Revision of Critical Habitat for Hawaiian Monk Seals

Final Biological Report

Prepared by:
National Marine Fisheries Service
Protected Resources Division
Pacific Islands Regional Office
1845 Wasp Blvd., Building 176
Honolulu, HI 96818

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List of Acronyms

ACP	Hawaii's Area Contingency Plan (ACP)
CHRT	Critical Habitat Review Team
CWB	Clean Water Branch
DOD	Department of Defense
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
FEP	Fisheries Ecosystem Plan
FFS	French Frigate Shoals
FR	Federal Register
INRMP	Integrated Natural Resource Management Plan
MHI	Main Hawaiian Islands
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NWHI	Northwest Hawaiian Islands
OTEC	Ocean Thermal Energy Conversion
PIFSC	Pacific Islands Fisheries Science Center
PIRO	Pacific Island Regional Office
SAR	Stock Assessment Report
USFWS	United States Fish and Wildlife Service

EXECUTIVE SUMMARY

Section 4 of the Endangered Species Act (ESA) requires the designation of critical habitat of threatened and endangered species and provides for the revision of critical habitat based on the best scientific data available. This report contains a biological assessment in support of a revision to critical habitat for the Hawaiian monk seal (*Neomonachus schauinslandi*[1]). The revision was prompted by a 2008 petition requesting the National Marine Fisheries Service (NMFS) revise the existing critical habitat designation by expanding the current critical habitat in the Northwestern Hawaiian Islands (NWHI), and by designating additional critical habitat in the main Hawaiian Islands (MHI) (Center for Biological Diversity, 2008). After reviewing the best available scientific information, NMFS announced in the 12-month finding (74 FR 27988; June 12, 2009) that the revision to critical habitat for the Hawaiian monk seal was warranted and that it intended to move forward with a proposed rule for critical habitat.

A critical habitat review team (CHRT), consisting of seven NMFS biologists, was convened to evaluate critical habitat for the species. Members of the team were tasked with using the best scientific data and knowledge available to identify habitat features essential to the conservation of the species, delineate specific areas within the geographical area occupied[2] which contain at least one essential habitat feature, and identify special management considerations or protections required within each specific area. The team identified essential features necessary for monk seal conservation, including those features that support resting, reproduction, molting, predator avoidance, and foraging. The geographical area occupied by the species consists of marine and terrestrial areas in and surrounding the Hawaiian Archipelago and Johnston Atoll. Within this occupied area, the CHRT identified 16 specific areas of terrestrial and marine habitats within the Hawaiian Archipelago where essential features exist to support Hawaiian monk seal conservation. Areas in the NWHI include terrestrial and marine habitat around Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, Maro Reef, Gardner Pinnacles, French Frigate Shoals (FFS), Necker Island, and Nihoa Island. Areas in the MHI includes terrestrial and marine habitat around: Kaula Island, Niihau, Kauai, Oahu, Maui Nui (including Molokai, Lanai, Kahoolawe, and Maui), and Hawaii. The CHRT did not identify any unoccupied[3] areas.

Critical habitat designations increase the protections for listed species by bringing awareness to the species' habitat needs (by identifying essential features) and by requiring consultation to ensure that federal agency activities[4] do not destroy or adversely modify designated areas. Prohibitions against the destruction and adverse modification of designated critical habitat are specific to federal agencies. The consultation process, identified in Section 7 of the ESA and outlined in joint NMFS and United States Fish and Wildlife regulations (USFWS), establishes a

[1] Listed as *Monachus schauinslandi* under the ESA, the Hawaiian monk seal has recently been classified into a newly erected genus *Neomonachus*, due to profound molecular, morphological and temporal divergence demonstrated between the Mediterranean and the Hawaiian and Caribbean monk seals ((Scheel et al., 2014))
[2] Occupied refers to those areas that have been identified as within the geographic range of the species at the time it is listed.
[3] Unoccupied areas refer to those areas outside of the geographic range of the species at the time it is listed.
[4] Activities refer to any action that is carried out, funded or authorized by a federal agency.

method for avoiding and mitigating impacts to critical habitat. In addition to these identified protections, critical habitat designations may allow for informed natural resource planning for all stakeholders utilizing these areas. The ESA recognizes that recovery efforts may take many forms, and that habitat plays a key role in providing for the recovery of all endangered or threatened species. Critical habitat designations are just one measure in a suite of recovery efforts that work in concert to alleviate stress on imperiled populations to encourage population survival and growth. A revision to Hawaiian monk seal critical habitat allows NMFS to employ the most current and best scientific and commercial information available to identify the essential features and establish the areas for the designation that best promote the species' conservation (i.e., survival and recovery). This report summarizes the available data on Hawaiian monk seal presence, distribution, and use of the identified areas and the CHRT's process for determining these areas as essential for conservation of the Hawaiian monk seal. The assessment and findings provided in this report are used in conjunction with other agency analyses (e.g., economic analyses) to support NMFS' proposal to revise the areas designated as critical habitat for the Hawaiian monk seal.

