texts) and wind names memorialize areas where koholā breach. Koholālele, meaning leaping whale, is a wind offshore of Hāna, Maui. 'O ka pā mai a ka makani Koholālele, kai hālulu i ke alo a'o Ka'uiki. The Koholālele wind blows, the sea roars in the presence of Ka'uiki hill (Song: Ka Uakea). When and where koholā are seen, a deity is seen.

Table 19 illustrates the wide range of cultural resources and uses that could occur within or adjacent to sanctuary boundaries. While many may not rise unto themselves as being discrete properties eligible for NRHP, cultural resources are nonetheless protected under NHPA and NEPA and should be documented, treated and any adverse impacted mitigated accordingly.

There are cultural resources that have been identified as significant within sanctuary boundaries. These include traditoanal Hawaiian fishponds, surfing site and navigation sites. The Office of Hawaiian Affair's Kipuka Database is a geographical information system (GIS) that provides the location of and basic information on historic and culturally important sites in Hawaii, which are searchable by traditional Hawaiian land divisions (<http://www.kipukadatabase.com>).

Traditional Hawaiian Fishpond System (loko i'a)

Hawaiian fishpond systems, loko i'a, are some of Hawai'i's most significant traditional cultural resources. They are biocultural articulations of Hawaiian innovation in the areas of engineering, education, hydrology, aquaculture and biology. Further, they demonstrate traditional Hawai'i's excellence in sustainability, food sovereignty and natural resource management (Watson 2012).

The history of loko i'a is rich and extensive. According to oral histories, Hinapukui'a, whose name translates to "Hina gathering seafood," is the goddess of fishermen. She is the wahine (wife or mate) of Kū'ulakai, and she is the sister of Hinapuku'ai, Hina gathering vegetative foods. She is also the mother to 'Ai'ai. Hinapukui'a's kane (husband or mate), Kū'ulakai, is the god and kupuna of fishermen and is said to have built the first fishpond at Leho'ula on the island of Maui. Kū'ula, as he was also known, was said to be kino lua, dual bodied. He was said to be empowered with mana kupua, supernatural powers. He could control all the fish in the sea. Kū'ulakai and Hinapukui'a lived in Alea-mai on East Maui. They made their residence near Kaiwiopele, the cinder hill names for "the bones of Pele", named for the place where Pele left some of her iwi (bones) after a battle with her sister, Nā-maka-o-Kaha'i. It was near Kaiwiopele that Kū'ulakai built the first traditional Hawaiian fishpond in Hāna. Kū'ulakai would share his knowledge of fishing and fishing practices with maka'āinānā (common citizens) across Hawai'i through his son, 'Ai'ai, identified also as a god of fishermen. Written sources and oral traditions tell of 'Ai'ai's extensive travels throughout Hawai'i during which he established fishing alters, called kū'ula after his father, and fishing areas, known as ko'a (Watson 2012).

Loko i'a (traditional Hawaiian fishpond systems) were an important part of Hawai'i's complex and sustainable natural resource management system. The full-scale development of loko i'a from mauka (the mountains) to makai (the ocean) dates back over half a millennium. Cultivation and propagation centered on many different fresh and salt-water plants and animals, with the

primary species being the prized ‘ama‘ama (mullet) and ‘awa (milkfish). An inventory in the early 1900s found 360 loko i‘a in the islands and identified 99 active ponds with an estimated annual production total of about 680,000 pounds, including 486,000 pounds of ‘ama‘ama and 194,000 pounds of ‘awa. Loko i‘a were extensive operating systems that produced an average of 400–600 pounds per acre per year, a significant amount considering the minimal amount of fishpond “input” and maintenance effort apparent by that time. Increasing immigration and western influences during the nineteenth and twentieth centuries, coupled with industrialization, and urbanization had a devastating impact on the traditional Hawaiian resource management systems in Hawai‘i (Watson 2012).

In the past decade, there has been a renewed interest in the repair and operation of traditional Hawaiian fishponds, for their cultural, economic and ecological value. Community organizations and traditional fishpond practitioners face the challenge of maintaining and restoring fishpond systems. Government regulations often restrict activities in the near shore area and the process to obtain permits can be complicated. The difficulty of Hawaiian fishpond revitalization is compounded by the unique, fragile, and sometimes rugged environments in which they exist. Due to their geographic locations, unique ecosystems, engineering and complex biological functioning, Hawaiian fishponds are subject to a myriad of regulations and oversight by a host of different agencies. The end result is that obtaining the necessary permits and approvals to restore, repair, maintain and reconstruction fishponds is both costly and time-consuming.



The sanctuary is committed to supporting local community efforts to restore fishponds in Hawai‘i. The sanctuary has been instrumental in establishing a Regional General Permit (RGP) with the U.S Army Corps of Engineers Honolulu District Office that will allow the State to streamline the permitting process by utilizing a single application process for restoration activities. The objective of the RGP is the restoration, repair, maintenance and reconstruction of loko i‘a across the pae‘āina of Hawai‘i (Hawaiian Archipelago). This action will stimulate traditional Hawaiian cultural activities, the restoration of fishpond systems and their related ecosystem services.

Surfing Sites

Hawaiians practiced six different traditional surf sports: *he‘e nalu*, or board surfing; *pākākā nalu*, or outrigger canoe surfing; *kaha nalu*, or body-surfing; *pae po‘o*, or bodyboarding; *he‘e one*, or sand sliding; and *he‘e pu‘e wai*, or river surfing (Clark 2011). ‘Ōlelo Hawai‘i use the word *au*, or “swim” to describe the manner in which surfers would head out into the lineup by holding onto

the backs of their boards and kicking out to sea with the rest of the board extending in front of them (Clark 2011).

During the 1800s both Hawaiian and non-Hawaiian writers described surfing as a “national pastime,” implying that the activity was both beloved and widely practiced. There are numerous mentions of surfing’s prominence in Hawaiian nūpepa, such as:

Na paani kahiko o Hawai‘i nei, oia hoi ka heenalua, lelekawa, heeholua,
piliwaiwai a me ka mokomoko. He nui a lehulehu wale na hana o Hawai‘i nei,
e pili ana I nei mea he lealea, a ua kapaia mai lakou, na paani kahiko o Hawai‘i
nei. O ka heenalua, oia kekahi paani nui loa o Hawai‘i nei, mai na‘lii a na
makaainana

*The traditional past-time sports of Hawai‘i were surfing, cliff jumping, hōlua
sledding, and boxing. There were a great many things done here in Hawai‘i for
pleasure and they were all called the ancient sports of Hawai‘i. Surfing was a
very popular sport in Hawai‘i from the chiefs to the commoners*

- Ka Nupepa Kuokoa, Dec 23, 1865. P. 1. (Clark 2011).

Men and women both traditionally engaged in surfing activities in Hawai‘i. One woman who displayed exceptional surfing abilities was the goddess Hi‘iaka, as observed in *Ka Mo‘olelo ‘O Hi‘iakaikapoliopole*:

‘O ia hele ia o lākou nei a kā‘alo pono ma waho aku o Kahaka‘aulana, i ia wā i
‘ike mai ai ‘o Hi‘iaka iā Pele‘ulu e he‘e nalu ana i kai. ‘O kona nalu e he‘e ana,
‘o ia ka nalu a Kapu‘uiki. ‘Ike pū maila nō ho‘i ia i nā kāne a me nā wāhine e
he‘e nalu ana, a hū maila kona aloha iā Hilo i “ka he‘e pu‘ewai” o nā kāne a me
nā wāhine. I ia wā kēia i ho‘ohālike iho ai iā Pele‘ula mā me ka po‘e he‘e
pu‘ewai o Hilo, a kau a‘ela ‘o ia i kēia kau. -Nogelmeier. *Ka Mo‘olelo*. P. 298

*They sailed until passing just outside of Kahaka‘aulana, when Hi‘iaka saw
Pele‘ula surfing down at the beach. She rode the waves of Kapu‘uiki, Hi‘iaka
also saw men and women surfing, and was filled with fond recollections of
Hilo, remembrances of the men and women “surfing the river mouth.” As she
was comparing Pele‘ula and the others to the surfers of Hilo, she began this
chant.*

-Nogelmeier. *The Epic Tale*, P. 278. (Clark 2011)



Various chants and rituals surround the practice of surfing. The best known of the traditional surfing chants are kū mai chants, which were used to beckon the surf. Although there are several versions, each chant begins “Kū mai. Kū mai,” which is usually translated as “Arise. Arise” (Clark 2011). Shoreline vines called Pōhuehue, or beach morning glory (*Ipomoea pes-caprae*), were integrated into these rituals. Surfing chants were also composed in honor of Hawaiian royalty, such as Queen Emma and Queen Lili‘uokalani, whose surfing chant was named “Halehale ke aloha” (Clark 2011).

A list of primary surf locations in Hawai‘i was compiled from the writings of Hawaiian scholars John Papa‘Īi and Samuel Kamakau, and from the personal notes of noted Hawaiian scholar and linguist Mary Kawena Pukui in *Surfing: A History of the Ancient Hawaiian Sport* (See box; Clark 2011).

Traditional Surfing Spots in the Populated Hawaiian Islands.

Hawai‘i Island: Not all traditional sites still exist on Hawai‘i Island. The Pu‘u ‘Ō‘ō-Kupaianaha eruption of Kīlauea destroyed many surf sites at the bays of Kalapana and Kaimū. In *Hawaiian Surfing: Traditions from the Past*, John R.K. Clark lists 85 sites on Hawai‘i Island that have been mentioned a variety of texts (Clark 2011).

Maui: The most famous surf spot in Maui was ‘Uo, a site off the town of Lahaina. Although the reef that creates the waves at ‘Uo was altered with the dredging of a small boat harbor and channel, the spot is still one of the most popular in Lahaina today. Contemporary surfers know it as Lahaina Breakwater or Lahaina Lefts. Clark lists 29 surf sites on Maui (Clark 2011).

Moloka‘i: Surfing spots exist on each side of the island that are still visited by residents today. Hawaiian scholar Samuel Kamakau writes that the chiefs of Moloka‘i considered the surf sites at Hālawā and Kalaupapa as two of the best on the island. The only other site listed by Clark is Kalamaula (Clark 2011).

Lāna‘i: The most popular spot on Lāna‘i is at the southeastern end of Hūlōpoe Beach. Although there are no written accounts of Hawaiians surfing on the island, a kanikau published in 1878 names the surf spot at Hūlōpoe as ‘Uolokeahi. This is the only surf spot on Lāna‘i that Clark mentions (Clark 2011).

Kaho‘olawe: Although there are no written accounts of Hawaiians surfing on Kaho‘olawe, during the summer months waves break along the south end of the island at several surf spots. Clark mentions that there were about 80 men, women, and children living on Kaho‘olawe who likely partook in surfing (Clark 2011).

O‘ahu: Has more surf spots than any other Hawaiian Island and some of the best spots in the world on its North Shore. Clark lists 46 sites on O‘ahu (Clark 2011).

Kaua‘i: One of the most popular traditional surf sites was an offshore reef break in Kapa‘a called Makaīwa or Kamakaīwa. Clark lists 12 sites on Kaua‘i (Clark 2011).

Ni‘ihau: Clark lists 21 sites and references *Ni‘ihau: Traditions of an Hawaiian Island* by Reriotera‘i Tava and Moses Keale, Sr. (Clark 2011).

Traditional Navigation and Voyaging Sites

It is estimated that kanaka maoli (Native Hawaiians) began to slowly migrate to and populate the Hawaiian Islands in the year 450 A.D. It is believed that this migration, most likely from the Marquesas, was accomplished by many small groups of Polynesians setting out to sea in 80-100 foot canoes (wa‘a).

Voyaging required technologically sound vessels as well as advanced knowledge of open sea navigation. These double hulled canoes were fastened with sails and carved from a single log, often measuring longer than 100 feet. The tree would be selected by a kahuna kalai wa‘a and then cut, dragged and hollowed out by a group of men until it was ready for lashing. The wa‘a used to migrate through the Pacific were very large, made specifically for transporting people, plants, and livestock.



Once the canoe was prepared and loaded it would set out to sea. Traditional navigators could identify and name up to 150 stars, and knew the proper procedures of crossing from the northern to the southern hemisphere. Navigators used all elements and senses available to them to lead their voyage, paying close attention to stars, wind, waves and currents in order to calculate the proper heading. After populating Hawai‘i, there is no record of subsequent long ocean voyages and it is believed that navigation subsided for nearly five centuries. In 1970, the Pacific Voyaging Society constructed the *Hokule‘a* to demonstrate traditional navigation techniques (Handy et al. 1999). The *Hokule‘a*, star of gladness, is an ancient navigating replica built to demonstrate that Hawaiians skillfully navigated the Pacific Ocean in order to finally settle in Hawai‘i. The wa‘a was used for a long open voyage, without modern-day instruments, from Hawai‘i to Tahiti. Returning to this practice sparked an intense interest in Hawaiian culture in Hawai‘i. Nainoa Thomson exemplified the way that embarking on this oceanic journey revived a deep pride and reverence for all things Hawaiian (Harden and Brickman 1999).

7.2.2.3. Maritime Heritage Resources

Maritime heritage resources refer to cultural, archeological, and historical properties associated with coastal and marine areas and seafaring activities and traditions. These include shipwreck sites, historic aircraft sites, the remains of landings and dock facilities, prehistoric archaeological sites, and other types of materials. The existing maritime heritage resource inventory for resources within the sanctuary’s boundaries is comprised of vessels and historic aircraft reported lost within the sanctuary, and vessels and historic aircraft wreck sites confirmed by surveys within the sanctuary. The inventory has been compiled from various sources, such as historical documents (Thrum’s *Hawaiian Annual*, Thomas’ *Hawaiian Registered Vessels*, *Pacific Commercial Advertiser*); federal databases (Naval Historical Center aviation and shipwreck databases, inventory report *US Navy Shipwrecks in Hawaiian Waters: an Inventory of Submerged Naval Properties*); non-agency researchers (Bob Lewis, Rick Rogers); and field site investigations (University of Hawai‘i Marine Option Program, Hawai‘i Undersea Research Laboratory, Smithsonian Institute).



Historic documents indicate at least 195 ships and aircraft have been lost within the current sanctuary boundaries (including proposed boundaries for Ni‘ihau). Of these losses, some have been salvaged and some completely broken up and lost over time.

Approximately 33 sites have been confirmed by known location, and 18 have been archaeologically surveyed and assessed. It is highly probable that many more

sites have been found by sport divers and fishermen, but information regarding shipwreck locations is not always publically disclosed.

Maritime heritage resources in the Hawaiian Islands are representative of important phases in Hawai‘i’s history. Nineteenth century whaling shipwrecks represent some of the earliest sites in the Hawaiian Islands. These sites are the physical record from a critical contact period when British, French, and American whalers substantially influenced the social, economic, and political climate of the Hawaiian Kingdom. Whaling shipwrecks are exceedingly rare worldwide and may possess data about the technological advancement of the industry as well as the personal histories and effects of the sailors.

Nineteenth and early twentieth century interisland commercial vessels, both sail and steam, make up most of the vessel losses, many from the formative days of Hawai‘i’s plantation period. A variety of vessel types reflect the Hawaiian, American, and Pacific/Asian multicultural setting among the islands. Provisioning ships crossing the Pacific necessitated increased commercial trade among Hawai‘i’s landings. Sandalwood was also exported in large quantities. Local shipping concentrated on a variety of agricultural products: potatoes, rice, sugar cane, and pineapple. Cattle ranching became popular in the 1860’s, and special vessels transported herds between the islands. Locally built sampans, originally designed in Japan, opened the tuna industry beginning in 1900. The variety of sailing brigs (sandalwood), sailing schooners (agricultural products), inter-island steamers (sugar and plantation building supplies), and fishing vessels reflect the changing nature of Hawaiian economy and society.

The U.S. Navy has an important history in the Hawaiian Islands. Of the many types of military properties lost in Hawaiian waters (approximately 80 U.S. Navy ships and submarines), two types highlight critical innovations in naval strategy: amphibious vessels and naval aircraft. Landing craft, a whole new class of vessels, mark the locations of training areas used during the 1930’s and 1940’s to refine tactics and methods for the island-hopping campaign in the Pacific. And of the many aircraft lost in Hawaiian waters, more than 70 historic civilian, army, and navy aircraft were lost within the current sanctuary boundaries alone. The technical development of flying boats in Hawai‘i dates back to the 1920’s and 1930’s as do the oldest located submerged aviation crash sites. Many of these wrecks and aircraft crash sites are also grave sites that deserve appropriate respect and protection.

7.2.3. Human Uses

Human uses of the marine environment in Hawai‘i include recreational and commercial fishing, offshore development, vessel traffic and harbors, and recreation and tourism. Cultural use of the marine environment is discussed above in this section.

7.2.3.1. Fishing Activity

Recreational Fishing

Fishing is a common recreational activity in Hawai‘i. A quarter of the population participates in some form of recreational fishing at least one time per year (U.S. Department of the Navy 2008). In addition, fishing is very popular with tourists visiting Hawai‘i. Data on recreational fishing in Hawai‘i is very limited because no license is required for non-commercial, saltwater fishing. Hawai‘i has a well developed recreational fishing infrastructure with approximately 25 small boat harbors and 20 boat ramps. NOAA Fisheries suggests that the number of boats that participate in recreational fishing in Hawai‘i is likely between 5,000-6,000 (NMFS 2007). Residents and visitors spend approximately \$450 million on recreational fishing in Hawai‘i every year (Steinbeck et al. 2004). Common target species for recreational fishermen include marlin (blue and striped), tuna, wahoo, and mahimahi (NMFS 2007).



The Hawai‘i Marine Recreational Fishing Survey (HMRFS) estimate that in 2006, approximately 396,413 recreational fishermen brought in 17.6 million pounds of fish (HIPA 2009). The USFWS estimates the total number of recreational fishermen in Hawai‘i at 158,000 in 2006, a significantly lower number compared to HMRFS. The discrepancy between the two sources of data may be due to different survey methodologies and accuracy of data, as well as the lack of licensing and reporting requirements.

Commercial Fishing

Commercial fisheries in Hawai‘i are extensive and include fish caught for sale, as well as charter fishing services. All commercial fishermen are required to acquire an annual renewable commercial marine license (CML). In 2013 there were 3,970 licensed commercial fishermen in the State of Hawai‘i (State of Hawai‘i 2012). In 2011, over 29 million pounds of fish were caught for commercial purposes in the State, worth over \$71 million (WPacFIN 2011). The overall price per pound (based on amount paid to commercial fishermen by dealers) for all commercial fish in 2009 was approximately \$3.12, an increase from \$0.13 from the previous year.

Year	Number of Commercial Fishermen	Pounds Landed
2003	3,434	24,054,939
2004	2,971	22,230,489
2005	3,248	24,876,316
2006	3,137	24,636,892
2007	3,220	26,563,127
2008	3,196	33,310,542
2009	3,557	28,065,282
2010	3,373	29,164,222
2011	3,691	33,032,579
2012	3,992	31,786,440
2013	3,970	33,137,716

Table 20. Number of fishermen and pounds landed in Hawai‘i (2003-2013).

Source: *Commercial Marine Landings Summary Trend Report 2013*.

Total commercial landings vary between islands. An overwhelming majority of commercial fish landed between 2001 and 2013 came into O‘ahu. 2-4 million pounds of commercial fish were landed annually on Hawai‘i Island throughout the decade with the highest catch landed in 2007 (approximately 3.5 million lbs landed).

Year	O‘ahu	Hawai‘i	Kaua‘i & Ni‘ihau	Maui County
2001	16,332,445	3,206,429	588,460	537,833
2002	18,524,895	3,348,816	569,250	463,948
2003	19,289,833	2,717,512	663,914	609,991
2004	18,321,652	2,766,497	617,976	783,934
2005	20,887,310	3,693,069	579,603	611,085
2006	18,827,011	3,085,746	554,203	516,486
2007	26,290,499	3,560,404	791,542	608,345
2008	28,331,757	2,400,633	594,863	765,315
2009	24,123,239	2,719,908	767,019	763,733
2010	25,325,284	2,734,198	799,710	805,148
2011	28,827,042	2,642,718	771,101	738,961
2012	27,339,527	2,685,704	835,979	874,622
2013	28,045,235	3,255,962	971,686	813,935

Table 21. Commercial fish landings by port in Hawai‘i (2001-2013).

Source: *Commercial Marine Landings Summary Trend Report 2013*.

There are several methods and gear types used to fish commercially in Hawai‘i. In 2013, longline fishing landed over 25 million pounds or 76.2% of all commercial fish landed that year. Trolling and tuna handline are the other common fishing methods used in the Hawaiian Islands over the past decade.

Year	Aku Pole and Line	Longline	Handline	Trolling	Net	Trap	All Other Methods
2011	(N/A)	26,351,386	2,143,751	2,858,373	651,744	89,040	938,285
2012	369,116	24,558,662	2,211,202	3,390,318	483,258	40,461	733,423
2013	(N/A)	25,278,607	2,927,627	3,374,073	435,010	93,749	1,028,650

Table 22. Commercial and sea landings by fishing method in Hawai‘i (2011-2013).

Source: *Commercial Marine Landings Summary Trend Report 2013*.

A wide variety of species are landed commercially in Hawai‘i. The pelagic fishing industry is the largest and most valuable in Hawai‘i, accounting for approximately 27.5 million pounds (92.5%) of commercial landings in 2010. The tuna fishing industry accounted for over half (58.1%) of all commercial fish landed in Hawai‘i and approximately 62.7% of all pelagic fish landed in Hawai‘i that year. Bigeye tuna and billfish (particularly blue marlin, striped marlin, and swordfish) are the main target species for pelagic fishing but other species such as mahimahi, ono (wahoo), and moonfish are also important (NMFS 2005 in Monk Seal PEIS 2014).

In 2010, deep bottom fish made up about 1.5% of commercial landings (447,016 lbs). Target species include snappers, jacks, and a single species of grouper that is concentrated at depths of 30 to 150 fathoms (NMFS 2005 in Monk Seal PEIS 2014). The most desirable species are seven deepwater species known as the Deep 7 (opkapaka, onaga, hapuupuu, ehu, kalekale, gindai, and lehi). Inshore fish made up 1.6% of commercial landings (471, 391). With presently no active commercial coral reef fisheries in the Northwestern Hawaiian Islands, the commercial catch primarily comes from nearshore reef areas around the populated Hawaiian Islands (NMFS 2005 in Monk Seal PEIS 2014). Inshore fish species popular for commercial purposes include akule (which dominates nearshore commercial landings), soldierfish, surgeonfish, goatfish, squirrelfish, unicornfish, and parrotfish (Monk Seal PEIS 2014).

7.2.3.2. Offshore Development

Offshore Energy Production

Renewable energy production is expanding throughout the Hawaiian Islands. In 2008, the State of Hawai‘i and the Department of Energy established the Hawai‘i Clean Energy Initiative (HCEI). The HCEI seeks to increase the use of renewable energy in Hawai‘i to 70% by 2030. In 2011 only 12% of the electricity used in Hawai‘i was generated from renewable sources. The primary renewable energy sources in Hawai‘i are geothermal, Ocean Thermal Energy Conversion (OTEC), wind, solar, and biofuels, with solar power. The Bureau of Ocean Energy Management (BOEM) is currently exploring opportunities to expand renewable energy opportunities in Hawai‘i.

Hawai‘i has one geothermal power plant, Puna Geothermal Venture, located on Hawai‘i Island. The facility began operating in 1993 and produces both base load and dispatchable electricity. In 2011, the facility produced 233 gigawatt-hours (GWh) or approximately 20% of the total electricity used on Hawai‘i Island. The plant also produced 20% of all renewable electricity generated statewide.

Ocean thermal energy converts renewable solar energy stored in the ocean into electrical energy. A 1-MW floating OTEC pilot plant was completed and a 1-MW OTEC demonstration facility is in the planning stages and power plants up to 100-MW in capacity have been proposed for

locations off O‘ahu. Wind energy has been a success in Hawai‘i producing almost 31% of the state’s total renewable energy. Currently there are seven utility scale wind generation projects in Hawai‘i: two on O‘ahu, two on Hawai‘i Island, and three on Maui. In 2011, solar energy provided eight percent of Hawai‘i’s renewable energy generation.