BACKGROUND

The Hawaiian monk seal (*Neomonachus schauinslandi*) was listed as endangered throughout its range under the ESA in 1976 (41 FR 51611; November 23, 1976). In 1986, critical habitat for the Hawaiian monk seal was designated at all beach areas, sand spits and islets, including all beach crest vegetation to its deepest extent inland, lagoon waters, inner reef waters, and ocean waters out to a depth of 10 fathoms (18.3 meters (m)) around Kure Atoll, Midway Islands (except Sand Island), Pearl & Hermes Reef, Lisianski Island, Laysan Island, Gardner Pinnacles, French Frigate Shoals, Necker Island, and Nihoa Island in the Northwestern Hawaiian Islands (NWHI) (51 FR 16047; April 30, 1986). In 1988, critical habitat was expanded to include waters around previously designated areas out to the 20 fathom (36.6 m) isobath and to include Maro Reef (53 FR 18988; May 26, 1988).

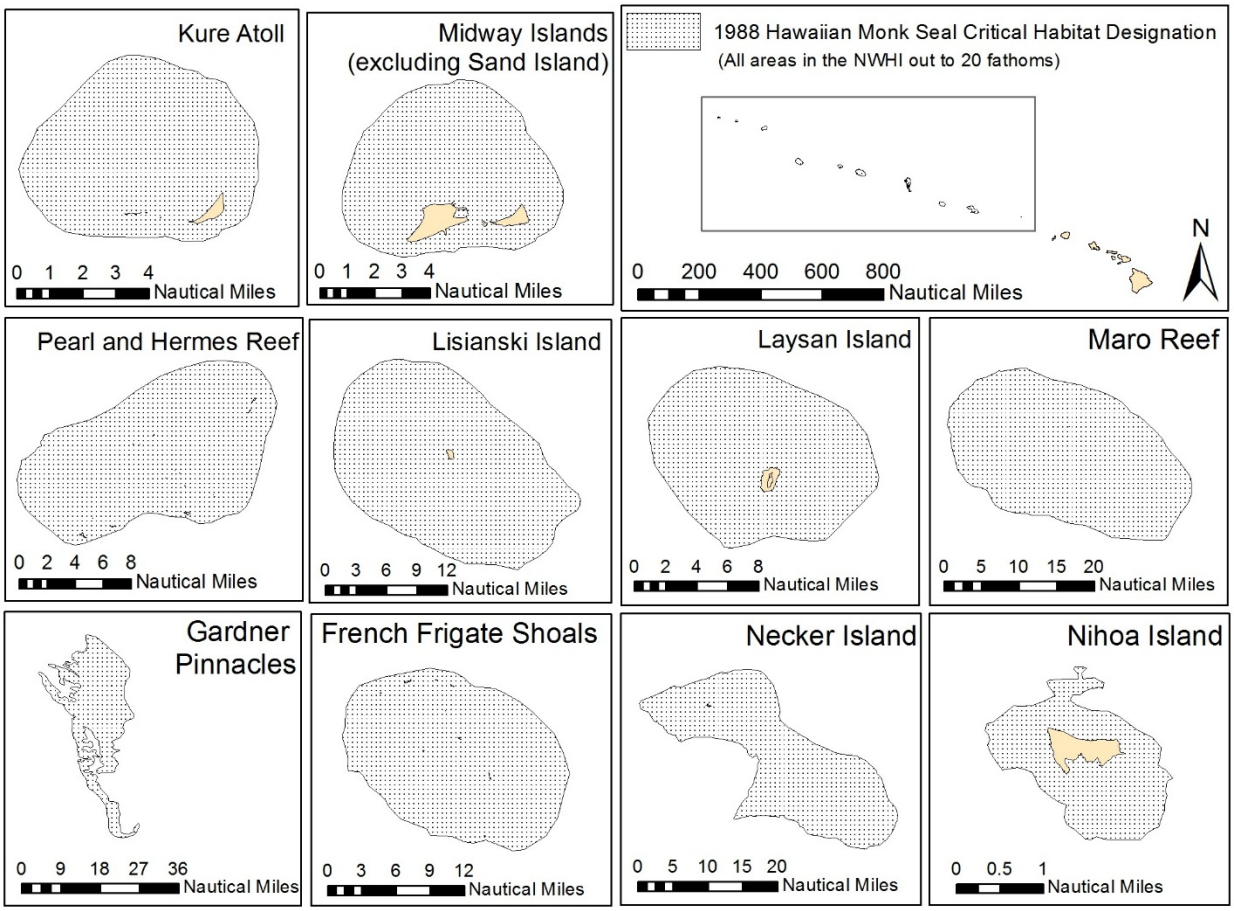

Figure 1. 1988 Hawaiian monk seal critical habitat.

On July 9, 2008, NMFS received a petition dated July 2, 2008, from the Center for Biological Diversity, Kahea, and the Ocean Conservancy (Petitioners) to revise the Hawaiian monk seal critical habitat designation under the ESA (Center for Biological Diversity, 2008). The Petitioners sought to revise Hawaiian monk seal critical habitat by adding the following areas in the MHI: key beach areas, sand spits and islets, including all beach crest vegetation to its deepest extent inland; lagoon waters; inner reef waters; and ocean waters out to a depth of 200 m (656

feet (ft)). In addition, the Petitioners requested that designated critical habitat in the NWHI be extended to include Sand Island at Midway, as well as ocean waters out to a depth of 500 m (1,640 ft) (Center for Biological Diversity, 2008).

On October 3, 2008, NMFS announced in its 90-day finding that the petition presented substantial scientific information indicating that a revision to the current critical habitat designation may be warranted (73 FR 57583; October 3, 2008). Having reviewed the currently available scientific information, NMFS announced its intent to move forward with the revision to Hawaiian monk seal critical habitat on June 12, 2009 in its 12-month finding (74 FR 27988; June 12, 2009).