The University of Hawai‘i-Mānoa hosts the Hawai‘i National Marine Renewable Energy Center (HINMREC). HINMREC, in collaboration with the Department of Defense, aims to establish a multiple-berth wave energy test center at Kāne‘ohe Bay, O‘ahu. The first ocean wave-generated electricity (hydrokinetic) ever transmitted to the grid in the U.S. was developed by an Ocean Power Technologies PowerBuoy® at Kāne‘ohe Bay in 2010. In a cooperative program with the Navy, three Ocean Power Technologies PowerBuoys® were deployed from 2004 to 2011. On the north shore of Kaua‘i, developers are exploring the potential for wave energy. However there is likely to be public opposition due to the scenic beauty of the coastline and the potential for impact to that scenery (E21 EPRI Survey and Characteristics of Potential Offshore Wave Energy Sites in Hawai‘i 2004). Developers are also considering the potential for a wave energy site on the northeast coast of O‘ahu (between Kahuku and Makapu‘u Points).

The HCEI proposes to establish an undersea cable system between the Hawaiian Islands. The cables would connect transmission systems throughout the islands with the intention of promoting renewable energy projects, increasing energy independence, and decreasing energy costs. In December 2010, the U.S. Department of Energy (DOE), with the State of Hawai‘i acting as a joint lead agency, announced its intent to prepare a Programmatic Environmental Impact Statement (PEIS) to assess the potential effects of the proposed Hawai‘i interisland renewable energy program. The possible locations of the proposed cable will be determined during the design, environmental review, and permitting phases with full public input.

The Hawai‘i Clean Energy Programmatic Environmental Impact Statement (PEIS), produced by the US Department of Energy and the State of Hawai‘i, along with several other federal and state agencies, evaluates the potential impacts of clean energy technologies on Hawai‘i’s environment. The analysis in this PEIS is intended to guide the implementation of clean energy technologies to achieve the Hawai‘i Clean Energy Initiative (HCEI) goal of sourcing 70% of the state’s energy needs through clean energy by 2030. The PEIS analyzed technologies that fell into the following five categories: energy efficiency, distributed renewables, utility-scale renewables, alternative transportation fuels and modes, and electrical transmission and distribution. The PEIS determined whether the potential activities within these categories would affect various environmental resources in Hawai‘i including:

- Geology and Soils
- Recreation Resources
- Climate and Air Quality
- Land and Marine Transportation
- Water Resources
- Airspace Management
- Biological Resources
- Noise and Vibration
- Land and Submerged Land Use
- Utilities and Infrastructure
- Cultural and Historic Resources
- Hazardous Materials and
- Coastal Zone Management
- Waste Management
- Scenic and Visual Resources
- Socioeconomics
- Environmental Justice
- Health and Safety

Among these environmental resources, the PEIS outlines four areas of particular concern: biological resources, especially endangered and threatened species, land and submerged land due to limited land availability in Hawai‘i, cultural and historic resources, especially those of significance to native Hawaiian culture, and scenery important to culture and tourism.

Aquaculture

NOAA works collaboratively with federal, state, regional, local, academic and business partners to support the development of sustainable aquaculture in locations compatible with other uses. Additionally, the University of Hawai‘i, Hawai‘i’s Pacific University Affiliate Oceanic Institute, and private firms are engaged in aquaculture research and demonstration projects. In July 2008 Hawai‘i enacted legislation (HB 2261) which created a loan program for agriculture and aquaculture renewable energy projects. Aquaculture loans are available for persons who devote most of their time to aquaculture or derive a major portion of their income from aquaculture farming operations. In 2011 the sanctuary partnered with the University of Hawai‘i to host “Ho‘olālā i ka mahii‘a o kēla mua aku”, a workshop focused on visioning the future of aquaculture in Hawai‘i.



There are two aquaculture projects that have been located within sanctuary boundaries (Crecco 2013). In 1999, Cates International launched a biconical sea cage, the SeaStation 3000 that produced 70,000 Pacific threadfin fingerlings (aka moi) for sport fishing (Davidson 2006). Currently, Blue Ocean Mariculture supports an active aquaculture farm near Kona, Hawai‘i. Their hatchery facility is located at the Natural Energy Laboratory of Hawaii Authority (NELHA). They produce Hawaiian Kampachi™ for distribution in Hawai‘i and the U.S. mainland. Blue Ocean claims to maintain a very low fish biomass levels relative to the rate of water exchange in an effort to preserve good water quality (Blue Ocean 2013). They also report conducting comprehensive testing of the local benthos based on protocols set by the U.S. Environmental Protection Agency and the State of Hawaii Department of Health (Blue Ocean 2013).

7.2.3.3. Tourism and Recreation

The tourism and recreation sector is the largest industry in the Hawai‘i ocean economy. In 2009 it employed 93.5% of all ocean workers and produced 87.6% of the Hawai‘i ocean economy’s GDP (ENOW Final Economic Report 2012).

Tourism

The economy of Hawai‘i has been dependent on tourism and tourism-related activities since statehood in 1959 (Monk Seal PEIS 2014). In 2011, visitor-related expenditures reached nearly 14 billion dollars to the local economy in Hawai‘i and contributed over a billion dollars in state tax revenue. An estimated 121,800 jobs in the State are in industries related to tourism (Table 23).

Year	Visitor-related expenditures (million dollars)	Gross domestic product (million dollars)	Household income (million dollars)	State tax revenues (million dollars)	Jobs (1,000)
2002	11,045.5	8,789.0	5,432.0	879.7	159.6
2003	11,468.3	9,139.4	5,600.8	876.5	161.9
2004	12,406.8	9,800.3	5,967.3	919.9	163.1
2005	13,554.6	10,675.9	6,427.6	1,007.5	171.4
2006	14,198.4	11,348.9	6,484.5	1,104.2	167.1
2007	14,568.0	11,505.0	6,567.9	1,171.7	163.4
2008	13,090.4	10,696.1	5,779.3	986.1	141.5
2009	11,587.5	1/ 8,898.0	5,436.8	890.7	125.3
2010	12,618.1	9,689.4	5,148.2	971.6	114.8
2011	13,839.3	10,627.2	5,646.5	1,065.6	121.8
2012	16,109.2	12,370.2	6,572.5	1,260.3	136.9
2013	16,367.4	12,568.5	6,677.9	1,260.3	134.2

Table 23. Economic activity generated by visitor-related expenditures (2002-2013).Source: *Hawai'i State Data Book 2013*.

Year	Visitor Arrivals (staying overnight or longer)	Average Number of Visitors/Day	Estimate Visitor Expenditures (millions of dollars)
1993	6,070,995	100,430	7,808
1994	6,364,674	107,904	9,544
1995	6,546,759	105,649	10,067
1996	6,723,141	106,404	9,569
1997	6,761,135	108,019	10,102
1998	6,595,790	112,068	9,910
1999	6,741,037	117,998	9,844
2000	6,948,595	123,441	10,396
2001	6,303,791	118,106	8,916
2002	6,389,058	121,030	9,465
2003	6,380,439	123,389	9,889
2004	6,912,094	132,355	10,702
2005	7,416,574	144,396	11,696
2006	7,528,106	149,545	12,301
2007	7,496,820	150,960	12,626
2008	6,713,436	135,239	11,220
2009	6,420,448	129,100	9,819
2010	6,916,894	136,407	10,889
2011	7,174,397	142,027	12,070
2012	7,867,143	201,267	14,365
2013	8,003,474	202,976	14,521

Table 24. Select tourism statistics for the State of Hawai'i (2013).Source: *Hawai'i State Data Book 2013*.



Approximately 8 million people visited Hawai‘i in 2013. This is a 1.7% increase from 2012, however it is still lower than 2006 when total visitor arrivals reached over 7.5 million. Tourism in the State declined from 2006 through 2009 but visitor arrivals have steadily increased since then. In 2013, the average number of visitors per day averaged 202,976 with a majority of visitors on O‘ahu (88,980), followed by Maui (48,054). Fewer visitors travel to Hawai‘i (26,550) or Kaua‘i (20,816) with the least number of visitors arriving in Lāna‘i (723) and Moloka‘i (701).

Visitors who arrive by air stayed an average of nine days in Hawai‘i. Total spending by visitors in Hawai‘i in 2013 was just over \$14 billion, nearly 23% greater than 2009 (approximately \$9.8 billion). Tourism expenditure peaked in 2006 at \$2.7 billion but then declined in 2008 and 2009.

Hawai‘i is a popular destination for both domestic and international tourists. A majority of visitors to Hawai‘i travel from the United States (65%). Japanese and Canadian tourists are the top two international tourist groups. Other major market areas include Oceania (particularly Australia), Europe, and Latin America (Hawai‘i State Data Book 2011).

The travel and tourism industry has been recognized as a key driver for economic recovery and reinvestment in the United States. In 2012, President Obama signed an executive order establishing a Task Force on Travel and Competitiveness as part of a comprehensive effort to spur job creation across the country (Executive Order 13597, 2012). The Task Force developed a National Travel and Tourism Strategy to promote domestic and international travel throughout the United States. The strategy further proposes to attract 100 million international visitors annually by the end of 2021, more than a 50 percent increase over the number expected in 2012. This could have significant impacts on the State of Hawai‘i, which currently welcomes 7.8% of all international visitors to the United States (DOC Office of Travel & Tourism Industries). The National Travel and Tourism Strategy suggests that National Marine Sanctuaries and National Parks are central to attracting new visitors.

The Hawaiian Islands Humpback Whale National Marine Sanctuary is actively contributing to the President’s goal and National Travel and Tourism Strategy. Turtle Bay Resort, LLC, signed a Memorandum of Agreement (MOA) with the sanctuary in August 2012 to work together to increase public awareness about sanctuary programs and its special places. Turtle Bay Resort is located on the north shore of O‘ahu and provides humpback whale watching and learning opportunities to 75,000 visitors annually. Turtle Bay Resort and sanctuary staff jointly provide educational opportunities to learn about marine conservation to reach broader audiences including the north shore communities, residents of Hawai‘i, and local, national, and international visitors.

The sanctuary also entered into an MOA with Oceanology, LLC (2012). The purpose of the MOA is to provide marine conservation information to residents of Hawai‘i, local, national, and international visitors, with a focus on the communities of Lahaina and Ka‘anapali, Maui. Sanctuary staff will support Oceanology to educate and inform residents and visitors on the



importance of the sanctuary, the role it plays to generate revenue, and develop opportunities for the business community to support the sanctuary, in addition to outreach opportunities for Whalers Village and Whalers Village Museum and a number of other tourist, visitor, and community initiatives as identified in the MOA.

Recreation

Recreation activities in Hawai‘i are primarily centered on the ocean. Ocean based recreation includes surfing, pleasure boating, fishing, swimming, snorkeling, SCUBA-diving, whale-watching, water-skiing, kite-boarding, kayaking, relaxing at beaches, and cruises, among others (Monk Seal PEIS 2014). There are an estimated 52 scuba dive shops in Hawai‘i with 22 on O‘ahu, 21 on Maui, six on Kaua‘i, two on Hawai‘i Island and one on Lāna‘i.

Recreation activities contribute significantly to the local economy in Hawai‘i. Ocean recreation in Hawai‘i supports an \$800 million industry (DOBOR 2011). As a result of population growth and demand for new products and destinations, ocean recreation in the State is increasing (DOBOR 2009). In 1999, the direct revenues from the ocean tour boat industry in the State were approximately \$132 million (Utech 2002).

The State of Hawai‘i has nearly 185 miles of sandy shoreline. Over 24 miles of this shoreline is safe, clean, accessible, and generally considered suitable for swimming. There are also 1,600 surf sites throughout the State.

Area	State total	Hawai‘i	Maui	Lāna‘i	Moloka‘i	O‘ahu	Kaua‘i
Miles of sandy shoreline:	184.9	19.4	32.6	18.2	23.2	50.3	41.2
- Safe, clean, accessible	24.4	1.2	7.9	-	-	12.5	2.8
- Other	160.5	18.2	24.7	18.2	23.2	37.8	38.4
Numbers of surfing sites (4)	1,600	185	212	99	180	594	330

Table 25. Surfing sites in Hawai‘i.¹⁰

Source: *Hawai‘i State Data Book 2013*.

The tour boat industry includes whale watching, snorkeling, dinner cruises, and sunset cruises, and is a growing segment of Hawai‘i’s economy. In 1999, the largest share of the revenue is from snorkeling tours (approximately \$67 million) and dinner cruises (approximately \$47 million). Tours in Maui brought in the highest revenue followed by those in O‘ahu. The total economic impact, including direct, indirect, and induced revenues was estimated to be \$225 million. The industry supported 3,232 jobs in 1999. Between 1990 and 1999, revenues from this industry in the Hawai‘i Island, Maui and Kaua‘i increased by 25% in real terms (Utech 2002).

The whale watching industry in Hawai‘i plays a strong role in the state’s economy contributing \$11 million in total revenues annually, with a total economic contribution of up to \$74 million

¹⁰ A surfing site is defined as “specific wave-breaking zone caused by a shoal and having sufficient consistency to be identified as a surfable riding area, either seasonally or in a combination of seasons.

per year. Approximately 50 operators statewide hosted whale watching tours to an estimated 330,000 people during the 120-day migration season in 2008 (ONMS Socioeconomic Fact Sheet 2011).

The Hawai‘i Tourism Authority has established a number of portfolio sporting events with partners that include professional surfing competitions, transpacific yacht races, world championship triathlons, the NFL Pro Bowl, the PGA Tour, and international fishing tournaments, to enhance the economy and quality of life. A few notable major sporting events include the Hawaiian Iron Man Triathlon, XTERRA Trail Running World Championship, Diamondhead Basketball Classic, the Sheraton Hawai‘i Bowl, and several premier golf championships.

There are seven major National Parks in Hawai‘i. Hawai‘i Volcanoes National Park is the largest (323,431 acres), and the most visited park is the U.S.S. Arizona Memorial which received nearly 1.7 million visitors in 2011.

National Park	Acreage	Visits
Hawai‘i Volcanoes National Park	323,431	1,583,209
Haleakalā	33,264	785,300
Pu‘uhonua o Honaunau National Historic Park	420	363,282
Kaloko-Honokohau National Historic Park	1,163	158,124
Pu‘ukoholā Heiau National Historic Park	86	125,645
U.S.S. Arizona Memorial	59	1,786,024
Kalaupapa National Historic Park	10,779	101,112

Table 26. Visitors and acreage of National Parks in Hawai‘i (2013).

Source: *Hawai‘i State Data Book 2013*.

Hawai‘i also has seven State managed parks that offer recreational opportunities. Wailua River State Park is the smallest however the park welcomes the most visitors.

State Park	Acreage	Visits
Nāpali Coast State Wilderness Park	6,175.0	423,100
Ahupua‘a ‘O Kahana State Park	5,256.5	88,200
Kōke‘e State Park	4,345.0	303,900
Waimea Canyon State Park	1,866.4	430,700
Kekaha Kai State Park	1,642.5	235,000
Sacred Falls (Kaluanui) State Park	1,375.9	(NA)
Wailua River State Park	1,093.0	888,100

Table 27. Visitors and acreage of State Parks (2013).

Updates to visitation have not been conducted since 2007.

Source: *Hawai‘i State Data Book 2011*.

7.2.3.4. Education

Sanctuary education programs seek to enhance public awareness, understanding, appreciation, and wise and sustainable use of the marine environment, and the natural, historical, cultural and

archeological resources of the National Marine Sanctuary System (16 U.S.C. §1431(b)(4)). They are designed to enhance public awareness, understanding and appreciation of the sanctuary and its resources, and to inspire and support stewardship activities. In Hawai‘i, the sanctuary offices provide education programs that have focused on making constituents aware of humpback whales and the ocean they live in, with the understanding that ocean-literate citizens will help protect not only endangered humpback whales, but also all natural resources. Sanctuary education staff on O‘ahu, Kaua‘i, and Maui coordinate with non-profit organizations and the local communities to further promote messages of sustainable use and marine conservation. Between 2008 and 2013, the sanctuary participated in over 150 community events, reaching over 100,000 people. Events included naturalist trainings, public lecture series, and trainings for different user groups, citizen scientist projects, teacher workshops, student presentations, field studies, and community outreach events. The sanctuary offices also offer education cruises for high school students on NOAA ships.

The Sanctuary Ocean Count project aims to increase public awareness of the sanctuary to protect species, and current ocean issues, including threats to humpback whales while also promoting responsible viewing of all marine wildlife. The project was initiated as a means to provide Hawai‘i residents and visitors (national and international) with the opportunity to observe humpback whales in their breeding grounds by conducting a yearly shore-based census during the peak-breeding season. Although the census does not claim to provide scientifically accurate results, it serves as a tool to supplement scientific information gathered from other research activities. The count also provides snapshot data as well as information on how whales use inshore waters on an average peak season day.

7.2.3.5. Research and Monitoring

The sanctuary is an important partner in marine science research and education efforts in Hawai‘i. Monitoring the health of the humpback whale population is an ongoing research activity conducted in partnership with several collaborators. New methodologies to identify whales, improve disentangling gear, collect biopsy tissues to assess body condition and potential diseases, stranding response protocols, and a variety of other projects, are a vital component of the research and monitoring program. A few ongoing research projects include underwater behavior and acoustic study of humpback whales, air photo identification to determine a number of traits, assessment of probability of vessel strikes, function of whale songs, and reproductive and calving characteristics.

The sanctuary initiated, helped coordinate, and was a key collaborator in a North Pacific wide humpback whale study called SPLASH (Structures of Population, Levels of Abundance and Status of Humpback Whales). The SPLASH was, and is still, one of the largest whale research projects to date, encompassing over 50 research groups and more than 400 researchers in 10 different countries, pooling resources towards gaining information on the humpback whales’ numbers, population structure, and overall health throughout the entire North Pacific Ocean (Calambokidis 2010). In addition, since 2002, the sanctuary has been conducting its Large Whale Response Program within the broader framework of national and international programs aimed at gaining information toward understanding and reducing the threat of entanglement, whale-vessel collisions, and other threats for large whales in the North Pacific and elsewhere.

7.3. Institutional Environment

The Hawaiian Islands Humpback Whale National Marine Sanctuary staff work with numerous State of Hawai‘i government offices, federal agencies, and non-profit organizations. This section provides a description of these authorities and jurisdictions.

7.3.1. State Government

Office of Hawaiian Affairs

The Constitution of Hawai‘i established the Office of Hawaiian Affairs (OHA) under the terms of Article XII, Sections 4 through 7, in 1978. OHA is charged with the administration of 1.8 million acres of royal land held in trust for the benefit of Native Hawaiians. OHA functions both as a government agency with a strong degree of autonomy and as a trust, under the direction of nine trustees elected statewide. OHA manages a property and monetary trust, funded in part by a pro rata share of income derived from the ceded lands portion of the public land trust, for Native Hawaiians. The purpose of OHA is to provide the opportunity for a better life and future for all Hawaiians.

Department of Land and Natural Resources

The Department of Land and Natural Resources (DLNR), established under Hawai‘i’s Revised Statutes, section 26-15, is headed by the Board of Land and Natural Resources. The DLNR is responsible for the management of the State’s public lands and the water and mineral resources on those lands. The DLNR’s jurisdiction encompasses nearly 1.3 million acres of state lands, beaches, and coastal waters including 750 miles of coastlines, state parks, historical sites, forest and forest reserves, aquatic life and its sanctuaries, public fishing areas, ocean recreation and coastal programs, wildlife and game management areas, public hunting areas, and natural area reserves.

Administrative rules for the DLNR are found in the Hawai‘i Administrative Rules (HAR), Title 13, Chapters 1 and 8. The Divisions of Aquatic Resources, Boating and Ocean Recreation, Conservation and Resources Enforcement, State Parks, Forestry and Wildlife, State Historic Preservation, and Office of Conservation and Coastal Lands, are located within the DLNR. The administrative rules for each of these DLNR Divisions are mentioned in the respective section below and the details are available on the DLNR website.

Division of Aquatic Resources

The Division of Aquatic Resources (DAR) is responsible for managing Hawai‘i’s marine and freshwater resources. Management programs include commercial fisheries and resource enhancement, aquatic resources protection, habitat management, and recreational fisheries. The administrative rules for these programs are under Hawai‘i Administrative Rule § 13-4. Major program areas include projects to enhance long-term sustainability of the fisheries resources, protect and restore the aquatic environment, protect resident aquatic and native species and their habitat, and provide facilities and opportunities for recreational fishing.

No license is required for marine recreational fishing in Hawai‘i. The DAR issues permits and licenses for freshwater fishing, selling aquatic life and other aquatic resources activities. Most licenses and permits are available at DAR offices and information regarding commercial,

bottom, and freshwater fishing regulations and pertinent water and marine resources information is available on the DAR website.

The DAR is responsible for establishing Marine Life Conservation Districts (MLCD) as authorized by chapter 190, Hawai‘i Revised Statutes, to conserve and replenish marine resources of the State. MLCDs include Hanauma Bay, Pūpūkea, and Waikīkī on O‘ahu, Kealahakua Bay, Lapakahi, Old Kona Airport, Waialea Bay and Waipae Tidepools on Hawai‘i Island, and Honolulu-Mokule‘ia Bay, Manele-Hulopo‘e, and Molokini Shoal on Maui. MLCDs are designed to conserve and replenish marine resources, thus fishing and consumptive uses are limited or prohibited entirely within them.

The DAR is also responsible for the management of a number of other marine managed areas, including bottom restricted fishing areas, fishery management areas, fishery replenishment areas, other marine managed areas, and public fishing areas.

Division of Boating and Ocean Recreation

The Division of Boating and Ocean Recreation (DOBOR) is responsible for the management and administration of statewide ocean recreation and coastal areas programs which includes 21 small boat harbors, 54 launching ramps, 13 offshore mooring areas, 10 designated ocean water areas, 108 designated ocean recreation management areas, associated aids to navigation throughout the State, and beaches encumbered with easements in favor of the public. The DOBOR manages all harbors and boating facilities that are located within the sanctuary.

The DOBOR’s jurisdiction covers the “waters of the State.” According to Hawai‘i Revised Statute, Section 200-23, this means “any waters within the jurisdiction of the State, the marginal seas adjacent to the State, and the high seas when navigated as part of a journey to or from the shores of the State.” This includes all coastal waters out to 3 nautical miles and all interisland traffic. DOBOR shares water management responsibility with numerous other state and federal agencies, therefore many management decisions are determined on a case-by-case basis.

The DOBOR manages Designated Ocean Recreation Management Areas (ORMA). The purpose of ORMAs are to (1) provide for increased public access, (2) reduce user conflicts, (3) promote overall public safety, and (4) avoid possible adverse impacts to humpback whales or other marine life (Hawai‘i Administrative Rule § 13-256-16). Also, ORMAs are established to control certain commercial activities within designated locations and time periods as well as regulate equipment types. Both recreational and commercial vessels may operate within an ORMA when authorized. There are 28 ORMAs located within sanctuary waters.

Division of Conservation and Resources Enforcement

The Division of Conservation and Resource Enforcement (DOCARE) is responsible for enforcing all laws relating to conservation, natural, cultural, and historic resources in Hawai‘i. State law enforcement officers enforce all state laws involving state parks, historical sites, forest reserves, aquatic life and wildlife areas, coastal zones, conservation districts, shorelines, and small boat harbors. The DOCARE law enforcement personnel work in collaboration with NOAA Office of Law Enforcement and the U.S. Coast Guard on unauthorized activities within the sanctuary.

Division of State Parks

The Division of State Parks is responsible for the administration of the State Park System and the State's recreation planning program. The authorities and jurisdictions for the Hawai'i State Park System are in the Hawai'i Administrative Rules, Title 13, DLNR, chapter 146. The Division plans, constructs, operates, and maintains state park facilities and develops interpretive programs for park visitors in effort to promote resource protection. The Division manages and administers 52 state parks comprised of nearly 25,000 acres on the five major islands, with several parks located on shorelines within the sanctuary.

Division of Forestry and Wildlife

The Division of Forestry and Wildlife (DOFAW) is responsible for the management of state-owned forests, public hunting areas, plant and wildlife sanctuaries, and the natural area reserves. There are 47 coastal, offshore, wetlands, and mountain sanctuaries, which have either prohibited or restricted entry unless under permit. Program areas include introduced species control, pest management, forest management, fire management, trail system and camping management, watershed protection, and the Natural Area Reserves System.

The Natural Area Reserves (NAR) are managed by DOFAW, established by chapter 195 of the Hawai'i Revised Statutes. DOFAW is mandated to manage the NARs to remain as unmodified as possible and a special use permit is required for any activity to be conducted within a NAR. There are two NARs located in the mountains of Maui in an ahapua'a above the sanctuary.

State Historic Preservation Division

The State Historic Preservation Division (SHPD) is responsible for the management of cultural and historic sites throughout the islands. Administrative rules pertaining to historic preservation are found in Title 13, subtitle 8. Programs are administered through three branches: History and Culture, Archaeology, and Architecture. The statewide inventory of historic properties contains information on more than 38,000 sites in Hawai'i, many of which are in the sanctuary.

Office of Conservation and Coastal Lands

The Office of Conservation and Coastal Lands (OCCL) is responsible for ensuring environmentally responsible regulatory management of approximately 2 million acres of private and public lands within the State Land Use Conservation District. In 1961 the State Land Use Law (Act 187; codified as Hawai'i Revised Statute, chapter 205) established the State Land Use Commission (LUC) and granted the LUC the power to zone all State lands into three districts: agriculture, conservation, and urban, with rural district added in 1963. The OCCL acts as the zoning authority for proposed and ongoing activities on public and private lands in the conservation districts, and for coastal lands out to the seaward extent of the State's jurisdiction.

Office of Planning

The State of Hawai'i Office of Planning is responsible for assisting the Governor in the overall analysis and formulation of state policies and strategies. The Office operates with direction from (1) the Hawai'i State Planning Act, which is a broad policy document that sets the table for all activities, programs, and decisions made by the local and state agencies; and (2) the New Day Comprehensive Plan, which outlines the Administration priorities. The Office of Planning includes the Special Plans Branch, the Geographic Information Systems Program, and the Coastal Zone management Program.

Coastal Zone Management Program

The Coastal Zone Management (CZM) Program acts as the State's resource management policy umbrella for the design and implementation of land and water uses and activities throughout the State. The federal CZM Program was created through passage of the Coastal Zone Management Act (CZMA) of 1972 and codified in 1977 in the Hawai'i Revised Statutes, Chapter 205A. The purpose of this law is to provide for the effective management, beneficial use, protection, and development of the coastal zone. This federal-state partnership has served to facilitate responsible protection, restoration, and development of coastal communities in Hawai'i.

The CZM area of responsibility includes the entire State since there is no point of land more than 30 miles from the ocean. The Native Hawaiian ahupua'a land use system prevails in the CZM program with the land-sea connection throughout the State.

To assist with federal project planning, the CZM Program uses the Federal Consistency Review as established under the CZMA. The CZMA requires federal activities and development projects to be consistent with approved state and coastal programs to the maximum extent practicable. This federal consistency review process allows the State to coordinate and plan for integrated resource management with proposed federal actions in Hawai'i.

Hawai'i Ocean Resources Management Plan

The Hawai'i Ocean Resources Management Plan (ORMP) is a statewide plan that sets forth the State's ocean and coastal resource management priorities. The ORMP supports effective management, beneficial use, protection, and development of the State's coastal zone, which includes all lands of the State and the area extending seaward from the shoreline to the limit of the State's police power and management authority, including the U.S. territorial sea. The ORMP is a requirement under Hawai'i Revised Statutes §205A-3 and is a major component of the State's Coastal Zone Management (CZM) Program.

The ORMP was updated in July 2013, and serves as a road map for managing ocean resources in the islands, based on recognition of the ecological connections between the land and sea, the link between human activities and its impacts on the environment, and the need for improved collaboration and stewardship in natural resources governance. The ORMP works by identifying eleven management priorities for the next five-year planning period, by identifying responsible agencies and resources, and by providing a method for performance measures and reporting.

Sanctuary staff participated in the update of the ORMP and the sanctuary is listed as a partner on seven of the eleven Management Priorities in the plan: Marine Resources, Coral Reefs, Ocean Economy, Cultural Heritage of the Ocean, Training, Education and Awareness, Collaboration and Conflict Resolution, Community and Place-Based Ocean Management Projects.

Aha Moku Advisory Council

The Aha Moku Advisory Committee was established within the Department of Land and Natural Resources to advise the Chairperson of the Board of Land and Natural Resources on issues related to land and natural resources management. In July, 2012, Governor Abercrombie signed into law H.B. 2808, Act 288, to formally recognize the Aha Moku system and establish the Committee. The Chairperson of the Board of Land and Natural Resources has oversight of the Aha Moku Advisory Committee.

The aha moku is a system of best practices based on the indigenous resource management practices of moku (regional) boundaries that take into account the natural contours of the land, the resources therein, and methodologies needed to sustain those resources and the community. The aha moku advisory committee serves to foster understanding and practical use of Native Hawaiian expertise and methodology to promote responsible stewardship throughout the 43 moku in Hawai‘i.

The aha moku advisory committee is made up of eight members appointed by the Governor and confirmed by the senate. The members are appointed from a list submitted by the aha moku councils of each island. Sanctuary staff recognize the expertise the aha moku advisory committee has to offer to the Hawaiian Islands and the sanctuary and look forward to their support and continued collaboration.

7.3.2. Federal Government

National Oceanic and Atmospheric Administration

National Marine Fisheries Service

NOAA Fisheries is tasked with managing the marine resources in federal waters in the Pacific Region. The primary laws NOAA Fisheries is responsible for implementing within the region are the Magnuson-Stevens Fisheries Conservation and Management Act (MSFCMA), the Marine Mammal Protection Act (MMPA), the Endangered Species Act (ESA), and the Presidential Proclamations for Pacific Marine National Monuments. The Pacific Islands Region is bound by the Mariana’s Archipelago in the west, the U.S. Pacific Remote Islands in the south, and the Hawaiian Archipelago in the north. The U.S. EEZ that lie within this region total about 1.5 million square nautical miles, roughly equal to all the U.S. EEZ waters surrounding the continental U.S., including Alaska.

NOAA Fisheries jurisdiction includes activities in both domestic and international waters with emphasis on managing fisheries stocks in the U.S. EEZs in American Samoa, Guam, the Commonwealth of the Northern Mariana Islands, the Pacific Remote Islands (Kingman Reef, Howland, Baker, Jarvis, and Wake Islands, and Johnston, Midway, and Palmyra Atolls) and Hawai‘i.

The Pacific Islands Regional Office (PIRO) is responsible for drafting and implementing federal fishery regulations, issuing federal fishing permits, and monitoring fisheries through its Observer Program. Other major Fisheries Service responsibilities include the coordination with international organizations to implement and monitor fishery agreements and treaties, conservation and recovery of protected species, the preservation and restoration of marine habitat and co-management of four Marine National Monuments in the Pacific.

Sanctuary staff works closely with PIRO, primarily with the Sustainable Fisheries, Protected Resources, and Habitat Conservation Divisions.

Western Pacific Fisheries Management Council

The Western Pacific Fisheries Management Council (WPFMC) is one of eight regional fishery management councils established by the Magnuson Fishery Conservation and Management Act (MFCMA) of 1976. The most significant accomplishment of the Act was to guide development of the domestic fishing industry by phasing out foreign fishing in the U.S. EEZs. The MFMCA

was amended in 1996 with goals to rebuild overfished fisheries, protect essential fish habitat, and reduce bycatch. The Council is made up of 16 members representing a cross-section of the regional communities and several Council advisory groups to develop ecosystem-based fishery management plans. Management measures created by the Council and approved by the Secretary of Commerce are implemented by NOAA Fisheries PIRO and enforced by the NOAA Office of Law Enforcement, the U.S. Coast Guard and local enforcement agencies. The WPFMC area of responsibility includes American Samoa, Guam, Northern Mariana Islands and the State of Hawai‘i. Fishing activities in the sanctuary are managed by the WPFMC, NOAA Fisheries, and the State of Hawai‘i Department of Land and Natural Resources, Division of Aquatic Resources.

Office of Law Enforcement

As part of NOAA Fisheries, the NOAA Office of Law Enforcement (OLE) is responsible for the enforcement of NOAA's mandates, primarily the NMSA, MSFCMA, MMPA, and ESA, in the Pacific U.S. EEZs. To execute the enforcement functions within this vast region, the OLE has offices in Honolulu, Hawai‘i, American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands.

NOAA's policy for enforcement within national marine sanctuaries is to prevent violations of the National Marine Sanctuaries Act through education, patrols, inspections, and investigations. Education is the primary tool to inform the public of the sanctuary regulations and guidelines to prevent unauthorized activities and threats to the humpback whales and associated marine resources. Sanctuary personnel assist the OLE with comprehensive forums and education and outreach materials to inform the public of the regulations and guidelines for long-term resource conservation and protection.

Enforcement of the sanctuary regulations and guidelines are also conducted through OLE patrols, inspections and investigations. To fulfill the enforcement mandates, OLE has secured the assistance of the U.S. Coast Guard (USCG) through an MOA for surveillance and enforcement in the sanctuary. In addition, OLE has entered into an agreement with the State of Hawai‘i DLNR to assist with enforcement, inspections, and investigations of unauthorized activities in sanctuary waters.

Pacific Islands Fisheries Science Center

The Pacific Islands Fisheries Science Center (Science Center), within NOAA Fisheries, administers scientific research and monitoring to support domestic and international conservation and management of the living marine resources within the NOAA Fisheries Pacific Islands Region of responsibility. The full suite of Science Center research themes and mandates that direct the key research and monitoring activities in the Pacific Region are identified in the Science Center 2013 Science Plan. The Science Center is responsible for research in ecosystems in the Western and Central Pacific Ocean including marine fisheries, protected species, such as the endangered Hawaiian monk seal, coral reefs, near island habitats and open ocean (pelagic) environments, and the human communities that depend on the natural marine environments. The Science Center research and monitoring mandates include the MSFCMA, MMPA, ESA, Coral Reef Conservation Act, international treaties, regional fishery management organizations related to the management of tuna fisheries, and U.S. government administrative and executive orders (i.e., presidential proclamations that created the Marine National Monuments). Within the

Science Center, the Coral Reef Ecosystem Division supports sanctuary personnel with coral reef monitoring and habitat mapping within the Hawaiian and sanctuary waters.

Office of Marine and Aviation Operations

NOAA's fleet of aircraft and ships is managed and operated by the Office of Marine and Aviation Operations (OMAO). Highly skilled NOAA Commissioned Corps officers and Wage Mariner civilians play a critical role in the collection of oceanographic, atmospheric, hydrographic, and fisheries data as well as ocean exploration, research, nautical charting, and ocean and climate studies from the aircraft and vessels. One NOAA Corps Officer is assigned to the sanctuary in the Maui office. The sanctuary staff relies on the support of the NOAA Corps Officer to use the NOAA small boats to conduct research and on-water responses. One NOAA Corps officer is also assigned to the ONMS Pacific Islands Region in Honolulu. OMAO staff also operate research vessels *Oscar Elton Sette*, *Ka'imimoana*, and *Hi'ialakai* in support of NOAA's mission.

National Centers for Coastal Ocean Science

NOAA's National Center for Coastal Ocean Science (NCCOS), within NOAA National Ocean Service, conducts and supports research, monitoring, assessment and provides technical assistance for managing coastal ecosystems and society's use of them. NCCOS' mandates include the National Coastal Monitoring Act, Coastal Ocean Program, Harmful Algal Bloom and Hypoxia Research and Control Act, National Contaminated Sediment Assessment and Management Act, Oceans and Human Health Act, NOAA Strategic Plan, Council on Environmental Quality Ocean Policy Task Force, Oceans and Human Health Act, and the Marine Pollution and Sanctuaries Act. NCCOS have conducted numerous research projects in the Hawaiian Islands and the sanctuary. The research reports and maps are available on the NCCOS website. Most notable and beneficial to sanctuary resource managers is the NCCOS benthic habitat classification manual, benthic habitat map for the nearshore waters of the populated Hawaiian Islands, and supplemental geospatial data.

Office for Coastal Management

NOAA's Office for Coastal Management was established in 2014 when NOAA combined two offices: the Coastal Services Center and the Office of Ocean and Coastal Resource Management. In addition to implementing specific initiatives, a top priority for NOAA's Office for Coastal Management is to unify efforts to make communities more resilient. Many organizations are involved, including the private sector, nonprofits, the scientific community, and all levels of government. The Office for Coastal Management works to be a unifying force in these efforts, providing unbiased NOAA data and tools and providing opportunities for the community to come together to define common goals and find ways to work smarter by working together. Issues run the gamut from protecting endangered species to erosion to generating better building codes for storm-resistant buildings.

Office of Response and Restoration

The Office of Response and Restoration (OR&R), within NOAA National Ocean Service, is responsible for protecting and restoring NOAA trust resources as mandated by the Marine Debris Act Amendments of 2012, the Clean Water Act, the Comprehensive Environmental Response, Compensation and Liability Act, the National Marine Sanctuaries Act, the Oil Pollution Act and other related laws. The OR&R provides expertise in preparing for, evaluating, and responding to

coastal ecosystem threats including oil and chemical spills, releases from hazardous waste sites and marine debris. The OR&R has three divisions; the Emergency Response Division (ERD), the Assessment and Restoration Division (ARD), and the Marine Debris Division.

Under the National Contingency Plan, NOAA ERD is responsible to provide scientific expertise to support the federal on-scene coordinator for hazardous material and oil spills. ERD supports scientists are available 24-hours, 7-days per week to respond to spill events. The ERD works to prevent and mitigate harm to coastal resources and is the primary NOAA office responding to oil spills and hazardous material releases. ERD provides scientific support to the U.S. Coast Guard for spills and technical assistance to other agencies for hazardous material releases.

Following a hazardous waste release, vessel grounding or oil spill, the ARD is responsible for evaluating and restoring coastal and estuarine habitats damaged. To assist with this, the ARD has joined with NOAA's General Counsel for Natural Resources and Office of Habitat Conservation to create the Damage Assessment, Remediation and Restoration Program (DARRP). In addition, the ARD may conduct Natural Resources Damage Assessment (NRDA) following an oil spill is warranted. Through the NRDA process, the ARD and the DARRP would work cooperatively with local communities, the State, private companies, and government agencies to restore sites where a hazardous waste, oil spill, for vessel grounding has occurred.

The NOAA Marine Debris Division has served to coordinate, strengthen, and promote marine debris activities within the agency and among partners and the public since 2005. Following the 9.0 earthquake and tsunami that struck Japan in 2011, the Marine Debris Act Amendments of 2012 were enacted by the Congress to reauthorize and amend the Marine Debris Research, Prevention, and Reduction Act. The 2012 Amendments direct NOAA Marine Debris Program to address the adverse impacts of marine debris on the U.S. economy, the marine environment, and navigation safety through identification, determination of sources, assessment, prevention, reduction, and removal of marine debris.

United States Coast Guard

The Department of Homeland Security's U.S. Coast Guard (USCG) has broad responsibility for enforcing all federal laws and regulations throughout the Pacific and assists NOAA Fisheries and the sanctuary with the enforcement of NOAA's mandates. The USCG provides on-scene coordination with Regional Response Center facilities under the National Contingency Plan for removal of oil and hazardous substances in the event of a spill threatening sanctuary resources. The USCG is responsible for regulating vessel traffic, maintaining aids to navigation, increasing boater safety, and coordinating search and rescue operations.

Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management (BOEM) is an agency within the Department of the Interior that monitors, regulates and permits offshore conventional and renewable energy projects. BOEM produces a Five Year Outer Continental Shelf (OCS) Oil and Gas Leasing Program, which outlines the scope and location of potential future energy production, although there are no lease areas around the Hawaiian Islands because of the absence of oil and gas resources. BOEM also grants leases for offshore renewable energy projects. In addition to leasing resources, BOEM evaluates national offshore resource reserves from a technical and economic perspective. The Office of Environmental Protection within BOEM conducts research on the environmental safety of ocean energy projects. BOEM established the Hawai'i OCS

Renewable Energy Task Force to evaluate and facilitate offshore energy development in Hawai‘i, particularly concerning the installation of power cables between islands. Members of the intergovernmental task force include representatives of federal, state and local government agencies, and offices that coordinate with Native Hawaiians. The sanctuary is an active member of this task force.

U.S. Army Corp of Engineers

The U.S. Army Corp of Engineers (USACE) is a division of the U.S. military that builds and maintains public infrastructure and military facilities. USACE undertakes public works projects such as dredging marinas, building levees, constructing military bases and more. With around 37,000 civilian and military employees, USACE works internationally in 130 countries. In the Honolulu District of USACE, civil works programs focus on water resource development including boating safety, coastal storm resilience and ecosystem restoration.

United States Fish and Wildlife Service

The U.S. Fish and Wildlife Service (USFWS), with the Department of Interior, works to conserve, protect and enhance fish, wildlife and plants and their habitats. USFWS aims to instill an environmental stewardship ethic, manage the nation's fish and wildlife resources and provide the public with opportunities to responsibly engage with those resources. USFWS enforces federal wildlife laws to protect endangered species and conserve and restore wildlife habitat. They manage a variety of natural resources from migratory birds and fisheries to wetlands and other refuges. USFWS manages the 150 million-acre National Wildlife Refuge System of more than 551 National Wildlife Refuges and thousands of small wetlands and other special management areas. Under the Fisheries program, USFWS also operates 70 National Fish Hatcheries, 65 fishery resource offices and 86 ecological services field stations. The vast majority of fish and wildlife habitat is on non-Federal lands so USFWS partners with state agencies, local organizations and private land-owners to foster aquatic conservation and assist voluntary habitat conservation and restoration. In the sanctuary, USFWS is responsible for protecting migratory seabirds pursuant to the ESA and Migratory Bird Treaty Act (MBTA).

National Sea Grant College

The National Sea Grant College Program, which is within NOAA's Office of Ocean Exploration and Research, encourages the wise stewardship of marine resources through research, education, outreach and technology transfer. Sea Grant is a grant program working in partnership between the nation's universities and NOAA. It began in 1966, when the U.S. Congress passed the National Sea Grant College Program Act. Sea Grant specializes in synthesizing the latest developments in marine research and making it accessible to the public. The sanctuary works closely with the University of Hawai‘i Sea Grant College Program to guide scientific research, increase public awareness of sanctuary issues, and promote ocean literacy.

United States Department of Defense

The U.S. Pacific Command, one of nine Combatant Commands located across the Continental U.S. and in Germany, is responsible for the U.S. armed forces activities in the Pacific Ocean area. The Commander, Pacific Command (PACOM), based in Honolulu, is the military authority to the U.S. Army Pacific Command, U.S. Air Force Pacific Command, the Marine Forces Pacific, and the Commander, U.S. Pacific Fleet. The U.S. Pacific Fleet, Navy, is the primary

Department of Defense (DOD) service with potential to conduct training exercises in or proximate to the sanctuary.

The Navy has identified the need to conduct current, emerging, and future training, research, and test and evaluation activities in the Hawai‘i Range Complex (HRC). The mission of the HRC is to support naval operational readiness by providing realistic training environment for forces assigned to the Pacific Fleet, the Fleet Marine Force and other users. The HRC encompasses the open ocean, offshore waters, and onshore areas located on or around the Hawaiian Islands. The HRC includes Hawaii OPAREA, which is composed of 235,000 square nautical miles of ocean area and airspace along with land ranges. The HRC, the sole range complex in the mid-Pacific, is a key training and testing area for the Navy because of its unique geographical attributes and proximity to Pearl Harbor and the Western Pacific. The HRC’s Pacific Missile Range Facility provides electronic tracking ranges that enable forces to train with safety and flexibility across the Pacific, including operations out of military facilities in California, Alaska and the western Pacific.

The HRC is used for training and assessment of operational forces, missile testing, testing of military systems and equipment, and other military activities. HRC is home to a broad spectrum of underwater, surface, and airspace instrumented range facilities. Notable instrumented range facilities in the HRC include arrays of underwater hydrophones (listening devices) on the seafloor off Kaua‘i and ship acoustic and electronic measurement capabilities off O‘ahu. Training minefields, which provide servicemen with the opportunity to train in detecting, avoiding or disabling, and placing mines, are located in all Hawaiian littoral waters, including off shore of O‘ahu, Ni‘ihau, and Kaho‘olawe.

Special Use Airspace is established by the Federal Aviation Administration (FAA) and exists throughout airspace above the Hawaiian Islands. Restricted Airspace exists adjacent to PMRF on Kaua‘i, around Ka‘ula Islet, and over Pohakula Training Area on the Island of Hawaii. Maritime Danger Zones and Restricted Areas are established by the Army Corps of Engineers and/or the U.S. Coast Guard.

The following are examples of U.S. Navy programs, initiatives, compliance requirements that directly or indirectly benefit marine resources:

- The Navy funds marine mammal monitoring to increase understanding of how at-sea training and testing activities affect marine species. These surveys and the data obtained through these studies support the Navy’s Integrated Comprehensive Monitoring Program. The Navy also co-funded surveys that have been conducted by National Marine Fisheries’ Pacific Island Fisheries Science Center. The Navy’s monitoring program uses a combination of techniques so that detection and observation of marine animals is maximized for the Hawaii Range Complex, and meaningful information can be derived to address monitoring objectives. For example, the monitoring objectives include: (1) increased understanding of likely occurrence of marine mammals or species in vicinity of Navy activities (presence, abundance, distribution, density); (2) increased understanding of how individual marine mammals or species respond to specific stressors both behaviorally and physiologically; and (3) increased understanding of how anticipated individual responses to individual stressors may impact long term fitness and survival or the impact of a population of marine mammals or species.

- In coordination with NOAA Fisheries, the Navy has developed a stranding response plan associated with the authorizations for at-sea training and testing activities in the Hawai‘i Range Complex. Through agreement with NOAA Fisheries, Navy may provide coordinated services to NMFS during uncommon stranding event investigations. Navy also developed a Regional Stranding Investigation Assistance Plan, which was entered into by Commander, Navy Region Hawaii with Pacific Islands Region Office of NOAA Fisheries in April 2013. Through the logistical assistance these agreements outline, NOAA Fisheries may be better able to investigate and understand causal effects of marine mammal strandings.
- In addition to other mitigation measures that Navy implements during training and testing activities at sea, since 2009, the Navy has instituted a specific mitigation measure recognizing the significance of the Hawaiian Islands for humpback whales. The Navy has designated a humpback whale cautionary area which consists of a 3.1 mi. (5 km) mitigation zone that has been identified as having one of the highest concentrations of humpback whales during the critical winter months. Training exercises in the humpback whale cautionary area require a much higher level of clearance than is normal practice in planning and conducting mid-frequency active sonar training.
- The Navy’s Pacific Missile Range Facility (PMRF) 2010 and Joint Base Pearl Harbor-Hickam (JBPHH) Integrated Natural Resources Management Plans (INRMP) 2011 afford conservation benefits. The primary goal of the INRMPs are to support and sustain the military mission on Kaua‘i and O‘ahu installations while managing, protecting, and enhancing biological diversity and ecosystem integrity of military lands and waters and associated endangered species and their habitats. Additionally, Integrated Cultural Resources Management Plans (ICRMP) have been prepared for Commander, Navy Region Hawaii (CNRH) facilities on Kaua‘i, at PMRF and on O‘ahu, at JBPHH. An ICRMP is intended to provide procedural guidance for identifying, evaluating, and managing historic properties located within military facilities.

The Department of Defense (DOD) is one of the primary users of the marine environment in Hawai‘i. Military operations occur throughout the Hawaiian Islands Humpback Whale National Marine Sanctuary. The DOD is currently subject to the ESA, the MMPA, and other relevant federal and state environmental laws. In addition, the DOD operating procedures include special precautions to ensure the protection of humpback whales prior to any training exercise or testing which may occur during whale season. A full list of DOD activities that occur within the Hawai‘i Range Complex can be found in Appendix C.