NMFS identified five steps to move forward with the designation of Hawaiian monk seal critical habitat in the 12-month finding, including the following: (1) Determine the geographical area occupied by the species at the time of listing; (2) Identify the physical or biological features essential to the conservation of the species; (3) Delineate areas within the geographical area occupied by the species that contain these features, and that may require special management considerations or protections; (4) Delineate any areas outside of the geographical area occupied by the species that are essential for the conservation of the species; and (5) Conduct economic, national security, and other required analyses to determine if any areas identified in steps 3 and 4 could be excluded from critical habitat consideration under Section 4(b)(2) of the ESA.

To complete these steps and determine the appropriate areas for consideration for the revision, NMFS convened a Critical Habitat Review Team (CHRT) consisting of seven biologists with experience working on issues related to Hawaiian monk seal research and management. The team used the best available scientific data, the current status of the species, and the recovery goals from the 2007 Recovery Plan (NMFS, 2007) to evaluate and identify critical habitat for the Hawaiian monk seal.

Subsequently, NMFS published a proposed rule to revise critical habitat for Hawaiian monk seals (76 FR 32026; June 2, 2011). Comments solicited from the public were received and reviewed by NMFS, and forwarded to the CHRT for consideration. The reviews and further deliberations of the CHRT have been incorporated into this report. The purpose of this report is to provide a biological assessment of the life history, movements, and habitat use of the Hawaiian monk seal in support of a revision to the critical habitat designation for the Hawaiian monk seal.

CRITICAL HABITAT UNDER THE ESA

Critical habitat is defined in Section 3(5)(A) of the ESA (16 U.S.C. 1532 (5)(A)) as:

"(i) the specific areas within the geographical area occupied by the species at the time it is listed…, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and

(ii) specific areas outside the geographical area occupied by the species at the time it is listed… upon a determination by the Secretary that such areas are essential for the conservation of the species."

Section 3 of the ESA (16 U.S.C. 1532(3)) defines the terms "conserve," "conserving," and "conservation" to mean: "to use, and the use of, all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this chapter are no longer necessary."

Section 4(a)(3)(A) of the ESA (16 U.S.C. 1533(a)(3)(A)) requires that, to the maximum extent prudent and determinable, critical habitat be designated concurrently with the listing of a species, and allows for, as appropriate, the revision of such designation.

Such designations of critical habitat must be based on the best scientific data available and are further guided by additional provisions of the ESA. One provision includes Section 4(a)(3)(B)(i) (16 U.S.C. 1533) which precludes from designation any lands owned by, controlled by, or designated for the use of the Department of Defense (DOD) that are covered by an Integrated Natural Resources Management Plan (INRMP) that the Secretary has determined in writing will benefit the listed species. A second provision in Section 4(b)(2) (16 U.S.C. 1533(4(b)(2)) of the ESA requires the agency to consider the economic, national security, and other relevant impacts of specifying any particular area as critical habitat. Under this provision of the ESA the Secretary may exclude any area from critical habitat if the benefits of such exclusion outweigh the benefits of specifying such areas as critical habitat, unless the exclusion of such areas would result in the extinction of the species.

Once critical habitat is designated, Section 7 of the ESA requires federal agencies to insure[5] that they do not fund, authorize (permit), or carry out actions that are likely to destroy or adversely modify that habitat. This is in addition to other requirements under Section 7 of the ESA that insure that actions do not jeopardize the continued existence of the listed species.

HAWAIIAN MONK SEAL NATURAL HISTORY AND STATUS

This section of the report provides background information relevant for understanding the habitat use and specific needs of the species. Following is a discussion of the Hawaiian monk seal's biology, including natural history, range, population status and trends, and habitat including a description of the differences between the NWHI and the MHI.

Natural History

Hawaiian monk seals are in the Phocidae family, known as the true seals, which are characterized by a lack of an external ear and an inability to draw the hind-flippers under the body for movement on land. Within the family Phocidae, the Hawaiian monk seal is a member of the subfamily Monachinae. Of the true seals, two other species of monk seal are widely

[5] Insure is used for consistency with the wording used in the ESA.

recognized; the recently extinct Caribbean monk seal (*N. tropicalis*) and the endangered Mediterranean monk seal (*M. monachus*). Deemed the most primitive phocids, the monk seals possess anatomical features that resemble early monk seal fossils from 14-16 million years ago (mya) (NMFS, 2007).

The three well known monk seal species are widely dispersed geographically (i.e., the Hawaiian Archipelago, and the Caribbean and Mediterranean Seas), however the historical biogeography of the monachine seals' dispersal remains uncertain (Arnason et al., 2006; Fyler et al., 2005; Repenning & Ray, 1977; Scheel et al., 2014). Nonetheless, information remains available to assist in estimating when these three lineages split from one another millions of years ago. Recent genetic, temporal and morphological evidence indicates that divergence occurred first between the Mediterranean monk seal lineage and a common ancestor of the Hawaiian monk seal and the Caribbean monk seal approximately 6.3 mya (Scheel et al., 2014). The divergence between the Hawaiian and Caribbean monk seal has often been linked to the closure of the Central American Seaway (Fyler et al., 2005) and Scheel et al.'s (2014) recent analysis incorporating genetic information from Caribbean monk seal specimens comports with this hypothesis, estimating that divergence occurred around 3.67 mya (Scheel et al., 2014). Regardless of the conflicting origin and dispersal descriptions of how monk seals came to the Pacific basin, the geological evolution of the Hawaiian Archipelago indicates that island habitat was available both in the NWHI and the MHI for seal colonization at, and prior to, the closure of the Central American Seaway (3mya). Emergent habitat at this time includes the Northwestern chain and the islands of Kauai and Niihau, which formed as early as 5 and 4.9 mya respectively (Juvik & Juvik, 1998).

Hawaiian monk seals are wide-ranging, air-breathing aquatic carnivores that spend a majority of their time in the ocean, although they continue to rely on terrestrial habitat. Monk seals utilize aquatic habitat for foraging, socializing, mating, resting, and traveling. Adept at propulsion in the water, individual monk seals may travel hundreds of kilometers (km) or miles (mi) in a few days (Littnan et al., 2006) and dive to more than 500 m (1,600 ft) (Parrish et al., 2002). Although a majority of its time is spent in the water, like many other seals, the Hawaiian monk seal utilizes terrestrial habitat to rest, molt, give birth, nurse, and avoid predators. In contrast to commonly recognized pinnipeds, such as sea lions, walrus, and harbor seals, which often haul out[6] in large groups, the Hawaiian monk seal is considered solitary, often hauling out individually. This solitary nature extends both on land and in the water; however, monk seals may congregate in small numbers (e.g., males may haul out with and guard females, or several animals may be found in relative proximity to one another) in favorable haul-out areas (Antonelis et al., 2006) or when interacting.