National Historic Preservation Act

The National Historic Preservation Act (NHPA; 16 U.S.C. 470 et seq.) is intended to preserve historical and archaeological sites in the United States of America. The act created the National Register of Historic Places, the list of National Historic Landmarks, and the State Historic Preservation Offices. Section 106 of the NHPA requires Federal agencies to take into account the effects of their undertakings on historic properties, and afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment. The historic preservation review process mandated by Section 106 is outlined in regulations issued by ACHP (36 CFR 800).

7.4. Operational Environment

7.4.1. Human Resources

Sanctuary Superintendent

The sanctuary superintendent oversees site-specific management functions, including revising and implementing the management plan. The superintendent is responsible for implementing specific programs or projects, establishing the administrative framework to ensure all resource management activities are coordinated, and maintains and manages an appropriate infrastructure to adequately support site operations. The superintendent reports to the Regional Director for the Pacific Islands Region of the Office of National Marine Sanctuaries (ONMS). General responsibilities of the sanctuary superintendent include:

- Serve as the primary liaison between ONMS and the State of Hawai‘i
- Submitting an annual operating plan that recommends priorities to ONMS for annual allocation of funds for site operations and resource protection;
- Formulating and directing research, education, marine resource management, cultural liaison programs and partnerships locally, nationally, and internationally;
- Determining staffing needs and requirements;
- Coordinating with ONMS in evaluating, processing, and issuing permits and conducting inter-agency consultations;
- Coordinate and consult with other resource management agencies, including regional, federal, state and local agencies;
- Working closely with constituents and the community; and
- Evaluating progress made toward achieving sanctuary goals and objectives.

State Co-Manager

The State co-manager is designated by the State of Hawai‘i to act as a liaison to the sanctuary. General responsibilities of the State co-manager include coordinating with the State on:

- State consultation on permit applications, enforcement activities, and use of recovered civil penalties;
- Communicating with DLNR and the Governor on federal sanctuary emergency regulations;
- State consultation on proposed changes to the management plan and regulations including approval of any substantive amendment or regulation by the Governor; and
- Any fishing regulations proposed to the State Board of Land and Natural Resources before those regulations may be promulgated as federal sanctuary regulations.

Sanctuary Staff

Basic staffing supports program activities in eight functional areas: (1) operations; (2) education and outreach; (3) policy; (4) resource protection; (5) science; (6) communications; (7) cultural resources; and (8) maritime heritage resources. Sanctuary staff have knowledge and expertise in policy, marine resource management, education and outreach, scientific research and monitoring program development, cultural and maritime resource protection and office administration.

7.4.2. Infrastructure

The sanctuary is comprised of five separate marine protected areas in the Hawaiian Islands adjacent to Kauaʻi, Oʻahu, Molokaʻi, Lānaʻi, Maui, and Hawaiʻi Island. In order to effectively manage these areas and implement this management plan, NOAA has sanctuary offices in Līhuʻe on Kauaʻi, Honolulu on Oʻahu, and Kīhei on Maui. The function of these offices is to provide an effective means to coordinate and communicate with communities while managing the sanctuary's resources. These offices range from housing a few staff to housing multiple staff, as well as visitor facilities, meeting rooms, and supporting field operations including the use of small boats.

Kauaʻi

The sanctuary is located on the north shore of Kauaʻi and includes the nearshore waters from Haʻena to past Kīlauea. The sanctuary office is centrally located in a business complex in Līhuʻe, where the staff can coordinate with local governments, organizations and communities around the island. There are efforts to expand the sanctuary's facilities to include space for more staff, a large meeting room, and visitor center, in collaboration with Papahānaumokuākea Marine National Monument. If the sanctuary establishes new boundaries around Niʻihau, staff will provide support from the Kauaʻi and Oʻahu offices.

Oʻahu

There are two sections of the sanctuary on Oʻahu, one that includes the north shore from Haleʻiwa to Kahana Bay and one on the south shore from Makapuʻu to near Waikīkī. The main management office for sanctuary staff with NOAA is located at the NOAA Daniel K. Inouye Regional Center on Ford Island within Joint Base Pearl Harbor-Hickam. This facility houses the majority of NOAA offices in Honolulu and includes staff of the Papahānaumokuākea Marine National Monument, Pacific Islands Regional Office and Pacific Islands Fisheries Science Center, and Pacific Services Center among others who work collaboratively with the sanctuary. In addition, sanctuary staff with the State of Hawaiʻi are located with the Department of Land and Natural Resources in the Kalanimoku Building in downtown Honolulu. They also have office space with their NOAA counterparts at the NOAA Inouye Regional Center.



Maui

The largest contiguous area of the sanctuary is found in Maui Nui. In 1994, the first sanctuary office was established on property owned by NOAA in Kīhei on Maui. This beachfront land was developed in the 1940's by the Navy who built two of the buildings on site. A new multipurpose building was built on the 1.17 acre property in 2006 to provide office space, storage and a large public meeting area. The two older buildings have recently been renovated with the two-story



building housing the visitor center and offices on the second floor. In 2012, the sanctuary opened a visitor's center. The renovated facility provides educational opportunities for local, national,

and international visitors. New exhibits are being developed to interpret marine and cultural resources, including the 500 year old Native Hawaiian fishpond located at the sanctuary's Kīhei property. The single story building now includes offices and a wet lab. Education and visitor programs are hosted from these facilities, which also provide support for humpback whale research and resource protection programs. The State collaborates with NOAA to provide slips for sanctuary vessels at Mā'alaea Harbor on Maui for the humpback whale research and disentanglement programs.

8. Site Specific Affected Environment

8.1. Ni‘ihau

Ni‘ihau is the seventh largest island in the Hawaiian Archipelago and is the westernmost island of the populated Hawaiian Islands. The island has an area of approximately 69.5 square miles (180 square km) and is estimated to be between 4.9 and 5.5 million years old (Ziegler 2002, Juvik & Juvik 1998). Ni‘ihau is located approximately 18 miles (29 km) west of the island of Kaua‘i across the Kaulakahi Channel. The maximum elevation is at Mt. Pānī‘au at 1,280 feet (390 m) high and the island has only 13 watersheds. The northeastern portion of the island forms steep cliffs that adjoin the ocean.

Ni‘ihau was formed by one shield volcano with volcanic peaks at Mt. Pānī‘au and remnants of a spatter cone at Kawaihoa point. The rest of the island’s land is composed of limestone that overlays original volcanic rock that was created during a former period of higher sea level (Stearns 1947). The arid climate is partially caused by the rain shadow of Kaua‘i (Juvik & Juvik 1998). Unique features of the island include several intermittent playa lakes, which exist both as seasonal dry sand flats and wet marshlands (Stearns 1947).



Lehua Island is a partially submerged volcanic tuff cone forming a crescent produced in the Pleistocene era and has an area of approximately 0.7 sq. miles (1.15 sq. km). The island is geologically part of the Ni‘ihau volcanic dome and lies 0.7 miles (1.1 km) directly north of Ni‘ihau. The uninhabited island is federal property administered by the U.S. Coast Guard. It is a designated seabird sanctuary

managed by the Department of Forestry and Wildlife (DOFAW) under the State of Hawai‘i Department of Land and Natural Resources.

8.1.1. Biophysical Environment

8.1.1.1. Habitats

Few formal assessments have been conducted in the marine environment surrounding Ni‘ihau. The benthic habitats surrounding Ni‘ihau and Lehua are mostly volcanic basalt hard bottom, coral reef and sandy softbottom (Battista et al. 2007). Benthic studies suggest that coral cover around Ni‘ihau and Lehua is relatively low. Williams et al. (2008) estimate coral cover at $5.0 \pm 4.4\%$, which is similar to the CRED Benthic data (2008) estimate of $4.2 \pm 1.7\%$ ($n=5$). Another report by Friedlander et al. (2008) estimate coral cover even lower ($3.0 \pm 1\%$). Figure 15 illustrates the relative coral cover estimated for the populated Hawaiian Islands (reproduced from March 2015

Friedlander et al. 2008). Coral cover was calculated from 1,682 transect sites surveyed between 2001 and 2010. The graph indicates that percent coral cover around Ni‘ihau is considerably lower than around the other islands shown.

Throughout the populated Hawaiian Islands, benthic cover of hard substrate is predominantly turf algae with a lower percentage of coral cover. On Ni‘ihau, the majority (53%) of benthic cover of shallow sites surveyed (from a 2010 survey) is turf algae and cyanobacteria (Figure 16; CRED Benthic Data 2010). The coral at Ni‘ihau and Lehua have been measured to have significantly lower prevalence of coral disease ($0.02 \pm 0.02\%$) then elsewhere in the populated Hawaiian Islands (Friedlander et al. 2008, Aeby et al. 2011). Lower incidence of coral disease could be the result of lower populations of coral to transmit infectious agents or a generally healthy disposition. Table 28 shows the percent disease prevalence for coral at different islands normalized by populations (Friedlander et al. 2008).



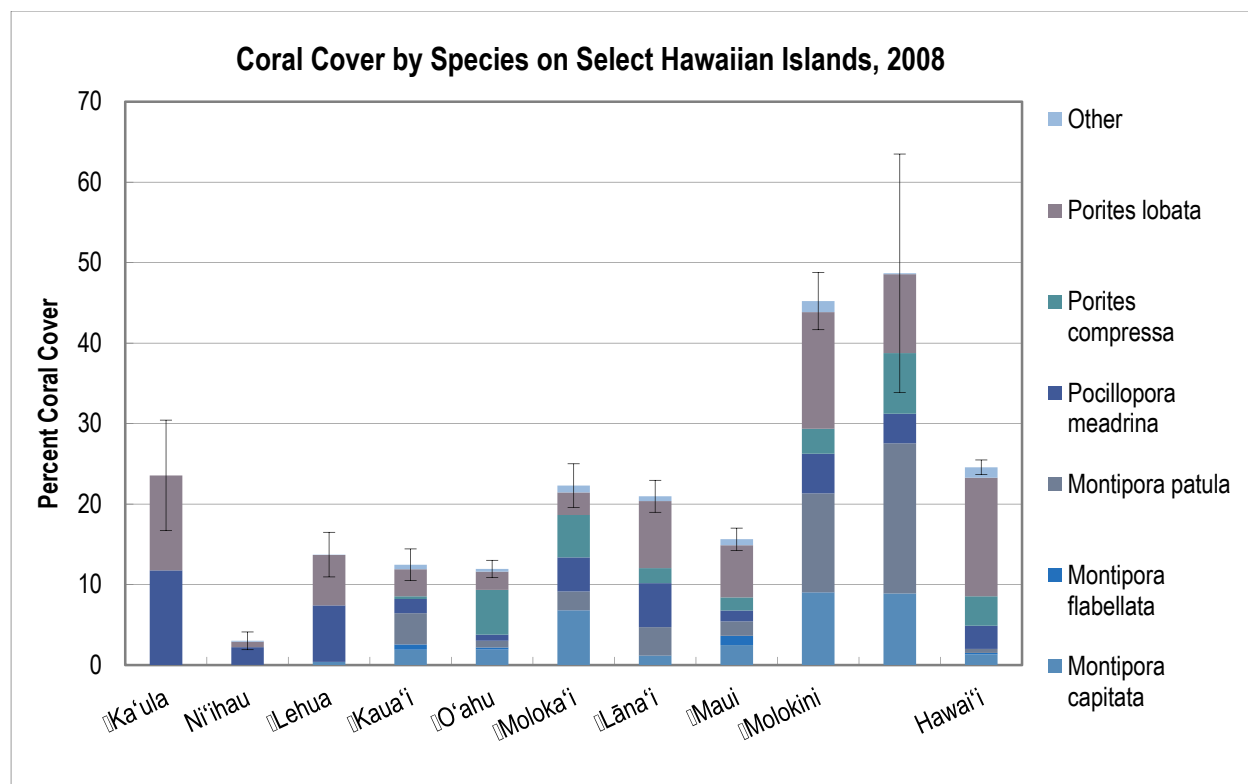


Figure 15. Mean percent coral cover in the populated Hawaiian Islands.

Source: CRAMP/DAR ($n=692$), PIFSC-CRED ($n=108$), FHUS ($n=859$) and WHAP ($n=23$).

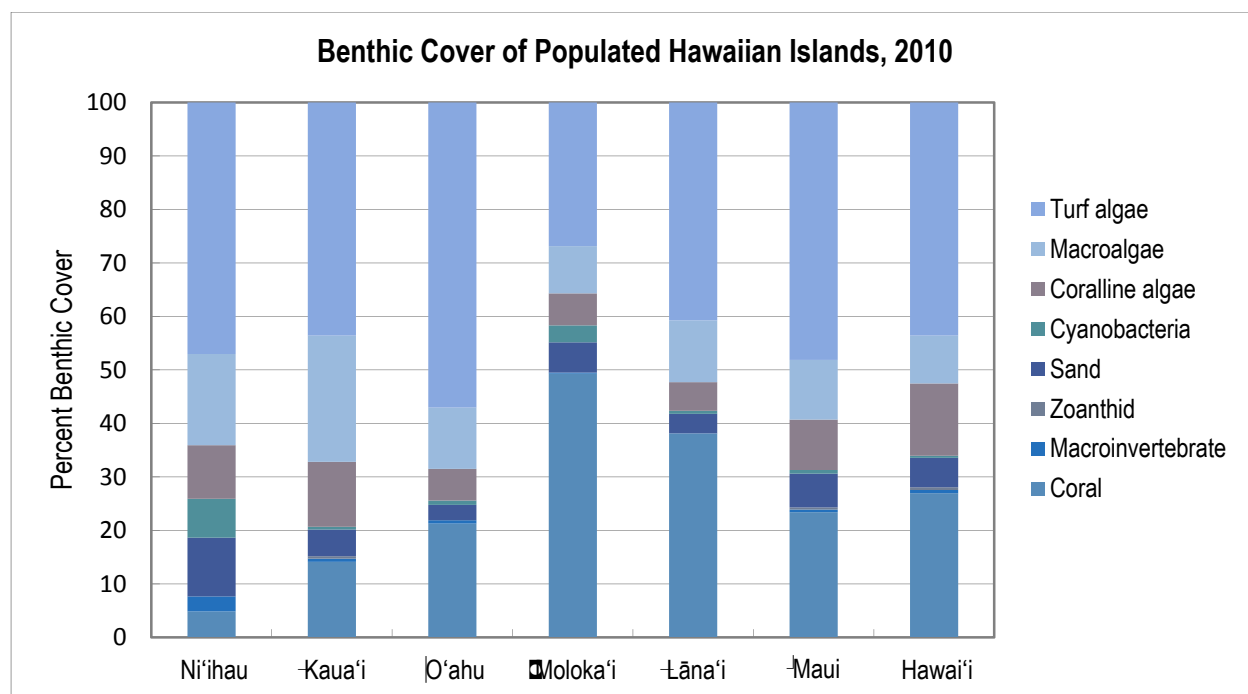


Figure 16. 2010 Benthic cover in the populated Hawaiian Islands.

Source: NOAA NMFS PIFSC CRED.

Island	Number of Sites Surveyed	Depth (ft)	Average Coral Cover (%)	Frequency of Disease Occurrence (%)	Average Disease Prevalence
Hawai‘i	19	24-50	29.2 ± 3.2%	100.0	1.20 ± 0.44%
Maui	11	7-50	41.1 ± 7.5%	100.0	1.36 ± 0.37%
O‘ahu	27	5-60	23.6 ± 3.9%	100.0	1.03 ± 0.25%
Kaua‘i	12	21-56	7.5 ± 1.8%	83.3	0.39 ± 0.21%
Ni‘ihau	6	30-50	<1 (<1)	16.7	0.02 ± 0.02%
Lehua	3	38-50	<1 (<1)	33.3	0.02 ± 0.02%

Table 28. Percent coral disease for coral in the populated Hawaiian Islands.

Source: *Aeby in Friedlander et al. (2008).*

8.1.1.2. Marine Species

Fish

Fish biomass around Ni‘ihau and Lehua is higher than elsewhere in the populated Hawaiian Islands, though lower than for forereefs in the Northwestern Hawaiian Islands (Figure 17 and Figure 18; CRED 2013, Williams et al. 2013, Williams et al. 2011, Williams et al. 2008). Fish biomass surveys conducted in 2005, 2006, and 2008 estimated fish biomass at 66.49 ± 12.63 SE g m⁻² for Ni‘ihau, and 68.37 ± 10.03 SE g m⁻² when combined with data from Lehua (Williams et al. 2013). Fish biomass surveys conducted in 2013 using a different methodology estimated that fish biomass at Ni‘ihau is approximately 58.51 ± 9.29 SE g m⁻² (Figure 19 and Figure 20; CRED Data 2013).



The total fish biomass of endemic species around Ni‘ihau is higher than around the other populated Hawaiian Islands (Figure 18). However, the proportion of all endemic fish to all fish species does not differ

significantly between Ni‘ihau and the other populated Hawai‘i Islands. This could be a reflection of the overall higher fish biomass at Ni‘ihau. There is higher biomass of certain fish families (i.e., snappers, goatfish, and soldier fish) in the fore reef environments of Ni‘ihau when compared to entire forereefs of some populated Hawaiian Islands (and some forereefs in the Northwestern Hawaiian Islands). There is also higher biomass of jacks in fore reef environments of Ni‘ihau compared to most of the other populated Hawaiian Islands. There is also a higher biomass and proportion of introduced fish species around Ni‘ihau than the other populated Hawaiian Islands. The significance of this is not well understood although it suggests that the levels of invasive fish should be closely monitored.

There are several reasons that could explain why the fish biomass around Ni‘ihau is relatively higher than around the other populated Hawaiian Islands. Fish biomass could be the result of

lower levels of fishing pressure than elsewhere in the populated Hawaiian Islands. Throughout the populated Hawaiian Islands, fish biomass is generally highest on shallow reefs adjacent to areas with low human populations and fish biomass generally decreases as human populations increase (CRED 2013; Williams et al. 2008). Figure 21 shows total fish biomass (g m^{-2}) by island human population and how fish biomass decreases as island human population increases. Additionally, high levels of fish biomass could be related to the high level of suitable fish habitat. However it is difficult to assess the latter because bathymetric resolution of data on submerged land structures at Ni‘ihau is relatively poor (at up to 50 square meters in some places) and there are significant bathymetric data gaps (up to 75 square km) in nearshore waters of Ni‘ihau (Battista pers. comm.). Resulting habitat maps and models use a minimum mapping unit of 1 acre (4,047 square meters), which makes these estimates quite coarse.

Deep water benthic habitats near Ni‘ihau have been understudied relative to the other populated Hawaiian Islands. A series of Tethered Optical Assessment Device (TOAD) surveys that took place in deep waters (generally 25-100 m) of Ni‘ihau revealed coral at mesophotic depths ranging between 25 – 100 m in 4 of 12 transects (PIBHMC 2005). The two most commercially valuable bottomfish species, Opakapaka Pink Snapper (*Pristipomoides filamentosus*) and Onaga Red Snapper (*Etelis coruscans*) were found to be significantly larger in size within the Bottomfish Restricted Fishing Area (BRFA) than outside the BRFA at Ni‘ihau (Moore et al. 2013). Furthermore, the relative abundance of the Kalekale Snapper (*Pristipomoides sieboldii*) was observed to be high relative to BRFAs at West and East O‘ahu (Moore et al. 2013). Hahalua (manta rays, *Mantus birostris*) and other large fish are also thought to be abundant near Ni‘ihau (Hollingworth 2008).

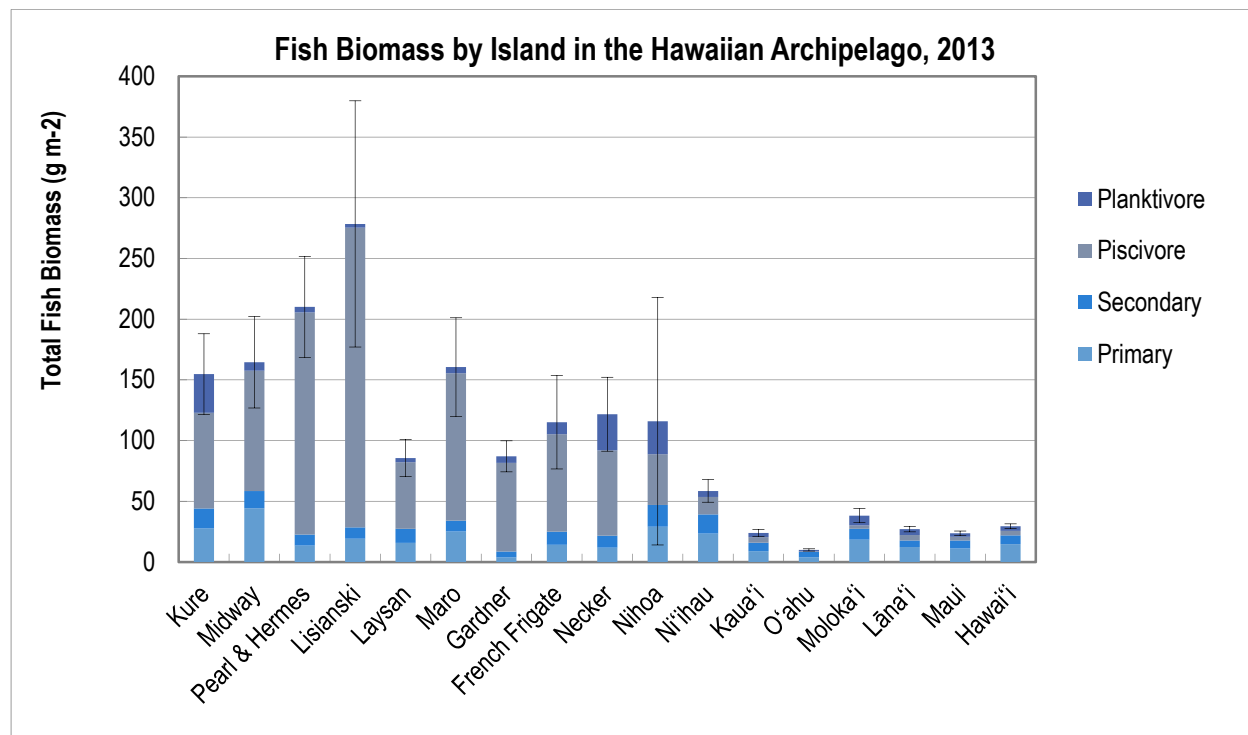


Figure 17. Fish biomass in the Hawaiian Archipelago.

Source: NOAA Coral Reef Ecosystem Division (2013)

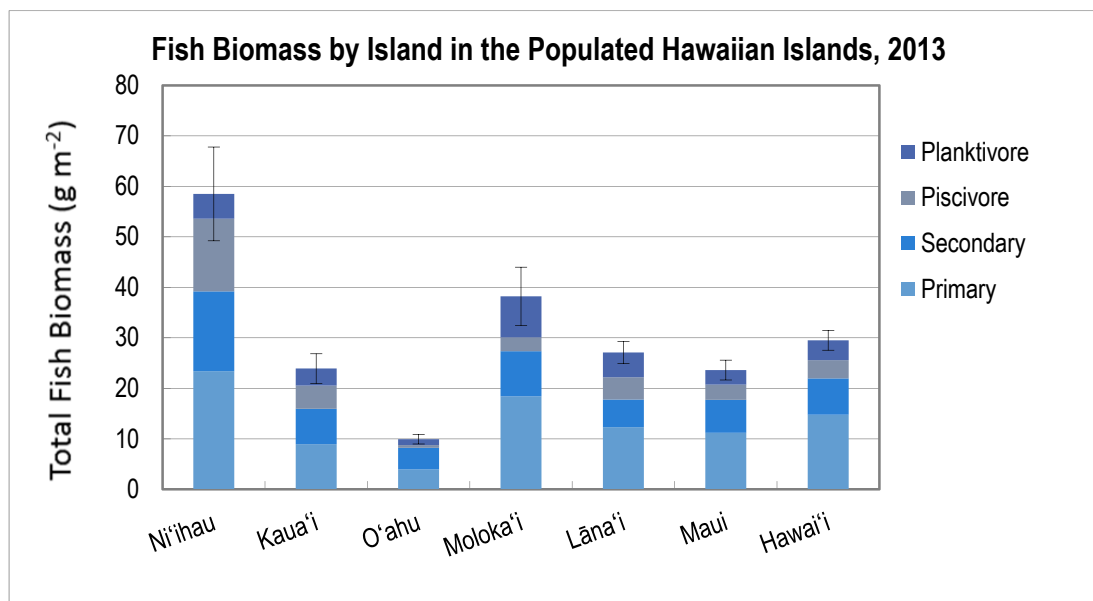


Figure 18. Fish biomass in the populated Hawaiian Islands.