Adult monk seals reach lengths of 2.3 m (7.5 ft) and weigh up to 273 kilograms (kg) (600 pounds (lb)). On average, adult males are smaller in size than females (NMFS, 2007). It is thought that Hawaiian monk seals have a lifespan of up to 30 years in the wild. Females reach breeding age at about 5 to 11 years of age in the wild (NMFS, 2010d), depending on body condition. Little is known regarding the sexual maturation of males, however behavior and size suggest similar maturation rates to that of the females (Antonelis et al., 2006). Mating occurs at sea, and gestation is thought to be approximately 11 months. Females typically will haul out on land near

[6] Haul out is a term used to describe the behavior of seals leaving water to be on land.

the birth site and give birth to a single pup (Johanos et al., 1994). Monk seal births have been documented throughout the year, though births are most common between February and August (NMFS, 2007). Upon birth, the female will nurse the pup for approximately 6 weeks. Throughout this time period, the mother remains with the pup, usually fasting and losing body mass (Kenyon & Rice, 1959). The nursing period concludes and weaning occurs when the mother returns to the marine environment to forage (T. C. Johanos et al., 1994). Females will mate about 3-4 weeks after weaning her pup, and 5-6 weeks after mating, she will haul out for 10-14 days or more to molt (Johanos et al., 1994; NMFS, 2007). At least several months are required for the now independent pup to teach themselves to successfully forage. During this time, pups survive on fat stores built up during nursing, resulting in considerable weight loss (NMFS, 2007). Juveniles (up to 3 years old) are generally longer than recently-weaned pups. Juveniles in the NWHI typically do not regain the post-weaning weight until approximately 2 years of age (Johanos et al., 1994); post-weaning weights have not been compared between post-weaned MHI pups and MHI juveniles.

Adult monk seals appear silvery white ventrally with dark silvery tinged brown or slate gray pelage (fur) dorsally. As the hair ages, the ventral pelage takes on a yellow tinge, while the dorsal pelage may appear dull brown or darker (Kenyon & Rice, 1959). A red or green tinge may develop from algal growth on the pelage when monk seals stay at sea for an extensive period (Kenyon & Rice, 1959). Monk seals undergo an annual molt, which is termed a catastrophic molt because the top layer of skin and fur is shed annually, leaving a silvery grey coat underneath. At birth, pelage is black and may occasionally be marked with small white patches, referred to as natural bleaches (Kenyon & Rice, 1959). The black pelage is lost during the postnatal molt, which occurs around the time of weaning.

Information on the hearing capabilities of Hawaiian monk seals is somewhat limited. An underwater audiogram for a single Hawaiian monk seal revealed a hearing range from approximately 2kHz to 48 kHz, with the most sensitive hearing at 12 to 28 kHz (Thomas et al., 1990). Sensitivity dropped off sharply below 8 kHz and above 30 kHz (Thomas et al., 1990). These results suggest that Hawaiian monk seal hearing is less sensitive than that of other pinnipeds, which is generally between 75 Hz and 75 kHz in water (Southall et al., 2007). Monk seals communicating in the airborne environment rely largely on short-range signals to alert conspecific animals, or to keep them informed of a signaler's location or general behavioral state (Miller & Job, 1992). For example, vocalizations often occur between males during aggressive interactions. Additionally, females and pups vocalize often throughout the nursing period to locate one another, to initiate nursing, or to indicate disturbance. Although vocalization may be common between the mom and pup pair, research indicates that females do not discriminate between filial and alien pups (i.e., females do not distinguish their pups vocalizations from other pups) and that foster parenting is prevalent at sites with multiple mom and pup pairs (Job et al., 1995).

Range

The range of the Hawaiian monk seal includes the entire Hawaiian Archipelago and Johnston Atoll. Today, seals are found throughout the Hawaiian Archipelago from Kure Atoll to the Island of Hawaii. Although no recent information indicates that seals are present, Johnston Atoll is considered part of the range because monk seals have occurred there naturally and at the time

of listing. The six main reproductive sites for the species are Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, and FFS, located from northwest to southeast in the NWHI. Based on the Hawaiian monk seal's 2012 Stock assessment's minimum population estimates, approximately 77 percent of the monk seal population utilizes these main reproductive sites (Carretta et al., 2013). Smaller reproductive sites also occur on Necker Island and Nihoa Island. Tracking and diving data indicates that monk seals utilize habitat at Gardner Pinnacles and Maro Reef[7] (Stewart et al., 2006). Although most of the seals tend to favor utilizing a single atoll or island for haul-out associated activities, 10-15 percent of the seals migrate among the NWHI reproductive sites (Carretta et al., 2013). Monk seals are found throughout the MHI and births have been documented on all of the major islands except Lanai (NMFS, 2001, 2007).

Information from Johnston Atoll is sparse, however Hawaiian monk seals have been observed on several occasions. A tagged yearling male monk seal from Laysan Island was first seen at Johnston Atoll in July 1968 (Schreiber & Kridler, 1969) and remained until at least August 1972. In January 1969, an untagged adult female monk seal arrived on Sand Island (a secondary island within Johnston Atoll) and gave birth to a female pup. The mother-pup pair remained on or near the pupping (birthing) beach until March 1969, when the pup was weaned and the mother disappeared. The pup remained until 1971 when it died from a deep flesh wound, probably from a shark attack (Amerson & Shelton, 1976). In July 1999, a tagged adult female from FFS arrived at Johnston Atoll and remained there for about a year (NMFS, 2001).

Additionally, unconfirmed, probable sightings of Hawaiian monk seals outside the Hawaiian Archipelago and Johnston Atoll have been reported from Palmyra Atoll (1,800 km or 1,118 mi) south of the NWHI), as well as Wake Island (2,000 km or 1,243 mi) southwest of NWHI). These reports include: two seals sighted on Palmyra Atoll in 1990, a seal sighted on Wake Island in the early summer of 1966, and a tagged seal sighted on Wake Island in February 1987 (NMFS, 2010c; Westlake & Gilmartin, 1990). Other more poorly-documented sightings have been reported from Bikini Atoll and to Mejit Island in the Marshall Islands (2,400 km or 1,491 mi southwest of the NWHI) (NMFS, 2010c).

In addition to the above reported natural occurrences of monk seals, NMFS has historically relocated, or translocated, animals within the species' geographic range to manage serious threats to the population or individual animals. Most translocations occurred within the NWHI and involved moving a newly weaned pup within an atoll or from one reproductive site to another to minimize risk of shark predation, or to minimize the risk associated with male aggression (Baker et al., 2011). Additionally, young seals have been moved within the MHI to minimize the risk of interactions or socialization with humans. Some historic translocations have involved moving animals from the NWHI to the MHI, MHI to the NWHI, or from the Hawaiian Islands to Johnston Atoll. These historic translocations are summarized below and in Table 1.

In 1984, nine adult males were relocated from the NWHI to Johnston Atoll, because of attacks on adult females and immature seals. At least three of these males were still at Johnston Atoll

[7] Tracking and diving information from the NWHI indicates that Maro reef may be used by monk seals that are considered residents of Lisianski or Laysan Island. Additionally Gardner Pinnacles is used by monk seals that utilize FFS.

the following year, and at least one male was still there in 1986. In 1994, NMFS relocated 21 adult male monk seals from the NWHI to the MHI in order to reduce male aggression and female deaths at Laysan Island, where males greatly outnumbered females at the time. In 2008, a minimum of five of the 21 relocated male monk seals remained in the MHI. No female monk seals have been relocated from the NWHI to the MHI; accordingly, all female monk seals in the MHI occur there naturally. NMFS has relocated three female monk seals (a juvenile in 1981, a pup in 1991, and a subadult in 2009) from the MHI to the NWHI. In 1998, two adult males determined to be responsible for drowning pups were relocated from the NWHI to Johnston Atoll. In 2003, a sub-adult male was relocated from the MHI to Johnston Atoll. This seal's habituation to humans led to the seal exhibiting aberrant behavior that posed a threat to the seal's natural development and a risk to public safety[8] (NMFS, 2010j). No sighting history is available for the latter three monk seals (NMFS, 2010j, 2010k). In summary, NMFS has relocated 21 males from the NWHI to the MHI, three females from the MHI to the NWHI, 11 males from the NWHI to Johnston atoll, and 1 male from the MHI to Johnston Atoll.

Table 1. Hawaiian monk seal translocations.