Source: NOAA Coral Reef Ecosystem Division (2013).

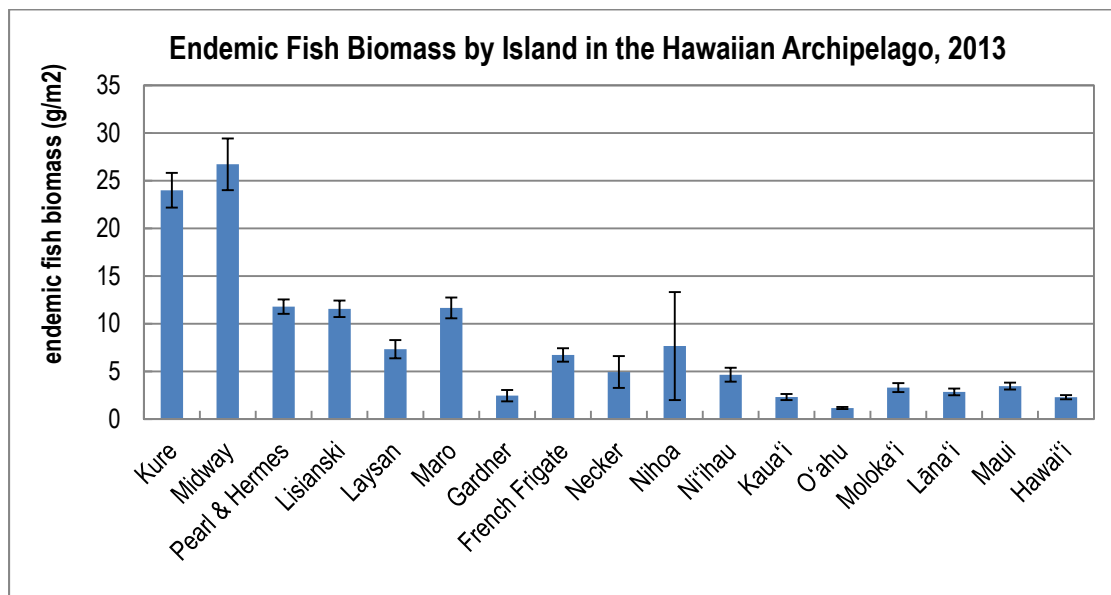


Figure 19. Endemic fish biomass in the Hawaiian Archipelago.

Source: NOAA Coral Reef Ecosystem Division (2013).

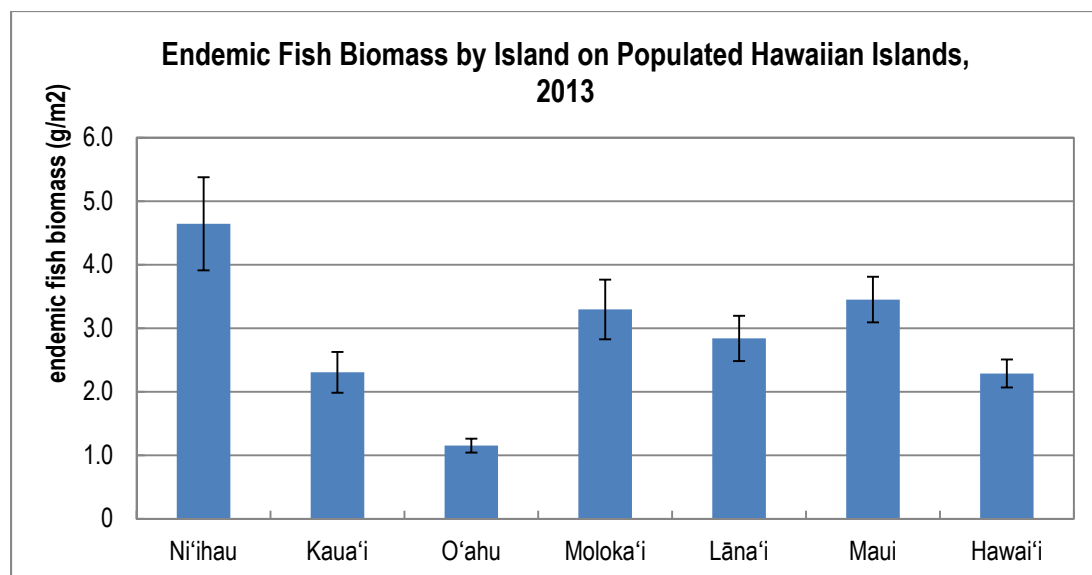


Figure 20. Endemic fish biomass in the populated Hawaiian Islands.

Source: NOAA Coral Reef Ecosystem Division (2013).

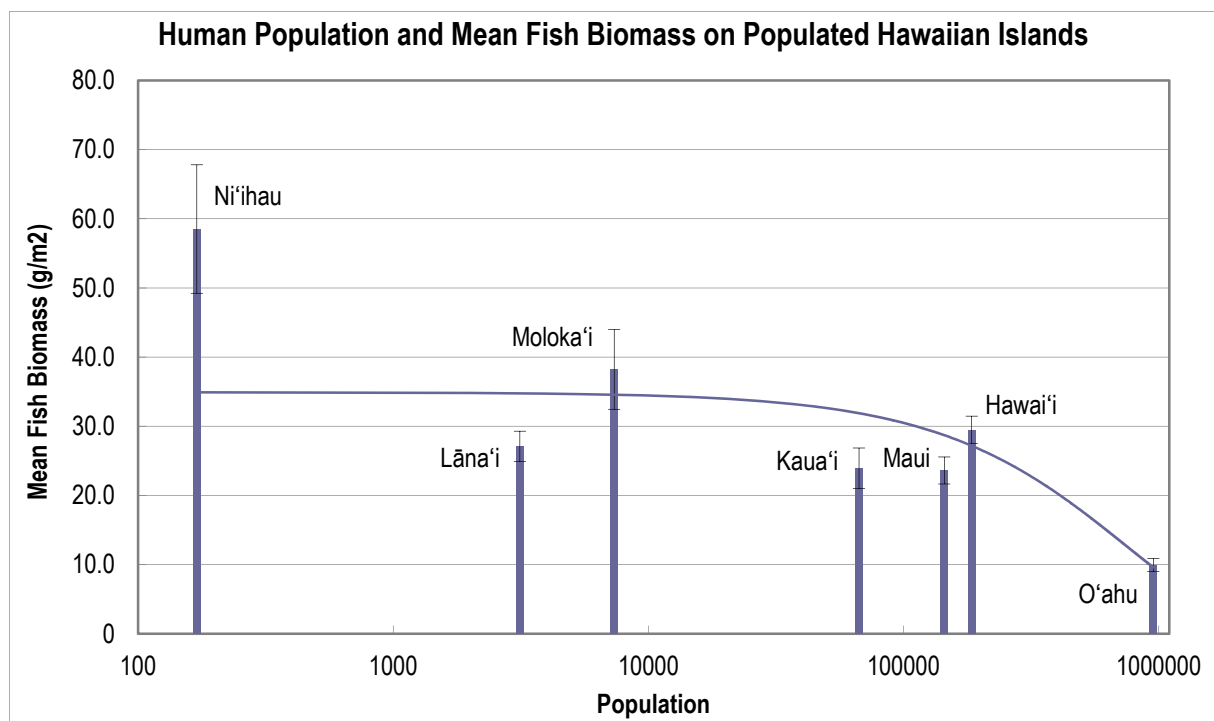


Figure 21. Relationship between human population and mean fish biomass.

Source: Census Data (2010); NOAA Coral Reef Ecosystem Division (2013).

Monk Seals

Hawaiian monk seals have a significant presence in Ni‘ihau and Lehua. Aerial surveys conducted in 2000, 2001, and 2008 documented approximately three times as many monk seals on the coastal areas of Ni‘ihau than other islands in the populated Hawaiian Islands (Figure 22).¹¹ Island-wide surveys of Ni‘ihau have observed between 17-69 monk seals at a particular time (Figure 23), higher than any other reported sightings on the populated Hawaiian Islands. There is also reason to believe that the population of monk seals at Ni‘ihau may be distinct. The NOAA Fisheries Monk Seal Research Program actively works to tag monk seals in the Northwestern Hawaiian Islands and often monk seals observed at Ni‘ihau do not have tags, which suggests that they may not frequently travel to the Northwestern Hawaiian Islands.



In 2011, at least six births were observed by NOAA personnel during on-site visits to Ni‘ihau (Tracy Wurth, NOAA, pers. comm.). In close partnership with the Robinson family and local residents, NOAA and partner agencies conducted three monk seal responses on Ni‘ihau in 2010 (NOAA 2011). In 2011, NOAA was invited to Ni‘ihau several times to treat an injured female and weaned pup and was given two monk seals carcasses for necropsy (Tracy Wurth, NOAA, pers. comm.).

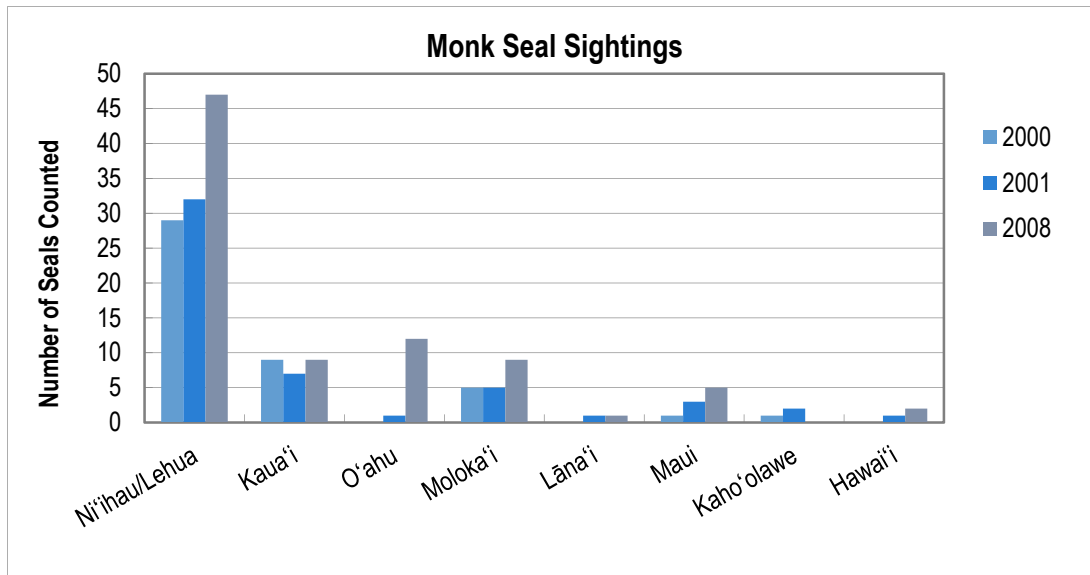


Figure 22. Monk seal counts from aerial surveys in the populated Hawaiian Islands.

Source: NOAA PIFSC/Charles Littnan.

¹¹ Aerial surveys give a small snapshot of information at only three time periods while they do not present enough information to assess island wide populations over time.

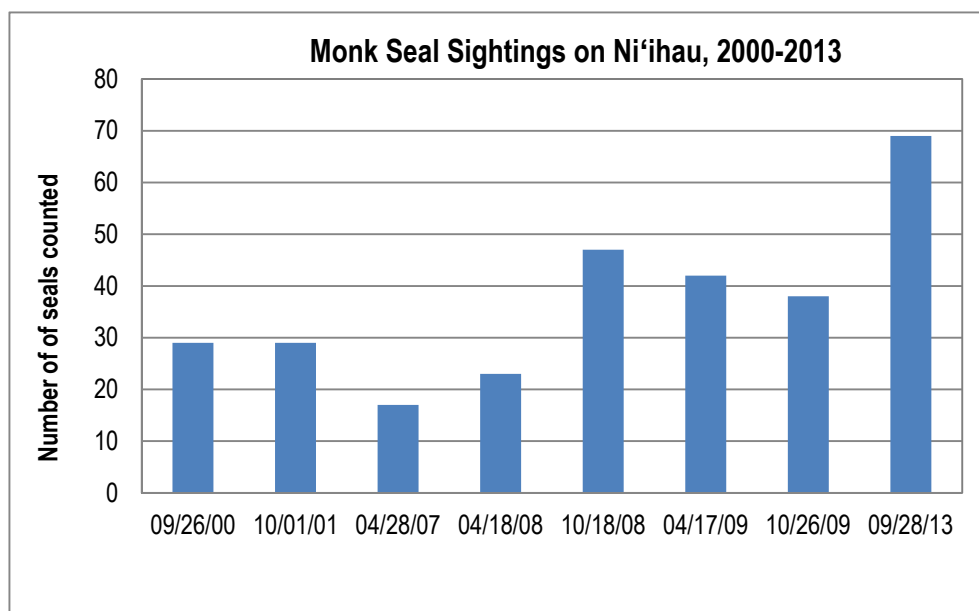


Figure 23. Monk seals counted during single-day aerial surveys of Ni'ihau.

[2013 data obtained by surveying beaches by foot and horseback]

Source: NOAA PIFSC/Charles Littnan.

Humpback Whales

Humpback whales have been observed with greater frequency near Kaua'i and Ni'ihau during recent aerial survey period (1993-2000) than during earlier surveys (1976-1980) (Mobley et al. 2001). Additionally, humpbacks were observed in greater numbers near Ni'ihau than near Hawai'i Island and O'ahu during 1993-2000 aerial surveys (Aki et al. 1994). The greatest population density of humpback whales is observed between one kilometer from shore to a 20 meter depth contour (Figure 24).

Dolphins

There are 18 species of odontocetes that may be found around the islands of Kaua'i and Ni'ihau. The common bottlenose dolphin *Tursiops truncatus* lives in demographically independent populations (island residents) between the islands of Ni'ihau and Kaua'i and is not believed to exchange with other islands (Baird et al. 2009, Martien et al. 2011). There is also a high-degree of site fidelity by rough-toothed dolphins in the channel between Kaua'i and Ni'ihau (*Steno bredanensis*) (Baird et al. 2008a in Baird et al. 2012). False killer whales (*Pseudorca crassidens*) have insular and pelagic populations, and there is some evidence to suggest that insular false killer whales near Ni'ihau and Kaua'i constitute an overlap zone between two populations, one near the populated Hawaiian Islands and one near the Northwestern Hawaiian Islands (Martien et al. 2014).



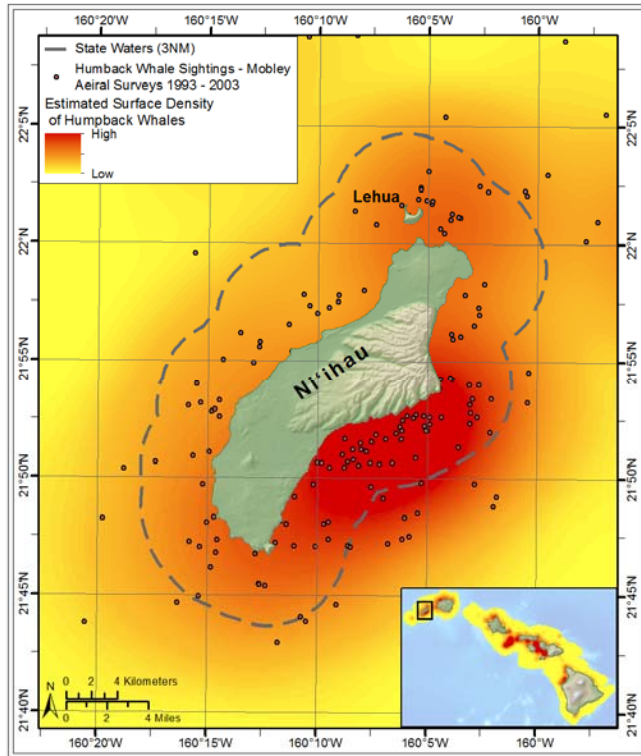


Figure 24. Humpback whale observations around Ni‘ihau and Lehua (1993-2003).

Source: Mobley (2003).

Seabirds

Lehua is an important seabird breeding habitat in the populated Hawaiian Islands. Recent research has documented eight breeding seabird species comprising over 25,000 pairs, including the largest breeding colonies of brown booby (*Sula leucogaster*) and red-footed booby (*Sula sula*) in the populated Hawaiian Islands (Vanderwerf et al. 2007). Additionally, Lehua is one of only two nesting sites for black-footed albatrosses in the populated Hawaiian Islands, and both the threatened Newell’s shearwater and endangered Hawaiian petrel have been sighted there. There are efforts to restore the island ecosystem including removal of introduced species and the re-introduction of native species (Duffy 2010).

Connectivity

Research on oceanographic current vectors, larval transport modeling and genetic connectivity suggest that marine species at Ni‘ihau are strongly connected with other nearby islands, especially between the islands of Kaua‘i, Nihoa and O‘ahu in the Hawaiian Archipelago. Currents originating near northern Ni‘ihau and Lehua moving east towards Kaua‘i, and other currents originating near southern Kaua‘i moving westward towards Ni‘ihau, suggest connectivity between Ni‘ihau and Kaua‘i.

An oceanographic larval transport modeling study predicted that larvae produced at Ni‘ihau may contribute larvae to reefs throughout the Hawaiian Archipelago, particularly Kaua‘i, and O‘ahu (Kobayashi 2008). Ni‘ihau may also receive larvae produced at islands throughout the Hawaiian Archipelago, particularly from Nihoa, Kaua‘i, and O‘ahu. Another study that modeled the larval transport of three bottomfish species predicted that larvae produced at Ni‘ihau are likely received throughout the archipelago. Ni‘ihau may also receive larvae from many islands, but particularly

Kauaʻi, and Kaʻula. The study also identified strong connections between Niʻihau and Kauaʻi with a substantial connection of larvae exported from Niʻihau to Kauaʻi. The subregion between Oʻahu through Mokumanamana in the Northwestern Hawaiian Islands may constitute a discrete population and connectivity unit and the islands between Oʻahu and Mokumanamana may act as stepping stones for connectivity between the Northwestern Hawaiian Islands and the populated Hawaiian Islands (Vaz 2012).

Genetic studies suggest that species in the waters at Niʻihau are well connected with those at nearby Kauaʻi and parts of the Northwestern Hawaiian Islands, however all trends can be slightly different for different species and additional research is needed. There are four distinct genetic breaks and barriers that are common to various combinations of species (Toonen et al. 2011). They occur between Niʻihau and the Northwestern Hawaiian Islands and between Kauaʻi and the rest of the populated Hawaiian Islands (Figure 25). A genetic study on the spinner dolphin (*Stenella longirostris*), found that animals at Niʻihau are related to animals at French Frigate Shoals, Kauaʻi, Oʻahu, and Maui and are different from those at other islands (Andrews et al. 2010). A study on the crown of thorns starfish (*Acanthaster planci*) found that animals at Niʻihau are related to animals at Kauaʻi, Oʻahu, Molokaʻi, Lānaʻi, and Hawaiʻi Island and are different from those at other islands (Timmers et al. 2011).

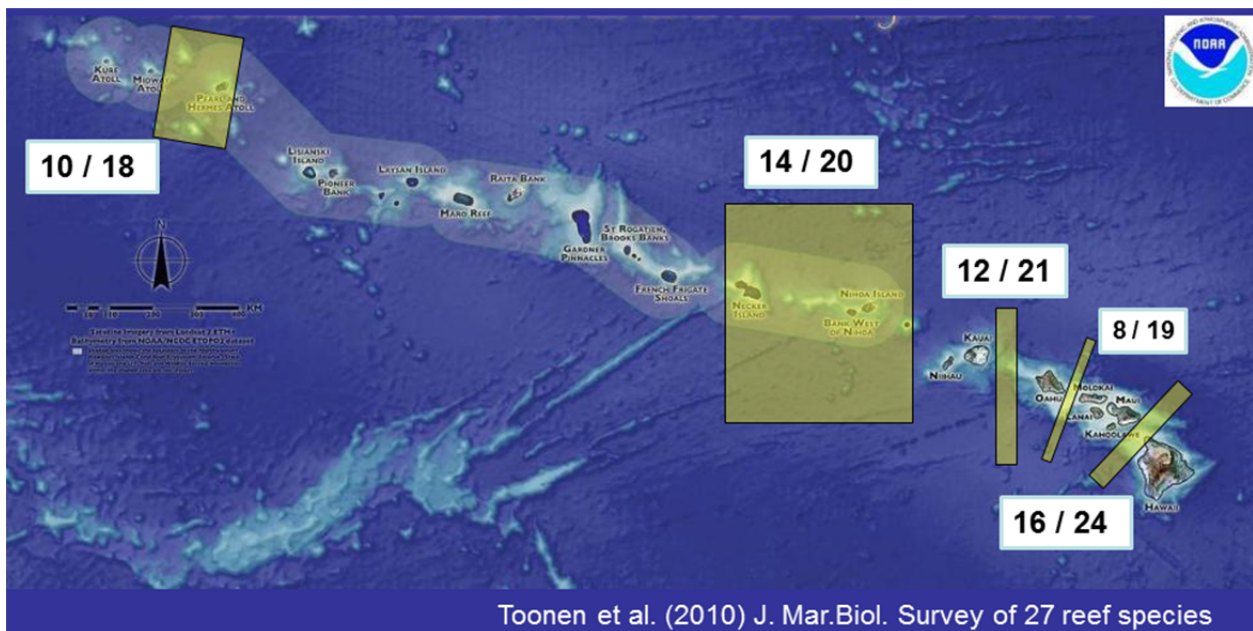


Figure 25. Genetic connectivity between marine species in the Hawaiian Archipelago.

Yellow boxes indicate breaks. Numbers indicate the number of species the break was detected for over the number of species analyzed. Based on a surveys of 27 reef species.

Source: R. Toonen.

8.1.2. Human Environment

8.1.2.1. Human and Economic Setting

Ni‘ihau is politically incorporated into Kaua‘i County. The island is privately owned by the Robinson family who have operated the Ni‘ihau Ranch continuously for nearly 150 years. The population of the island varies but the 2010 US Census recorded 170 residents on the island. Most of the Niihauan residents are Native Hawaiian and live in the main town of Pu‘uwai on the western side of the island. Ki‘i Landing, located on the northeast side of the island, is the primary port for the transport of supplies to the island by private barge. Formerly there were landings at Nonopapa and Kiekie on the west shore of Ni‘ihau, but they are no longer in operation. Ni‘ihau is relatively undeveloped except for residential houses, some common buildings such as the schoolhouse, and former ranching facilities. There are several species of feral ungulates roaming the island from previous introductions, including: pigs, goats, eland, aoudad (Barbary Sheep) and oryx.

8.1.2.2. Cultural and Historic Setting

History

Hawaiian mythology says that Ni‘ihau was the first Hawaiian island on which *Pele*, the fire goddess, set foot (Tava 1984). According to mo‘olelo regarding Ni‘ihau’s history, “Pele left Bora Bora and journeyed to the Hawaiian Islands, stopping first at Nihoa and then Ni‘ihau. While there, she tried to dig her fire pits, only to hit water. After her unsuccessful digging on Ni‘ihau, she left for Pu‘ukapele, Kaua‘i, which also proved unsuitable, and so on down the Hawaiian chain to the island of Hawai‘i.” The place where Pele tried to dig her fire pits on Ni‘ihau is called Kaluakawila; at Motupapa, Pele stood overlooking Kaua‘i in hopes of finding a home there. When Pele visited her lover Lohiau on Kaua‘i, the pair took frequent trips together from Kaua‘i to Ni‘ihau. Other references to Pele and her family are contained in the place names of Paepaeohiaka, Poliiolehua, Kealahula, and Makaohina.

Negotiations for purchasing the island were initiated in September of 1863, and the Sinclair sons offered the government \$6,000 for the island. In January of 1864 the government sold the island for \$10,000, with the exception of the two ahupua‘a, Halawela and Kahuku, which were sold to Iosia Koakanu, and 50 acres that had already been sold by the government to an individual named Papa. When Mrs. Sinclair died her sole heir was her grandson, Aubry Robinson. The Koakanus had applied for a royal grant during the Great Mahele in 1848. Their ahupua‘a was over 2,000 acres and ran across the island at two different locations. In 1864, the Sinclairs purchased the remaining land from the Koakanu family for \$800. The Sinclairs then built a permanent house on a plateau at Kiekie. Presently, descendants Bruce and Keith Robinson, own 47,217 of the island’s 47,705 acres (Tabrah 1987, Tava 1984). Because of its private ownership, the island is rarely accessed by visitors and is often referred to as “The Forbidden Island.” The relative isolation of the people on Ni‘ihau meant that traditional Hawaiian culture remained a stronger influence on Ni‘ihau than on other islands.

Residents

Ni'ihau's history shows a marked population island in 1778, when an estimated 10,000 people populated Ni'ihau. Mass migration due to drought and other factors left Ni'ihau with a population of 4,000 by the beginning of the nineteenth century. When the Sinclair family purchased most of the island in 1864, 1,000 residents lived on Ni'ihau. Four years later, 300 Niihauans remained. The population has remained under 300 since then, with a population of 170 recorded in the 2010 census. Two-thirds of the population in 1980 was of pure Hawaiian descent, making it the largest colony of Hawaiians in the state (Tava 1984).

Niihauans reportedly use traditional fishing methods such as nets, and fish in particular fishing spots called *koa* (Tava 1984, Meyer 1998). They also use contemporary fishing gear including rods and reels and motorboats. Fish populations have been reserved for Ni'ihau residents only, from the outer reefs inland, since 1839 when it decreed by King Kamehameha (Tava 1984). In the winter months, *pupu* shells wash up on Ni'ihau beaches in abundance and Niihauans collect the shells to make *lei pupu o Ni'ihau* for which the island is known (Tava 1984).

Niihauans were diligent famers, producing sweet potatoes, sugar cane, yams, salt and some taro; at times producing more of these crops than neighboring Kaua'i. When the Sinclairs purchased the island, they introduced cattle and sheep for ranching and eliminated dogs, which were traditionally raised for food by Niihauans. Other traditional practices that remained on Ni'ihau were cooking in underground ovens (*imu*) and producing charcoal produced from kiawe trees (Tava 1984, Meyer 1998). An archeological survey of the northeast section of the island showed evidence of agriculture and temporary shelters but no permanent habitation (US Navy 1998).

Hawaiian language and many traditional cultural practices have flourished because of the relative isolation of Ni'ihau. The prominence of manaleo, native speakers, and the information they provide about their unique dialect has informed an entire subset of linguistic experts on the history and future of 'ōlelo Hawai'i. The 'ōlelo no'eau gathered about Ni'ihau reflect mystique, history, and lineal ties to the landscape and surrounding environment.

Hula and Oli

The following chant was written for Kapiolani by the people of Ni'ihau as she toured Kaua'i. It tells of the love for the island and all its beauty:

E hoi ke aloha Niihau E
Our love gods out to you from Niihau
 i ka Wai-huna-o-ka-paoo
of the hidden waters of the paoo,
 Na-ulu-hua-i-ka-hapapa E
The breadfruit on the reef
 mehe ko eli lima o Halalii E
like the cane dug by Halalii hands,
 I ea Nihoa mahope E
Here is Nihoa behind
 i ke lau hapapa ike kai E
the seaweed reef in the ocean
 O ka la welawela ike kula E
The hot sun on the plains
 huli aku kea lo i Kauai E
turn to face Kauai.
 Haina ka inoa no ka Wahina E
This is the name of the lady,
 no Kapiolani no, he inoa e
Kapiolani is the name.

‘Ōlelo no‘eau	Translation	Interpretation
Pae mahu o Kauwai nei	Hermaphrodite of Kaua‘i	Mahu also meant sexless or without. This is from a string figure chant with references to Ni‘ihau.
Ekolu no pua lawa kuu lei	The three flowers (children). My lei is complete.	The three flowers are the islands of Ni‘ihau, Nihoa, and Ka‘ula.
Ekolu lakou keiki	They are the three children.	This saying pertains to ancient times: these were triplets born to Hina, goddess of creation, on the same day. No other children were born. They were named Ni‘ihau, Ka‘ula and Nihoa.
O kanaka o ka wai	The people of the water. This was used in reference to Kaua‘i.	
Ke hoi nei ko Ni‘ihau keiki I ka maluhia ka ulu hala o Halawela	When Ni‘ihau’s children return, there will be peace in the hala grove of Halawela.	This is a 1865 lament for the return of the island to the natives.
Aahu ae i ka manu o Ka‘ula	You then rule the birds of Kaula.	The ruling domain of hero Kawelo.
Ka ua lihu anu toetoe koou, ha ahi ka ke kapa o ka ua i lala ai	When the rain comes it is bitter cold. The fire is your blanket that will do away with the rain.	
I ka lani no ka ua wai e no ke pulu.	The rain is still in the clouds. It is time to prepare the mulch.	Months in advance, Niihauans prepared the land for planting, usually for uwala. Don’t wait for the rain to come; you may find yourself with little or no crop.
Pua e aka manu o Kaula i ke kai	The birds of Kaula die at sea.	Do not wander too far from home lest you be destroyed.
Hanau Ni‘ihau he aina, he motu, he aina i kea a i ka mole o ta aina	Born the island of Ni‘ihau, the land that is the stem of all the islands.	Ni‘ihau is the oldest of the eight Hawaiian islands.
Au ka toae, he la malie	When the koae swims, it is a calm day.	Good fishing day.
Ma ka mole mai o Lehua	By the foundation of Lehua.	Lehua and Ni‘ihau are one, as they were one island before sinking.
Moku ka ili la	Sun-snatching island.	Referring to Lehua.
Ena aku la manu o Kaula	The birds of Kaula are wild.	Reference to a shy person.
Ni‘ihau o Manoopupaipai	Queen Manoopupaipai of Ni‘ihau, an ancient alii.	A second meaning is “Ni‘ihau, island of belly-slapping,” referring to the heavy population on Ni‘ihau. People made fun of the many births. In days of old, Ni‘ihau, Kaua‘i and Maui were the most heavily populated of the Hawaiian Islands.
Kaua‘i kaili la, o Ni‘ihau ka la kau	Kaua‘i steals the sun; Ni‘ihau is the sun.	
Hoona ke ola i ka malu hau o Halalii	Comfortable is the life in the shade of the tree at Halalii.	Reference to a person and place on Ni‘ihau.

Table 29. Wise sayings compiled about and attributed to Ni‘ihau.

Source: *Honua Consulting*.

8.1.2.3. Human Uses

Fishing Activity

Traditionally, Niihauans only catch certain fish species during different seasons. The resources of Ni‘ihau waters have always been for residents only and kapu (restricted) to others. The restricted fishing area reaches from the outer reefs to the sands of the island. Table 30 summarizes sayings about fishing attributed to Ni‘ihau’s traditions.

‘Ōlelo no‘eau	Translation	Interpretation
Nee kulo aka lawaia ua ma malie	When the fisherman crouches low it is calm.	This would signal that it is time to fish on the reef or at shore.
Kahi e no ka malie hoomakaukau ka makau	The calm is far off, make ready the fishhooks.	There might be rough waters now, but don't wait for the calm. Be ready beforehand.
Kau ka iwa, he la makani	When the frigate bird flies, it will be a windy day.	
Au ka toae, he la malie	When the snapper swims, it is a calm day.	A good day for fishing.

Table 30. Wise sayings about fishing attributed to Ni‘ihau’s traditions

Source: *Honua Consulting*

In 2013, 32 commercial fishing licensees reported catching fish outside the reefs in the two reported fishing areas (505 and 506) that adjoin the shorelines of Ni‘ihau out to approximately two nautical miles (Table 31). Fishing catch varied considerably between 2007 and 2013 with highest numbers reported in 2007 and the lowest reporting number in 2009 and 2010. Since then, total catch biomass has generally increased while number of fish caught has varied. This may be due to the targeting of different species of fish, which can be a result of changes in fish abundance, changes in market demand, or changes in fishing behavior (e.g. fishing different areas because of difficult ocean or weather conditions or high gasoline prices). A majority of catch was reported in the reported fishing area on the leeward side of the island.

Fishing methods include troll, lay gill net, Kona crab net, inshore hand line, deep bottom fish hand line, casting, and spearing. Uku (46,688 lbs), Ono (39,653 lbs), Menpachi (15,766 lbs), and Kona Crab (7,771 lbs), are the top four species caught when considering a combination of mean number caught, mean weight caught, total number caught, and total weight caught. ‘Opihi were not commonly reported, although anecdotally it has been reported that commercial fishermen collect ‘opihī at Ni‘ihau. This culturally important resource has declined on most of the populated Hawaiian Islands. In area 505, 100 lbs of ‘opihī (without species information) were commercially collected in 2009. In the same area, 50 lbs of ‘opihī alinalina were reported collected in 2012. In area 506, 20 lbs (250 individuals) of ‘opihī alinalina were reported commercially collected.

Ni‘ihau Commercial Fishing Landing Data (Area 505 & 506)			
Fiscal Year	Number of Licensees	Number Caught	Lbs. caught
2007	32	330,720	225,359
2008	31	10,492	90,687
2009	30	7,755	21,128
2010	24	6,920	31,450
2011	27	18,376	48,379
2012	37	12,986	60,675
2013	32	11,769	59,126

Table 31. Commercial fishing near Ni‘ihau (FY2007 to FY2013).

Source: *State of Hawai‘i Department of Land and Natural Resources (2014).*

Recreation and Tourism

Several dive and recreational tour boat companies offer diving and tour excursions to Ni‘ihau from the island of Kaua‘i. Figure 26 shows the relative frequency of commercial dive and snorkel tour use around Ni‘ihau. The majority of recreational diving has been reported to occur around Lehua Island though commercial dive boats will less frequently visit dive sites on the southern and coast of Ni‘ihau and very rarely visit sites on the eastern coast of Ni‘ihau. Figure 27 shows the primary locations for commercial boat based wildlife viewing and snorkel tour locations around Ni‘ihau. Lehua remains the most popular location for wildlife viewing but moderate use is also seen along the northeastern coast. Less frequently, wildlife viewing boats will also travel to the southern coast of Ni‘ihau.

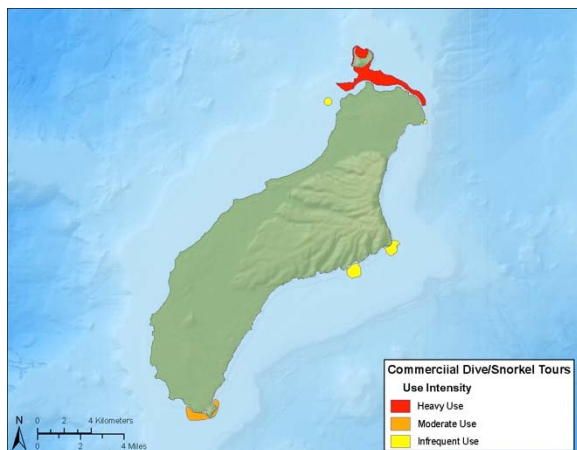


Figure 26. Commercial dive and snorkel tour locations around Ni‘ihau.

Source: *Office of National Marine Sanctuaries (2012).*

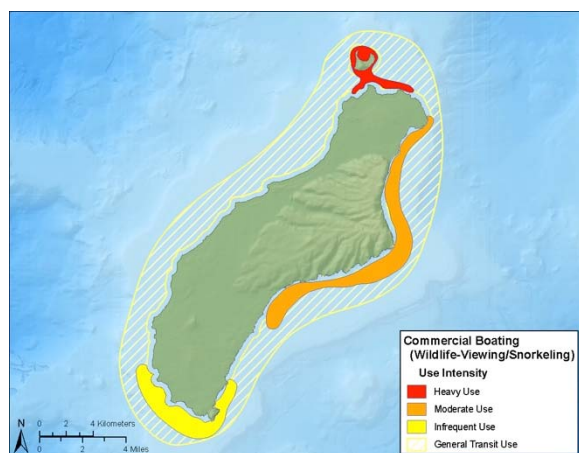


Figure 27. Commercial boat-based wildlife viewing and snorkel tours around Ni'ihau.

Source: *Office of National Marine Sanctuaries (2012).*

Military

The U.S. military's presence on Ni'ihau began in World War II when a Japanese pilot crashed his plane on the island. An infantry unit from Kaua'i was subsequently stationed on the island and the military remains active on the island today for testing and training. There is a Kingfisher Underwater Training Area off the southeast coast of Ni'ihau. A simulated underwater minefield was installed in an area 2 miles off the Ni'ihau coast between the depths of 300 and 1200 ft in flat areas without coral cover. The area is used to train with the kingfisher mine-detection system. The Department of Defense (DOD) also conducts operations along the western side of Kaua'i and Ni'ihau. Test ranges that extend beyond the 100-fathom isobaths are considered essential for national security and defense. Additional existing and proposed military activities around Ni'ihau are summarized in Table 32.

Military Activities Around Ni'ihau	
Existing	Proposed
• Radar • AEGIS drone targets on east coast of island • Special Warfare Operations • Electronic Combat Operations • Mine Countermeasure Exercises • Flare Exercises	• Increased electronic combat by 76% • Up to 6 Undersea War Exercises (USWEX) per year • Biennial RIMPAC exercise (including 3 strike groups) • Additional Major Exercises • Additional sonar usage

Table 32. Existing and proposed Navy activities around Ni'ihau.

8.1.3. Institutional Environment

Ni'ihau is privately owned by the Robinson family but the coastal waters around Ni'ihau and Lehua Island out to three nautical miles are managed by the State of Hawai'i. The waters beyond three nautical miles, to the outer edge of the United States Exclusive Economic Zone (200 nm) are under the jurisdiction of the federal government. The State of Hawai'i manages a Bottomfish Restricted Fishing Area to the south of Ni'ihau. The U.S. Navy administers the Kingfisher Training Range located two nautical miles to the southeast of Ni'ihau. Lehua Island is federal property administered by the U.S. Coast Guard. It is also a designated Seabird Sanctuary

managed by the Department of Forestry and Wildlife (DOFAW) under the State of Hawai‘i Department of Land and Natural Resources.

8.1.4. Threats to Resources

Many threats to marine waters of Ni‘ihau and Lehua are common threats to the marine waters of the populated Hawaiian Islands. Climate change, erosion, marine debris and vessel grounding may be particularly significant stressors to calcifying coral reef organisms such as coral at Ni‘ihau. The continuous recruitment and growth of calcifying organisms is critical to the cycle of reef structure maintenance and construction as natural bioerosion occurs. Damage to the already relatively low cover of coral by a range of stressors may impact the coral reef’s resilience.

Introduced species such as the bluelined snapper *Lutjanus kasmira* are known to harbor a parasite that is transmitted to native goatfish (Gaither et al. 2013). The impacts to native fish at Ni‘ihau are not well understood but there have been several reports of overfishing at nearshore waters of Ni‘ihau indicating that the population of native fish may be declining.

The high density of endemic Hawaiian monk seals may be susceptible to marine debris or changes in beach habitat from climate change. Other regional threats that apply to Ni‘ihau include bycatch, incidental take interactions and vessel interactions.

8.2. North Shore of Kauaʻi: Haʻena Ahupuaʻa to Keʻe

8.2.1. Biophysical Environment

8.2.1.1. Habitats

Haʻena ahupuaʻa is located on the north shore of the island of Kauaʻi, west of the town of Hanalei. Between Haeʻena Point, on the eastern edge of the ahupuaʻa, and Kailiu Point, 1.2 miles west of Haʻena Point, is Haʻena Beach. Keʻe Beach, just east of Kailiu Point, marks the eastern edge of the steep bluffs of the Na Pali Coast (Clark 1990, BookletChart Haʻena Point to Kepuhi Point 2003). Coral reef extends from Haʻena State Park to Keʻe Beach, approximately 100 m from the beach, forming a shallow sandy lagoon at Keʻe Beach (Clark 1990, PacIOOS 2013).

8.2.1.2. Marine Species



A baseline study of the marine life off Keʻe Beach, carried out by Save Our Seas and other institutes, documented species found in the shallow, sandy lagoon and on the reef flat. Fish species richness was low (40 species, 15 families), in comparison to neighboring Hanalei Bay (160 species). The lagoon had few fish, with the exception of a relative

abundance of goatfish (wekeʻula). The reef flat bounding the lagoon hosted more species. Wrasses, surgeonfish and damselfish were most abundant on the reef. Two endemic wrasse species, the saddle wrasse (hinalea lau-wili) and the belted wrasse (omaka), were the first and second most abundant species, respectively, while convict tang (manini) was the third most observed. The study observed mostly small fish and concluded that the reef and lagoon provided a good habitat for juvenile fish as well as grazing surgeonfish (Stepath 1999).

The endangered Hawaiian monk seal has been observed in the area, with greater frequency at Keʻe Beach and Tunnels Beach and lower frequency at Kailio Point and most infrequently at Haʻena Point (Hawaiian Monk Seal Observations 2012). Humpback whales have also been seen frequently in this area.

8.2.2. Human Environment

8.2.2.1. Cultural and Historic Setting

The approximate pattern of human settlement in the Haʻena area, as discovered through archeological research, begins with a period of marine-based economy and a subsequent

development of agriculture paralleled by a population expansion. Dating methods have proven unreliable in the region but settlement may have started as early as A.D. 1000 (Clark 1990, Dye 2005). Archeological research has unearthed materials to support both fishing and farming from fishhooks and adzes to taro patches (lo'i). Taro was grown in terraced ponds in the alluvial plains around Limahuli Stream and sweet potatoes were grown on the coastal terrace. The discovery of burials sites, imu (underground ovens), and heiau (shrines), indicates settlement in the area. The period of expanded settlement and agriculture was followed by a diminishing population in Ha'ena during the time of early European contact in the 18th and 19th centuries (Dye 2005).

Ha'ena Beach Park was once host to traditional Hawaiian net fishing called hukilau. The beach is called Maniniholo for the travelling manini fish (convict tang) found there. The name Maniniholo was also given to the dry cave across the highway, a lava tube. Hauwa Reef, on the eastern side of Ha'ena Bay, and Makua Reef, to the west, both have surf breaks near them. Surfing sites include Tunnels, off Ha'ena Point, Cannons, to the west of Ha'ena Point (Clark 1990).

East of Ha'ena Beach Park, Ha'ena State Park encompasses 230 acres between Limahuli Stream to the East and Na Pali Coast State Park to the west. The state park is home to many heiau sites, including several related to hula. A heiau to Laka, the goddess of hula, was built near Ke'e Beach. Just inshore of Ke'e Beach is a traditional fishpond called Naia (Fish Ponds 2012).

Ke'e Beach marks the head of the Kalalau Trail, first built by the Hawaiian Government around 1860 to connect the isolated valley settlements. It allowed for trade of commodities such as oranges, taro and coffee between the ahupua'a of Ha'ena, Hanaka'ia, Hanakoa and Kalalau (Kalalau Trail Brochure 2012).

8.2.2.2. Human Uses

Ha'ena State Park, often called "the end of the road", marks the end of Kuhio Highway and the start of the Kalalau Trail into Na Pali State Park. The park includes part of Ke'e Beach. The Ha'ena State Park and Na Pali trailhead see about 500,000 people annually (Higuchi 2008). DLNR estimated that 1700 people visit the Ke'e Beach area daily – 450 of which embark on the Kalalau trail. The other 1250 of which use Ke'e Beach (Stepath 1999).



The beaches in Ha'ena State Park attract multiple water sports including surfing and windsurfing, boating, snorkeling and SCUBA diving. Tunnels Beach, on Ha'ena Point, is a popular spot for surfing and windsurfing, as well as boating, snorkeling and diving along the reef where rock arches and tunnels can be found. The area is a popular launch site for kayaking trips to the Na Pali Coast (Clark 1990).

8.2.3. Institutional Environment

The Na Pali Coast State Wilderness Park, encompassing part of Ke'e Beach, prohibits disturbing all "plants, geological, historical and archaeological features." Boating, hunting and fishing are restricted to certain areas within the park (Park Rules).

Parts of the populated Hawaiian Islands are designated as conservation districts by the State. Those districts are then divided into subzones of varying classifications: protective, limited, resource, general or special. A section of the reef and surrounding water near Kailiu Point is designated a protective subzone, which means the area is intended for protection of natural and cultural resources. The coastline to the west of Kailiu Point is designated a resource subzone, which ensures the sustainability of natural resources within the subzone. To the east of Kailiu Point, the coastline is a designated limited subzone, which intends to limit use of areas where the natural environment constricts human settlement. Each subzone classification has different land uses that are prohibited, restricted and permitted therein (Haw. Adm. Rul. Title 13, Chapter 5).

The Ha'ena community-based subsistence fishing area (CBSFA) was established in 2006. The CBSFA encompasses the water within 1 mile of the shoreline of Ha'ena ahupua'a. The bill requires DLNR to consult with the Ha'ena community to regulate fishing practices, including gill netting and spear fishing, and to establish no-take zones in waters off the ahupua'a of Ha'ena, among other regulations (Haw. Rev. Stat. §188-22.9). Ha'ena residents have proposed regulations to DNLR including restricting the use of non-traditional fishing gear, but the proposal had yet to be approved.

8.2.4. Threats to Resources

In the bill establishing the Ha'ena CBSFA, the State recognized a decline in fish populations in the region of Ha'ena State Park as a result of increased tourism and detrimental fishing practices (Haw. Rev. Stat. §188-22.9). The baseline study by Save Our Seas suggested that tourist walking on the Ke'e reef flat detrimentally affected the coral cover (Stepath 1999). Hawaiian monk seals, endemic to Hawai'i and observed in the area, are endangered, with only 1,200 remaining. Threats to their population include bycatch and entanglement in marine debris and declining fish populations on which they prey (Hawaiian Monk Seal 2013).

8.3. North Shore of Kaua‘i: Hanalei River

8.3.1. Biophysical Environment

8.3.1.1. Habitats

The Hanalei River is located on the east side of the Hanalei ahupua‘a and the mouth of the river opens up into Hanalei Bay adjacent to the Hanalei Beach Park. The position of the head of tide (brackish water) at the Hanalei River estuary varies with time and can range from the mouth to 16,076 feet (4900m) upstream (Harrison et al. 1991).

Distance Upstream	% Head of Tide
0m	100
2297 feet (700m)	90
6562 feet (2000m)	80
9843 feet (3000m)	70
13123 feet (4000m)	30
16,404 feet (5000m)	0

Table 33. Maximum upstream point of measurable salinity in the Hanalei River.

Source: Adapted from Harrison et al. (1991).

8.3.1.2. Marine Species

The Hanalei River estuary provides a breeding area for many juvenile native fish species including the mullet or ama‘ama (*Mugil cephalus*) and the flagtails or aholehole (*Kuhlia sandwicensis*). Giant trevally (*Caranx ignobilis*) and bluefin trevally (*Caranx melampygus*) also breed in the estuaries, although they are found with less frequency. Smith and Parrish (2002) found evidence of these species as far as 13,123 feet (4000m) upstream. Weke (*Mulloidés flavolineatus*) are also present in the river but it is unknown whether they breed in the estuary. It is believed that they migrate to the ocean before reaching maturity (Harrison et al. 1991). The blacktail snapper or to‘au (*Lutjanus fulvus*) is relatively abundant in the Hanalei River and largely inhabits the brackish water area in the estuary. The fish is common with both commercial and recreational fishermen because it is a popular food for consumption. O‘opu naniha (*Stenogobius genivittatus*), one of the few freshwater fish in Hawai‘i, is found in the Hanalei River. White ulua (*Caranx ignobilis*) and omilu (*Caranx melampygus*) are found exclusively in the Hanalei River.

The estuary also supports all five species of the endemic Hawaiian goby fish. Many goby fish are amphidromous which means they migrate between freshwater and saltwater during different stages of their lifecycle. The O‘opu Nakea (*Awaous stamineus*) was reported in ranges of the river



from the mouth to 8 miles (13km) upstream (Harrison et al. 1991). Juvenile species develop upstream and migrate downstream when they reach maturity. Female species attach fertilized eggs to the rocks located at the mouth of the river and then guard them until they hatch and return upstream. Nests of the O‘opu Nakea were found to be concentrated at least as far as the first riffle in the Hanalei River. Other Hawaiian goby species including *Lentipes concolor* and *Sicyopterus stimpsoni*, display less movement throughout their lifecycle.

The wetland areas directly adjacent to the Hanalei River provide habitat for several Native Hawaiian water birds including the Hawaiian stilt or ae‘o (*Himantopus mexicanus knudseni*), the Hawaiian coot or ‘alae ke‘oke‘o (*Fulica alai*), the Hawaiian moorhen or ‘alae ‘ula (*Gallinula chlorops sandwicensis*), the Hawaiian duck or koloa maoli (*Anas wyvilliana*). The endangered Hawaiian hoary bat or ape‘ape‘a (*Lasiurus cinereus*) can be found in this area as well. Several endangered Hawaiian geese or nēnē (*Branta sandwicensis*), have also been released into the Hanalei National Wildlife Refuge.

8.3.2. Human Environment

8.3.2.1. Cultural and Historic Setting

The Native Hawaiian goby fish, which are found in the Hanalei River, were an important resource to the Native Hawaiians. O‘opu Nakea, O‘opu Nopili, and O‘opu Akupa were food sources, typically wrapped in ti leaves and cooked, dried, or eaten raw. O‘opu Nopili was also used in ceremonies, such as the weaning ceremony for first-born children and house-warming feasts. Juvenile goby (called hinana) were also were prized by Native Hawaiians. Communities would hold traditional fishing events to encourage the juvenile fish out to sea where they would be trapped. O‘opu Alamo‘o was kapu (sacred) and believed to be related to the mo‘o gods and bad luck if caught.

The wetlands surrounding the river provide a rich environment for the Native Hawaiian practice of taro farming. Taro farming has been conducted for over 1,000 years in Hanalei Valley. Taro was a main staple of Native Hawaiians and could sustain past island-wide native populations. There are also a number of historic sites located directly adjacent to the Hanalei River. The Hanalei Bridge is on the National Register of Historic Places. The Ho‘opulapula Rice Mill is the only remaining rice mill structure in all of Hawai‘i and is listed on the National Register of Historic Places.

8.3.2.2. Human Uses

The lower Hanalei River is common site for recreational activities including sightseeing tours, kayaking, and recreational and commercial fishing. The upper Hanalei River is included in the Hanalei National Wildlife Refuge and is closed to the public to minimize disturbance and protect endangered waterbirds. The wetlands surrounding the Hanalei River support taro farming, which provides a sustainable food source for the surrounding local population.

8.3.3. Institutional Environment

The U.S. Fish and Wildlife Service (USFWS) manages the Hanalei National Wildlife Refuge (NWR) which includes the upper Hanalei River. The Hanalei NWR was established in 1972 under the Endangered Species Act to conserve endangered water birds including the koloa maoli

(Hawaiian duck), the ʻālae keʻokeʻo (Hawaiian coot), the ʻālaeʻula (Hawaiian moorhen), the aeʻo (Hawaiian stilt), and the nēnē (Hawaiian goose). The Hanalei River Valley provides nesting and feeding habitat for these important bird species. The USFWS has identified an additional 27 native species and 18 introduced species of water bird that use the Hanalei River Valley. In 2009, the USFWS initiated a multi-year planning process to develop a Comprehensive Conservation Plan (CCP) and Environmental Assessment (EA) to guide the management of fish, wildlife, plants, habitats and public uses at Kīlauea Point, Hanalei, and Hulēʻia National Wildlife Refuges.

The Hanalei NWR has partnered with local education groups including the Hanalei Watershed Hui and the Waipa Foundation to educate the public about watershed management in the Hanalei River Valley. The Hanalei Watershed Hui is a 501(c)(3) nonprofit established in 2000 to implement the Hanalei American Heritage River Program and Hanalei Watershed Action Plan. Since then, the Hui has focused on the assessment and restoration of the natural, cultural and economic assets of Hanalei. The Hui partners with federal, state, and county agencies, NGOs, community organizations and residents to address issues and concerns (Hanalei Watershed Hui 2012). In 2009, the Hanalei Watershed Hui developed a Hanalei River Stewardship Plan to provide river users, surrounding land users and businesses with the tools and information to support sustainable use of the Hanalei River. The plan includes activities to disseminate education information to recreational river users as well as to create local stewardship events and activities. In 2014 the Hanalei Watershed Hui completed a Hanalei to Haʻena Disaster Resilience Plan.

The Waipa Foundation operates a community center and promotes traditional learning through hands on activities that connect students to their ʻāina (land and natural resources). The Waipa ahupuaʻa is located to the west of the Hanalei ahupuaʻa adjacent to the Waioli ahupuaʻa. The ahupuaʻa is owned by Kamehameha Schools and managed as a community-based 501(c)(3) nonprofit by the Waipa Foundation (Waipa Foundation 2012).

8.3.4. Threats to Resources

Degradation, pollution, or any other alteration to the river habitat could greatly affect breeding patterns and have negative impacts on Native Hawaiian fish populations, including goby, mullet, and trevally. These species are dependent upon the two-way migration through the estuary, so maintaining a way to migrate back and forth is necessary for the health of these populations. Threats from land-based sources of pollution may also impair water quality. The Hanalei River feeds into Hanalei Bay so poor water quality could threaten coral reef habitats. Additionally, the river currently lacks the proper infrastructure to support growing visitor populations. Without proper education and understanding, visitors may pollute the area and engage in excessive recreational activities that impact the natural biology of the Hanalei River.

8.4. North Shore of Kaua‘i: Pīla‘a Ahupua‘a

8.4.1. Biophysical Environment

8.4.1.1. Habitats

Pīla‘a ahupua‘a, East Waiakalua ahupua‘a, West Waiakalua ahupua‘a, and Kāhili ahupua‘a are located on the north shore of Kaua‘i east of Kīlauea Point. The eastern edge of Pīla‘a ahupua‘a is marked by Kepuhi Point. The bay stretching about 1.9 miles (3 km) between Kepuhi Point and



the eastern edge of Kīlauea Point National Wildlife Refuge, called Mokolea Point, contains a coral reef between 0.5 and 1.5 km offshore with a lagoon inland. The rest of the benthic habitat is characterized by mostly turf algae and uncolonized submerged lands (Shallow-Water Benthic Habitats of the Main Hawaiian Islands 2007, Booklet Chart Ha‘ena Point to Kepuhi Point 2003). Kīlauea Stream reaches the sea in this bay just east of Kīlauea Point National Wildlife Refuge. Pīla‘a Stream, much smaller than Kīlauea Stream, reaches the sea in the middle of the bay near Pīla‘a Beach (Englund et al. 2002).

8.4.1.2. Marine Species

The Hawai‘i Biological Survey of the Bishop Museum identified the riparian wildlife of Pīla‘a Stream and of a small tributary to the Pu‘u Ka ‘Ele Reservoir in conjunction with permitting for a private stream alteration project. The survey found four native bird species, the Black-crowned Night-Heron, the Common Moorhen, the Hawaiian Coot and the nēnē (Englund et al. 2002).

The survey found five native fish species in Pīla‘a Stream, near its mouth: three species of gobies endemic to Hawai‘i (*Awaous guamensis*, *Eleotris sandwicensis* and *Stenogobious hawaiiensis*), the Hawaiian flagtail (*Kuhlia xenura*) and the flathead mullet (*Mugil cephalus*). There were also two introduced species observed in the mouth of the stream, mosquito fish (*Gambusia affinis*) and the Mexican molly (*Poecilia Mexicana*) (Englund et al. 2002).

Hawaiian monk seals have been observed infrequently at Pīla‘a Beach and Waiakalua, and with greater frequency in the nearby Kīlauea Point National Wildlife Refuge. They have been observed with the greatest frequency just east of Pīla‘a at Larsen’s Beach, which is an identified pupping site (Hawaiian Monk Seal Observations 2012, Hawaiian Monk Seal Popping Sites 2012). It is possible that there is less ease of access to Pīla‘a so there are fewer reported monk seal sightings. Green sea turtles (honu) nest near the mouth of the Kīlauea Stream and also at Pīla‘a Beach (Sea Turtle Nesting and Basking Beaches 2012). Toothed whales live in the area, as evidenced by an odontocete stranding on Pīla‘a/Waiakalua in 1983 reported by the NOAA Fisheries-PAO (Maldini 2003). Humpback whales have also been seen frequently in this area.

8.4.2. Human Environment

8.4.2.1. Cultural and Historic Setting

The shoreline between Kīlauea Point National Wildlife Refuge and Kepuhi Point encompasses four ahupua‘a: Kahili, West Waiakalua, East Waiakalua, and Pīla‘a. The eastern part of the reef stretching across these four ahupua‘a is a well-known location for kohu harvesting. Kahili was once a mullet fishery but isn’t any longer. Kalihi ahupua‘a also used to be the location of a rock quarry that has since been abandoned. West and East Waiakalua, also known as Waiakalua-iki and Waiakalua-nui, were once terraced and irrigated by spring water for agricultural use (Clark 1990).

8.4.2.2. Human Uses

There are several beaches in the area, including Pīla‘a Beach, Waiakalua-iki and Waiakalua-nui and Kahili, or Rock Quarry, Beach. These beaches can be adequate for snorkeling but can be hazardous to swimmers and can be murky (Clark 1990, Jokiel and Brown 2004). There is a popular surf site near Rock Quarry Beach (Surfing Sites 2012). Approximately 500,000 visitors per year enter nearby Kīlauea Point National Wildlife Refuge to see Kīlauea Lighthouse and the surrounding wildlife (Visiting Kilauea Point National Wildlife Refuge 2013).



8.4.3. Institutional Setting

Kīlauea Point National Wildlife Refuge, on the western edge of Kahili ahupua‘a, was established to protect threatened and endangered species and their habitats. The refuge restores habitat for coastal plants and migratory birds, such as the nēnē, among other species (Management 2010). Parts of the populated Hawaiian Islands are designated as conservation districts by the State. Those districts are then divided into subzones of varying classifications: protective, limited, resource, general or special. Most of the shoreline between Kepuhi Point and Kīlauea Point National Wildlife Refuge is designated a Limited Subzone, which intends to limit use of areas where the natural environment constricts human settlement. Kīlauea Point National Wildlife Refuge itself is designated a Protective Subzone, which means the area is intended for protection of natural and cultural resources. Each subzone classification has different land uses that are prohibited, restricted and permitted therein (Haw. Adm. Rul. §13-5).

8.4.4. Threats to Resources

As a result of grading and other construction projects by a private landowner in Pīla‘a between 1997 and 2001, the quality of water flowing through coastal streams to the reef was severely degraded (Settlement Factsheet 2011). The reefs were inundated with mud and a significant amount of coral cover was lost (Jokiel and Brown 2004). Pflueger’s construction included

impounding streams to create ponds, which damaged stream habitats for fish, insects and birds. In 2005, Pflueger was found to be in violation of the Clean Water Act and was required to pay fines to the Environmental Protection Agency (EPA) and the State as well as restore some of the habitat lost (EPA 2011).

In the EPA's 2004 Waterbody Quality Assessment Report for Kīlauea Stream, turbidity was the reason for classifying the stream as impaired. Turbidity can be caused by urban runoff and erosion and can damage habitats by increasing water temperature and decreasing the dissolved oxygen concentration. Turbidity was cause for impairment in Kīlauea Stream again in 2006.

Three of the waterfowl species found in the survey of the Pīla'a area are at risk. The Common Moorhen, the Hawaiian Coot and the nēnē are on the Federal Register endangered species list (Englund et al. 2002). The same survey found that introduced fish were harming the endemic goby. Half of the 'o'opu nakea (*Awaous guamensis*) sampled were affected by either the disease fin rot or by parasitic leeches (Englund et al. 2002).

Honu are listed as a threatened species, due in part by the tumor-causing papilloma virus (Marine Mammals and Sea Turtles 2013, Van Houtan et al. 2010). The Hawaiian monk seal is listed as endangered, with only 1,200 individuals left worldwide (Marine Mammals and Sea Turtles 2013). Threats to their population include bycatch and entanglement in marine debris and declining fish populations on which they prey (Hawaiian Monk Seal 2013).

8.5. North Shore of O‘ahu to Ali‘i Beach

8.5.1. Biophysical Environment

8.5.1.1. Habitat

The north shore refers to the northwestern coastline of the island of O‘ahu between Ka‘ena Point, the westernmost point of the island, and Kahuku Point, the northernmost point of the island. Ali‘i Beach lies nearly halfway between these two points in Wailua Bay near the town of Hale‘iwa.

Hale‘iwa Harbor is situated between Hale‘iwa Beach Park and Ali‘i Beach Park on the west bank of the mouth of the Anahulu River. It is not included within sanctuary boundaries. The harbor was dredged and the rest of the bay is classified as bank/shelf with the exception of reef flat adjacent to Hale‘iwa Beach Park. The harbor is 90-100% uncolonized by either coral or algae. Outside of the harbor, much of the near shore submerged lands are characterized by 10-50% macroalgae and some seafloor is covered 50-90% in turf algae (Shallow Water Benthic Habitats of the Main Hawaiian Islands 2007). Outside of the harbor, coral cover extends intermittently to 1-2 km off the beach (Shallow Water Benthic Habitats of the Main Hawaiian Islands 2007).

8.5.1.2. Marine Species

The most commonly seen turtles in Hawai‘i are the hawksbill, *Eretmochelys imbricata*, and green sea turtles, *Chelonia mydas*. Green sea turtle (honu) feed on algae off rocks nearshore and nest and bask on beaches (Critters of the MLCD 2013, Site Characterization 2008). Honu nest at Pua‘ena Point and can appear at the mouth of the Anahulu River and at Ali‘i Beach Park (Hawai‘i Aquaculture Marine Mapper 2013). Spotted eagle rays (hailepo), or bullhead rays, travel alone or in schools of up to 30 rays, feeding on mollusks and crustaceans in the sand. (Critters of the MLCD 2013).

The endangered Hawaiian monk seal (‘Īlioheikaua, *Neomonachus schauinslandi*) feed on fish, cephalopods and crustaceans on offshore reefs and haul out on beaches to rest and to breed (Critters of the MLCD 2013). They have been observed with low frequency in the area (Sea Turtle Nesting and Basking Beaches 2012). From the Phocidae family, the Hawaiian monk seal is one of two remaining monk seal species in the world. They are most often found in the Northwestern Hawaiian Islands but they are now known to breed on all islands. (Critters of the MLCD 2013, Hawaiian Monk Seal 2013)

In the Pūpūkea-Waimea Marine Life Conservation District (MLCD) 4.5 miles to the northeast of Hale‘iwa Harbor, fish, invertebrate and marine mammals are well documented. The fish found in this nearby bay include the snortnose wrasse, endemic to Hawai‘i, the frogfish and the thornback cowfish, or makukana, which feed on algae and invertebrates on the reef. The fantail filefish, or ō‘ī li uwī‘uwī, is relatively rare on reefs but undergoes an irregular population bloom every several years overwhelming the shallow waters with their abundance only to get picked off by predators or wash ashore. Several members of the surgeonfish family can be found on the north shore including the white spotted surgeonfish (‘ahi), the orange band surgeonfish (na‘ena‘e), the eyestripe surgeonfish (palani), and the unicornfish (kala). These surgeonfish relatives are all herbivores feeding on algae off rocks (Critters of the MLCD 2013).

Bluefin trevally (o‘milu) feed on smaller fish and invertebrates and are preferred by fishermen. Gray chubs (nenu) are the most common species of chub found in Hawai‘i. Nenu inhabit rocky coastlines and have a largely herbivorous diet. The crowned toby, or pu‘uolai, is found only in Hawai‘i, preying on urchins, corals and crustaceans (Crittters of the MLCD 2013). The endemic Hawaiian goby o‘opu alamoo (*Lentipes concolor*) was discovered in a tributary of the Anahulu River in the early 1990’s after the species had been considered extinct or very rare in the 1980’s (Crittters of the MLCD 2013, Higashi and Yamamoto 1993). O‘opu alamoo are diadromous gobies with a long larval life compared to that of a marine goby (Radtke et al. 2001). Since the o‘opu alamoo was identified as a Category One endangered species candidate in the 1970’s, more research has been conducted on breeding behaviors to better inform conservation (Kinzie 1993).

8.5.2. Human Environment

8.5.2.1. Cultural and Historic Setting

Two ahupua‘a meet at Hale‘iwa Harbor: Pa‘ala‘a to the southwest and Kawaihoa to the northeast (State of Hawai‘i Ahupua‘a Boundaries 2010). Both of these ahupua‘a are contained within the moku of Waialua, once considered to be a political and agricultural center of Hawai‘i (Alameida 1994). The perennial water source that the Anahulu River provided along with the alluvial flats and terraces along the river made the Anahulu Valley an attractive place for settlement and agriculture, especially taro. Archeological analysis has shown a fluctuating pattern of settlement from seasonal to permanent to abandoned (Dega and Kirch 2002).

With the establishment of the North Shore Surfing Reserve in 2010, the State of Hawai‘i legislatively recognized the cultural importance of surfing to the State. (Hawai‘i Exec. Order No. 10-07 2010) The north shore is famous for several surf breaks, including two state Designated Recreation Zones dedicated to surfing in Waialua Bay. Spearfishing is the traditional Hawaiian practice of fishing with a spear either by boat or freediving. This tradition was practiced across the populated Hawaiian Islands, and has been promoted on the north shore of O‘ahu by the North Shore Underwater Club for over fifty years (Stoffle and Allen 2012).



8.5.2.2. Human Uses

Hale‘iwa is a common tourist destination on O‘ahu and the nearby Hale‘iwa Beach Park and Ali‘i Beach Park are host to a number of aquatic activities. In the winter, the increased surf break off Ali‘i Beach attracts recreational and competitive surfers. There are two recognized surfing breaks in the area: one 0.3 mile (0.5 km) off of Pu‘aena Point and the other 0.3 mile (0.5 km) off of Ali‘i Beach Park. Hale‘iwa Harbor is the origin for several boating activities including

snorkeling, SCUBA diving, and fishing. There is one dive site approximately 0.6 mile (1 km) off of Ali‘i Beach Park. There is a small state Designated Recreational Zone for commercial personal watercraft a couple hundred yards to the west of Pua‘ena Point (Ocean Recreation Zones 2012).

8.5.3. Institutional Environment

The Hawai‘i Division of Aquatic Resources (DAR) regulates fishing in Hale‘iwa Harbor according to Haw. Rev. Stat. §188-35 Fisheries Management Area. The 0.063 square mile (0.1638 square km) management area encompasses Hale‘iwa Harbor from 10 yards downstream of the Anahulu Bridge to 100 yards off both the harbor’s breakwater and the Hale‘iwa Beach Groin. The DAR controls fishing within the area with several regulations including only using one line with two or fewer hooks when fishing and using no more than 10 nets of a diameter of 2 m when crabbing (Regulated Fishing Areas on O‘ahu 2013).

The North Shore Hawai‘i Surfing Reserve, which stretches from Hale‘iwa to Ali‘i Beach Park to Sunset Beach to the northeast from the high water mark out to the surf breaks, was established in 2010 by Executive Order (EO) 10-07. The EO mandated that the State of Hawai‘i Department of Land and Natural Resources (DLNR) can accept funding to assist in the promotion and preservation of the reserves. This includes erecting signs and markers indentifying the reserve and helping other organizations and agencies to protect the cultural and environmental integrity of the reserves (Hawai‘i Executive Order 10-07 2010).

Pūpūkea-Waimea Marine Life Conservation District (MLCD), to the northeast of Hale‘iwa Harbor, is regulated by DAR. The MLCD prohibits fishing and taking sand, coral or other specimens from the area, with a few exceptions such as catching finfish and collecting certain algae species (Marine Life Conservation District, O‘ahu, Pupukea 2013). The non-profit organization Malama Pūpūkea-Waimea helps to protect the MLCD through education and other community efforts (Mission and Programs 2013).

8.5.4. Threats to Resources

Turtle populations are low in Hawai‘i with green sea turtles and hawksbill turtles listed as threatened and endangered species. The green sea turtles’ endangerment is due in part by the tumor-causing papilloma virus (Marine Mammals and Sea Turtles 2013, Van Houtan et. al. 2010). The Hawaiian monk seal is endangered as well, with only 1,200 individuals left worldwide (Marine Mammals and Sea Turtles 2013).

8.6. Maunalua Bay

8.6.1. Biophysical Environment

8.6.1.1. Habitats

Maunalua Bay is located on the South Eastern Shore of the island of O‘ahu, between Lē‘ahi (Diamond Head) volcanic cone and Koko Head peak. The bay is often delimited as the waters between Kūpikipiki‘ō Point (Black Point) near Lē‘ahi to Kawaihoa Point at Koko Head. The bay adjoins five ahupua‘a across seven watersheds with at least four perennial streams and as many as 52 drainages (most of which have been channelized) and are largely urban with impervious surfaces. There are several locations along the shoreline where natural freshwater springs feed into the bay.



8.6.1.2. Marine Species

The majority of the benthic geomorphology is hard bottom with isolated patches of sand and fringing aggregate coral reefs mostly parallel to the coastline. Aggregate coral reefs host typical Hawaiian coral reef species. Native seagrass as well as native and introduced macroalgal meadows are dominant on sand and soft-bottom habitats. Sea turtles, Hawaiian monk seals, and humpback whales all utilize the waters of Maunalua Bay as habitat. The Paiko Lagoon is a State of Hawai‘i Wildlife Sanctuary for sea and shore birds. The sand flats of Maunalua Bay are well-regarded habitat for bonefish and yellow fin goatfish which are fishery target species. Introduced algae have colonized the submerged lands and compete with native organisms in some locations of the bay. Recent restoration efforts have cleared up to 2.9 million pounds of introduced algae and restored up to 23 acres of softbottom-sand habitat (Nature Magazine). In many locations land based sources of pollution have led to sedimentation on nearshore reefs and degraded water quality (Wolanski et al. 2009).

8.6.2. Human Environment

8.6.2.1. Cultural and Historic Setting

The fishpond in Maunalua, Kuapā Pond or Loko Keahupua o Maunalua, was once one of the largest fishponds in the Hawaiian Islands, measuring 523 acres on a 1851 map (Wyban 1992). The original name for the pond, Keahupua o Maunalua, translates to “the shrine of the baby mullet of the two mountains” (Anchor QEA L.P. 2011). Keahupua o Maunalua probably served

Kahekili, the mo‘o (ruler) of O‘ahu, and his successor, Kamehameha I (Anchor QEA L.P. 2011). The pond was actively fished until 1959, when residential and commercial development began.

During the land distribution māhele in 1848, Maunalua was given to Kamāmalu, granddaughter of Kamehameha I. She rented Keahupua o Maunalua to William Webster who used the area around the pond for ranching (McElroy 2005). Webster drew the first map of the pond and shortened the name to Kuapā Pond (Anchor QEA L.P., 2011). In 1866, when Kamāmalu died, the fishpond was given to the Bishop Estate, who owns it still today (McElroy 2005). Several konhiki (fishpond managers) leased the fishpond from the Bishop Estate including Tokoi Jodoi, from 1915-1938, and Young Fong, from 1938-1947.

Keahupua o Maunalua received its first European visitors in 1786 when the English ships King George and Queen Charlotte anchored in Maunalua Bay twice that year and traded with the residents there. They exchanged nails, metal and beads for food and water. Kahekili came aboard and gave them gifts, including mullet from the fishpond (Anchor QEA L.P. 2011).

Descriptions and maps of the pond indicate that areas were walled into fish pens and some of the wetland may have been used for cultivation including taro. In some of the drier areas, sweet potatoes and other root vegetables were grown. In the 19th century, there was a Kamehameha Agricultural School in the ahupua‘a.

Kuapā pond translates to “walled pond” referring to an offshore fishpond, which is a misnomer since the pond is considered an onshore pond, or loko pu‘une, with a natural sand barrier (Anchor QEA L.P. 2011). The sand barrier was built up into a sea wall with rock on the outside to reinforce it. The seawall construction took several years and it is said that thousands of people formed a human chain to bring rock from the Ko‘olau Mountains to Maunalua (Costa-Pierce 2003). Other stories say that menehune built the seawall overnight (Wyban 1992).



There were several fishponds in the Maunalua ahupua‘a, most of which are no longer functional. Some ponds have been filled in to accommodate residential development such as Wailupe and Kupapa fishponds (Clark 2005). Development began in Keahupua o Maunalua in 1959 by Kaiser-Aetna. The development caused extensive dredging, being dredged at least 9 times since 1959, making most of the fishpond structure unrecognizable with the exception of a fish trap which may still be intact near the entrance to the marina (Anchor QEA L.P. 2011).

There used to be burial caves, fishing shrines – one to ‘ama‘ama (mullet) and another to akule (scad) – and other heiau around the fishpond. Most sites are no longer intact and one of the last known intact heiau, Hawea Heiau, located uphill of the pond on Kaluanui Drive, was damaged.

8.6.2.2. Human Uses

Offshore waters of Maunalua Bay have high human use by boaters, personal water craft users, kayakers, canoe paddlers, and other ocean users facilitated by a nearby public boat ramp and the private marina. Koko Marina has about 1,000 registered vessels (Anchor QEA L.P. 2011).

There is an artificial reef in Maunalua Bay approximately one mile offshore created to enhance fishing in the area. In 1961, the state's first artificial reef was created in Maunalua Bay by dumping cars and concrete pipe to create habitat that would attract fish (Brock and Norris 1989, Artificial Reefs 2014). As the original material has disintegrated and been washed offshore, tires, barges and a Navy landing craft utility (LCU) have been added to the area for increased fish habitat.

8.6.3. Institutional Environment

Maunalua Bay is a designated Ocean Recreation Management Area (ORMA) managed by the Division of Boating and Ocean Recreation (DOBOR). It was established to provide for increased public access, reduce user conflicts, promote overall public safety, and avoid possible adverse impacts on humpback whales or other protected marine life (Haw. Adm. Rul. § 13-256). ORMAs serve to restrict certain commercial activities to specific locations and time periods, as well as regulate equipment use. Permits are issued for activities within different zones and quotas are placed on the number of boats that can operate within a specific zone. For example, a maximum of six commercial personal watercraft may be authorized to operate within a 400 foot diameter area at any one time. Recreational and commercial vessels may use designated areas when a permitted activity is not taking place and may cross these areas at all times with caution. Paiko Lagoon Wildlife Sanctuary, located east of Niu Peninsula in Maunalua Bay is a regulated fishing area under the Division of Aquatic Resources (Other Regulated Fishing Areas 2014). Within the lagoon and on the State owned land surrounding the lagoon, it is prohibited to take, possess or harm plants or wildlife, or introduce other species.

8.6.4. Threats to Resources

The nearshore environment along Maunalua Bay has been impacted by a variety of anthropogenic stressors. The bay adjoins seven watersheds with at least four perennial streams, and as many as 52 drainages (most of which have been channelized), from watersheds that are largely urban with impervious surfaces. The characteristics of these modified drainages facilitate the rapid movement of storm water, sediments, nutrients and other chemicals directly into the ocean. The west side of the bay has experienced dramatic shoreline changes, sediment flux and eutrophication (Wolanski et al. 2009). The central part of the bay has experienced a land based sediment buildup coinciding with establishment of an introduced algae *Avrainvillea amadelpha*. The east side of the bay has been heavily developed, and the original shoreline has been extended seaward through fill and the construction of the Hawai'i Kai private marina. Offshore waters of Maunalua Bay have high human use by boaters, personal watercraft users, kayakers,

and canoe paddlers facilitated by a nearby public boat ramp and the private marina.



Several introduced species including at least four species of introduced algae and invertebrates such as sponges and bryozoans have become established in

Maunalua Bay. Large-scale restoration efforts to remove introduced algae have been ongoing and open up habitat for other species. The intention is for native species to reestablish, however introduced species could utilize the new habitat. Recently one of the top five most introduced algal species not previously known to Maunalua Bay or the south shore of O‘ahu was found near the boat ramp shoreline of Maunalua Bay (Conklin et al. 2009). However, educated ocean users were able to remove the algae from the shoreline before it had time to establish and subsequent surveys found no other signs of the alga, suggesting that it had come in as fresh material from a watercraft.

In surveys of marine algae, reef fish and invertebrates, a higher percentage of introduced species was found in Maunalua Bay, 18%, than in Waikīkī, 6.9%. The proportion of introduced species in Maunalua Bay is consistent with proportions in other harbors and bays around O‘ahu. Inside the marina, the percentage of introduced species reached 40%, the highest percentage recorded in Hawai‘i (Cole et al. 2002).

8.7. Penguin Bank

8.7.1. Biophysical Environment

8.7.1.1. Habitats

Penguin Bank is a submerged shelf located off the southwestern tip of the island of Molokaʻi. The mid-depth bank is 100-300 feet (40-100 m) and extends approximately 30 miles (50 km) southwest from Laʻau point (Clark 2002). There are three finger-like projections ranging from approximately 150 – 200 m on the southern portion of the bank, which enclose basins that extend to a depth of 400 m. The bank has a similar depth to other banks in the Hawaiian Archipelago. The production dynamics are also likely to be similar to banks located elsewhere in Hawaiʻi and the Pacific (Haight 1993). Penguin Bank used to be part of the Hawaiian Emperor seamount chain which formerly made up Maui Nui Island (Clark 2002).

8.7.1.2. Marine Species

Penguin Bank is geologically formed from a drowned volcano and capped with calcium carbonate deposits from marine calcification. The upper part of the bank is composed primarily of calcium carbonate pavement, sand and macroalgae. Calcifying macroalgae is thought to be major a contributor to sediment on the upper part of the bank (Agegian and Mackenzie 1989). One study found evidence of some calcium carbonate having a buffering effect to surrounding waters of Penguin Bank, thus decreasing the acidity (Sabine & Mackenzie 1995). This result has yet to be corroborated by further studies, but the existence of a buffering effect could mitigate ocean acidification making Penguin Bank a refuge habitat.

Multiple species of coral are recorded on the outer ledges (100 m – 400 m) of Penguin Bank, though mesophotic (depths at the lowest light penetration) reef ecosystems on the bank are uncharacterized and remain poorly understood. Within the current sanctuary boundaries (100 fathoms or approximately 183 m), about 35% of coral records are Scleractinian light dependent coral that survive on low light levels. Black and soft coral have a greater distribution over the bank and are well suited to the habitat as they are not light dependent. Both Scleractinian reef building corals as well as black and soft corals (44 site records) have been observed along the upper pinnacles and slopes of the 3 finger-like projections at approximately between 100 - 200 m depths of the southern part of Penguin Bank (Hawaii Undersea Research Laboratory data).

The outer ledges of the bank slope, along with mesophotic and deep sea coral, create habitat complexity and are well known productive bottomfishing locations. The basins contained within the southern 3 finger-like projections are recognized as important bottomfish habitat which led to the establishment of a Bottom Fish Restrictied Area (BRFA) 'F' with the following geographic boundaries: 21°02' N , 20°55' N, 157°34' W, 157°22' W. Numerous studies on the biology and ecology of bottomfish have been conducted in the BRFA.

Bottomfish connectivity studies have found that the bottomfish restricted area (BRFA) on southern Penguin Bank is a significant contributor to bottomfish larval export for the Main Hawaiian Islands (Vaz 2012). Bottomfish habitat areas that are predicted to receive larvae produced by fish at Penguin Bank include: Niʻihau, Kauaʻi, Oʻahu, Lanaʻi, Molokaʻi, Maui, Kahoʻolawe and Northern Hawaii Island (Vaz 2012).

Penguin Bank provides important foraging habitat for monk seals (Brillinger et al 2008), generally recognized at least out to the 200 m isobath though foraging may occur deeper. The dominant calcareous organisms on the non-sloping upper 100 – 200 m of Penguin Bank are red and green algae, benthic foraminifera, and bryozoans (Agegian and Mackenzie 1989). Crustacean coralline algae is the deepest dwelling algae that has been identified at Penguin Bank (Agegian and Abbott 1985). The primary sediments found in Penguin Bank are mixed mineralogic assemblage of benthically derived magnesian calcite and aragonite (Agegian and Abbott 1989).

There are currently three artificial reefs made of concrete and plastic that were deployed in deep water on Penguin Bank in 1985 (Moffitt, Parrish and Polovina 1989). Fish communities are monitored periodically around the structures to determine the potential impact of artificial reefs on fish and transient species aggregation and production. Habitat is a limiting factor in reef fish recruitment (Sale 1978). Bottom fish habitat is limited to small scattered areas (Haight 1993).

8.7.2. Human Environment

8.7.2.1. Historic and Cultural Setting

Historically, subsistence fishing by communities in the Penguin Bank area was found to be abundant. Hawaiians fished for moi, kumu, uhu, ‘opelu, ‘ono, akule, ‘ulua, and ‘ahi. There were many ko‘a, burial sites and heiau on the Moloka‘i coastline recognizing fishing in Penguin Bank (see box). Maui ali‘i Kiha‘a Pi‘ilani constructed trails to the coast lined with shells for access to marine resources (McGregor 2006).

The name Penguin Bank originated from the HMS Penguin which was originally used to survey the area. The British ship conducted deep sea soundings for the purpose of laying a telegraph cable between Canada and Australia in 1987 (Clark 2002).

“Every finger on top here, we have fishing shrines. And if you do one survey of all these fingers, connected to the Penguin Bank. Moloka‘i Nui A Hina owns the Penguin Bank. This is ours we want to save it for our generations. But every finger, where I pointing, get one heiau on top, a fishing shrine. Yeah, and were the ko‘a stay, the finger stay. You going throw for moi. Next step in the ocean, the ‘ulua, same finger, next step the ‘ahi, and the deep water fishes, connected to the Banks. So we have ko‘a’s right through.”
– Halona Kaopuiki, resident of Molokai, Office of Hawaiian Affairs

8.7.2.2. Human Uses

Today, Penguin Bank is one of the most heavily fished sites in Hawai‘i for opakapaka, onaga, ‘ula‘ula (Clark 2002). Subsistence fishing continues to occur off La‘au Point and is an important harvesting area for communities on Moloka‘i. Commercial fishing also occurs in Penguin Bank (Table 34). Between 2007 and 2013, between 129 and 172 commercial fishermen reported harvesting in Penguin Bank. Total number of fish caught has steadily risen from 17,658 to 29,891 over that same time period. Similarly, total pounds caught have increased from 93,693 to 159,229 pounds. Commercial fishing for deep-water snappers (e.g. *Pristipomoides* spp. and *Etelis* spp.) has been reported on the reef slopes.

Penguin Bank Commercial Fishing Landing			
Fiscal Year	Number of Licensees	Number Caught	Lbs. caught
2007	129	17,658	93,693
2008	128	21,022	95,249
2009	147	21,538	98,086
2010	158	23,333	111,043
2011	159	24,685	128,220
2012	147	20,621	113,312
2013	172	29,891	159,229

Table 34. Commercial fishing landing data reported for Areas 331 (2007-2013).

The annual paddling race from Moloka‘i to O‘ahu traverses Penguin Bank. The race covers 32 miles between Kalua Koi on west side of Moloka‘i to Waikīkī on O‘ahu. La‘au Point is the starting point for a swim/paddle race from Moloka‘i to O‘ahu. The race first began in 1952 and currently has about 160 paddlers participate annually (Moloka‘i 2 O‘ahu 2014).

The shallow depths around Penguin Bank make it a preferred location for military training and testing (Table 35). Submarines frequently conduct post-overhaul shallow-water dives. The area is also used for shallow-water anti-submarine warfare (ASW) operation.

Military Activities in Penguin Bank	
Submarines Post-Overhaul Shallow-Water Dives	All submarines completing any major repair work are required to conduct initial submerged testing in shallow water. It is necessary to conduct initial testing close to shipyard facilities in case an unscheduled return to port is required for repairs. Penguin Bank is the only shallow water in Hawaiian waters suitable for these required tests.
Shallow-Water ASW Operations	Exercises involving surface ships and submarine, using low power active sonar transmissions, that last from 2-5 days and use sonobuoys, smoke floats, expendable bathythermographs, and submarine-launched inert torpedoes. Operations are conducted in Penguin Bank because of the unique characteristics of the shallow water.
Submarine Mine Warfare Training	Submarines practice implanting inert mine shapes, which are later recovered by small crafts. The training cannot be conducted in deep water.

Table 35. Military activities that occur in Penguin Bank.

8.7.2.3. Institutional Environment

Penguin Bank was established as a Bottomfish Restricted Fishing Areas (BRFA) in 1998 by the State of Hawaii Division of Aquatic Resources. The original boundaries were expanded in 2007 to include previously unprotected areas. The State of Hawai‘i is currently undergoing a process to evaluate the current BRFA closures and make adjustments as necessary to the current management for the Hawaiian Islands bottom fish fishery. However the current revision plan calls for six BRFAs to remain closed including Penguin Bank. In addition, all precious coral beds in Penguin Bank are designated Essential Fish Habitat (EFH) under NOAA Fisheries and federal consultations are required for activities that may affect precious corals.

8.7.2.4. Threats to Resources

The mesophotic corals that grow on Penguin Bank are threatened by impacts from climate change such as ocean acidification, which could reduce the coral's ability to calcify, and coral bleaching due to rising sea temperatures. Penguin Bank used to be heavily fished, both recreationally and commercially, for species such as opakapaka, onaga, and 'ula'ula. To protect the fish populations from overfishing, the Penguin Bank BRFA was established in 1998 and then expanded in 2007. As reported fish catches from Penguin Bank are on the rise, overfishing could be a potential threat to the ecosystem. Hawaiian monk seals, which use Penguin Bank as an important foraging habitat, are an endangered species with only 1,200 individuals left worldwide (Marine Mammals and Sea Turtles 2013).

8.8. Maui Nui

8.8.1. Biophysical Environment

8.8.1.1. Habitats

Maui Nui (greater Maui) is a submerged marine landmass bound by Maui, Lānaʻi, Molokaʻi, and Kahoʻolawe. Geologic records indicate that 1.2 million years ago, Maui Nui was a volcanic island that covered 5,600 square miles (14,600 sq. km). The bathymetry of the Maui Nui area is relatively shallow. The Maui Nui area is made up of Pailolo Channel, Kalohi Channel, and ʻAuʻau Channel.

The ʻAuʻau Channel reaches depths of 450 feet (140 m), however the majority of submerged lands is in the mesophotic depth range between 130-300 feet (40-90 m) deep. Topography on the channel floor consists of numerous drowned solution basins and ridges, sediment plains, and conical reef pinnacles (Grigg et al. 2002). These were exposed during periods of low sea level during multiple glacial periods over at least the last 800,000 years (Lambeck et al. 2002). Reef growth in the Channel during the Holocene consists of a thin veneer a few meters thick on those topographic highs (Grigg et al. 2002).

The ʻAuʻau channel is unique, not only in terms of its geology, but also in terms of its physical oceanography and local weather patterns. There are several physical conditions that help make the ʻAuʻau Channel (specifically the southeastern portion) an ideal place for mesophotic hard corals. These conditions include having consistently good water quality and clarity because it is



flushed by tidal currents semi-diurnally; the amount of sediment run-off from the nearby land (i.e., notably between Launiupoko and Papawai Points) is lower than in other parts of Maui (Grigg 2006, Fletcher et al. 2008); and the sediments that do enter the water column are not continually re-suspended because this area is largely protected from seasonally strong wind and wave energy. Being protected from this strong wind and wave energy is also important because it creates

conditions favorable to faster rates of coral accretion (Dollar 1982, Dollar and Tribble 1993, Grigg 1998), and because it reduces the amount of mixing that occurs in the water column during the summer. This reduction in mixing may allow the water column to warm more uniformly (as seen in the summer water temperature profiles by Grigg 2006), pushing the thermocline (below the one seen at ~5 m) deeper than in other nearby locations. Combined, these oceanographic and weather conditions create patches of comparatively warm, calm, clear waters that remain relatively stable through time.

8.8.1.2. Marine Species

Humpback whales (*Megaptera novaeangliae*) are prevalent in the ‘Au‘au Channel region. A majority of humpback whales in the North Pacific come to Hawai‘i in the winter months for mating and calving (Baker et al. 1986). They are often seen in coastal regions and shallow banks (< 183 m) around Maui, Moloka‘i, Kaho‘olawe, and Lāna‘i (Baker and Herman 1981, Mobley et al. 1999). The whale-watching industry is significant to the local economy, generating up to \$11 million in annual revenues for the State. In 2008, approximately 50 tour operators statewide offered whale watching tours to an estimated 330,000 passengers (ONMS 2013). Although the population of northern humpback whales appears to have recovered over the last twenty years, threats from entanglement and ship strikes still exist.

A geographically independent population of manta rays (*Manta* spp.) has also been identified in the ‘Au‘au Channel region. *Manta alfredi* aggregate in shallow coastal areas with rocky or coral reef habitats with productive upwellings (Deakos et al. 2011). The high frequency of adult males and mating trains have been observed between December and April, suggest the Channel may be a significant mating area. In addition, *Manta alfredi* often visit the area to rid themselves of parasites (Deakos 2010). Manta rays are particularly vulnerable to localized anthropogenic threats in part because they come to maturity later in life, generally bare few offspring, and tend to be residential in nature (Deakos et al. 2011). In the ‘Au‘au Channel, they face threats from entanglement by non-target fishing gear. They may also be vulnerable to near shore anthropogenic impacts such as coastal development, storm water runoff, pollutant loadings, boat strikes, and unregulated ‘swim with manta’ programs (Deakos et al. 2011). Since the Maui manta ray population appears to be genetically independent, they may be at a higher risk to local threats and require additional management efforts (Musick 1999).

In addition, it is the historical center of the black coral jewelry industry in Hawai‘i (Grigg 1965, 1993). This has led to extensive interest in submerged lands surveys of coral beds by divers for jewelry production and even harvesting with remotely operated vehicles (ROV) and submersibles. More recently, research on the unique geology and reef communities of this region has increased due to the broad area of potentially suitable mesophotic habitat and the recent discovery of some areas with extensive coral coverage and Halimeda beds at mesophotic depths (Grigg et al. 2002, Kahng and Grigg 2005, Kahng and Kelley 2007, Rooney et al. 2010). Boland and Parrish (2005) surveyed black corals and fish communities off Lahaina, Maui. They identified forty fish taxa and observed that black coral trees provide important habitat for a wide range of fish species. Black coral harvesting has persisted since the 1950s for jewelry making in Hawai‘i. In 2001 *Carijoa riisei*, an octocoral native to the tropical Western Atlantic, was discovered overgrowing black corals in the ‘Au‘au Channel in Hawai‘i. *C.C riisei* spreads vegetatively and smothers the coral.

8.8.2. Human Environment

8.8.2.1. Cultural and Historic Setting

The waters off Lahaina, Maui referred to as Lahaina Roads, have historically been anchorage for both whaling ships and navy vessels. The basin is protected by Lāna‘i, Maui, Moloka‘i and Kaho‘olawe, making it ideal for safe anchorage (Martin 1979). During the attack on Pearl Harbor, Lahaina Roads was an additional target for the Japanese, hoping to find US Navy vessels at anchor (USS Maryland 1997).

8.8.2.2. Human Uses

Commercial fishing occurs throughout the Maui Nui area (Table 36). In 2013, 229 commercial fishermen reported catch in the area (Commercial Fishing Landing Area 320 and 321). They brought in 47,873 fish for a total of 144,162 pounds caught. Total pounds caught has risen gradually over the past six years and more than doubled since 2007 when 66,823 pounds were caught. The number of fish caught has also increased significantly since 2007 (27,389 caught) although overall catch reached a high in 2009 (66,042 caught).

Maui Nui Commercial Fishing Landing			
Fiscal Year	Number of Licensees	Number Caught	Lbs. caught
2007	137	27,389	66,823
2008	156	30,909	75,269
2009	187	66,042	95,177
2010	184	51,357	91,634
2011	215	57,008	127,594
2012	201	46,771	136,326
2013	229	47,873	144,162

Table 36. Commercial fishing landing data reported for Areas 320 and 321 (2007-2013).

Source: *State of Hawai'i Department of Land and Natural Resources.*



The waters between Maui, Moloka'i and Lāna'i are primary habitat for humpback whales during the winter months. Whale watching is a popular activity in the area and there are many tour operators that are based on Maui (Bendure and Friary 2008).

The 'Au'au Channel provides habitat for two species of commercially valuable black coral, *Antipathes dichotoma* and *A. grandis* which are harvested for jewelry. The coral is harvested by scuba divers loosening coral pieces and floating them to a boat at the surface with lift bags (Grigg 2001). Harvesting rates have increased over the last ten years although they have reportedly remained below estimates of maximum sustainable yield (WesPac 2013).

The channel between Maui, Lāna'i and Moloka'i is extensively used for the biennial RIMPAC exercise as an explosive ordinance disposal/min counter measure (EOD/MCM) exercise area as well as for shallow-water anti-submarine warfare. Salvage ship and diving operations are also frequently conducted in the area.

Military Activities in Maui Nui Area (Maui, Moloka'i, and Lāna'i)	
Shallow Water ASW Operations	Operations include using low-power active sonar transmissions, sonobuoys, smoke floats, expendable bathythermographs, and inert torpedoes. Operations take place inside the 100-fathom isobaths surrounding Maui, Moloka'i, and Lāna'i.
Mine-counter Measure (MCM) Training	Training includes the use of bottom-moored inert mines, sonar, towed mine sweeping device, and MCM surface ships.
Hawaiian Area Tracking System (HATS)	HATS is installed southeast of Lāna'i to provide a passive acoustic range for shallow water exercise torpedo firings.
USMC Helicopter Operations Training	Moloka'i has been identified as the only effective training area for local night vision goggles (NVG).
US Army Flight Training	Uses Moloka'i training area for day, night, unaided, and NVG training. Conduct flights in around Maui/Moloka'i for low level training and for transit routes between O'ahu and Hawai'i Island.

Table 37. Current Military activities that occur in the Maui Nui Area.

8.8.3. Institutional Setting

The 'Au'au Channel black coral bed was designated an "Established Bed" with a harvest quota of 5,000 kg every two years that applied to federal and state waters in Hawai'i. This was intended to prevent overfishing and achieve optimum yields of black coral resources (Fed. Reg. Vol. 73). In addition, a 5-year moratorium was placed on the harvest of gold coral throughout the U.S. Western Pacific. The moratorium was based on information that gold corals grew much more slowly and lived longer than previously thought, suggesting that these species were vulnerable to overharvest. In 2013, the moratorium was extended through June 2018 (Fed. Reg. Vol. 78). All precious corals beds in the Maui Nui area are designated Essential Fish Habitat (EFH) under NOAA Fisheries and federal consultations are required for activities that may affect precious corals. The precious corals beds in the 'Au'au Channel have been identified for their extremely important ecological functions and are further defined by NOAA Fisheries and WesPac as Habitats of Particular Concern (HAPC).

8.8.4. Threats to Resources

Land-based pollution and runoff threaten water quality in the nearshore areas around Maui. As detailed in the *2012 State Water Quality and Monitoring Assessment Report*, Maui Island has 76 impaired water areas, the highest number of impaired waters per island in the state (Hawaii Department of Health 2012). Five newly impaired waters off Maui have been listed since the previous assessment in 2010 while only one has been delisted. Among the pollutants measured in excess in the newly impaired waters are nitrogen, phosphorus, chlorophyll a, and ammonium (Hawaii Department of Health 2012). Some nearshore reefs in the Maui Nui area have shown decline in coral cover due in part to poor water quality, invasive algae and insufficient stocks of grazing fish to control algal growth (Hawaii DAR and Hawaii Coral Reef Initiative 2012). Both this nearshore coral and the mesophotic coral found in the 'Au'au Channel are threatened by impacts from climate change such as ocean acidification, which could reduce the coral's ability to calcify, and coral bleaching due to rising sea temperatures.