Age	Sex	From	To	Year	Management Threat	Number of Animals Released
Juvenile	Female	MHI	NWHI	1981	Human interaction	1
Adult	Male	NWHI	Johnston Atoll	1984	Male aggression	9
Weaned pup	Female	MHI	NWHI	1991	Human interaction	1
Adult	Male	NWHI	MHI	1994	Male aggression	21
Adult	Male	NWHI	Johnston Atoll	1998	Male aggression	2
Subadult	Male	MHI	Johnston Atoll	2003	Human interaction	1
Subadult	Female	MHI	NWHI	2009	Human interaction	1

Population Status and Trends

The 2013 Marine Mammal Stock Assessment Report (SAR) provides the best estimate of the total Hawaiian monk seal population as 1,209 individuals (Carretta et al., 2013). This estimate includes the sum of estimated abundances at the six main NWHI breeding subpopulations[9] located in the NWHI (Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island and FFS), an extrapolation of counts at Necker and Nihoa Islands, and an estimate of minimum abundance in the MHI (Carretta et al., 2013). Various methods are used to identify the best estimate for these sites annually depending on factors such as field research effort. More

[8] Natural animal behaviors (e.g., social interactions) can be forceful; consequently, when these behaviors are exhibited towards humans the animal may inadvertently pose a threat to human safety. Management measures are often taken when seals show a proclivity towards human interactions to discourage this behavior and encourage natural seal interactions.

[9] Although, monk seals found in the separate areas identified throughout the NWHI and/or in the MHI are not genetically distinct from one another, they are often described as subpopulations to distinguish variation in population trends observed between geographic areas. Similarly, seals using the NWHI and MHI may be referred to as subpopulations, to describe differences in research and management between these two geographic regions.

details about the annual methods used to estimate population size may be found in the corresponding stock assessment reports (Baker et al., 2004; Baker et al. 2006).

The 2013 SAR also provides minimum subpopulation estimates based on the number of seals individually identified within specific areas. Seals are individually identified using unique identifiers such as flipper tag numbers, bleach marks, unique scars, or a photo that allows for matching in the Pacific Islands Fisheries Science Center (PIFSC) identification database. In 2011 the minimum population estimate for the NWHI included 909 seals and the MHI estimate included 146 seals (Carretta et al., 2013). Beach counts of NWHI juveniles and adults (i.e., all seals except pups) were 69 percent lower than those of the late 1950s, and total abundance at the six primary NWHI sites (Kure Atoll, Midway Islands, Pearl and Hermes, Lisianski Island, Laysan Island, and FFS) is declining at a rate of about 3.4 percent per year (Carretta et al., 2013). The following is a review of pertinent information and trends with regard to historical changes in the population.

A complete history of Hawaiian monk seal population status and trends is unknown; however, data and historical accounts do indicate that the population in the NWHI was greatly impacted by early human exploitation. The first written accounts of Hawaiian monk seals in the NWHI were recorded during exploration in the early 1800s. While accounts from this time provide no basis for estimating population size, the accounts indicate a period of time when numerous seals were on the beaches and when trading and shipwrecked vessels exploited seals of the NWHI for oil, pelts, or food (Ragen, 1993). Reports from the end of the 19th century highlight the impacts from early human exploitation of the Hawaiian monk seal population by describing extended visits to Midway Islands and Laysan Island where no seals were seen, indicating near or total extirpation of seals at these sites (Ragen, 1999). Following the period of exploitation in the 1800s, the atolls and islands were settled for entrepreneurial and military reasons at various points in time.

The most consistent long-term monitoring of the monk seal population started in the late 1950s in the NWHI and included the six main subpopulations at Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, and FFS. Since 1958, beach counts were made at the islands almost every year (Figure 2), with a high count of 1,206 seals recorded in the spring of 1958 (NMFS, 1983). Although these counts do not provide a total population estimate[10], the beach counts show a large decline from the late 1950s to the mid-to-late 1970s: counts in the 1970s ranged from the low 500s to the high 600s (NMFS, 1983). This decrease was most evident in the western portions of the range and was once largely attributed to human disturbance related to military settlement (Kenyon & Rice, 1959; Ragen, 1993). However, more recent studies evaluating historic shifts in climate-ocean factors compared to monk seal trends suggest that human activities may have played a smaller role in influencing the declines in the NWHI subpopulations (Baker et al., 2012).

Military activities and presence eventually ceased at all NWHI sites by 1997[11] (Ragen, 1999). Since this time the USFWS, the State of Hawaii and NMFS have been working to manage the

[10] Beach counts were not standardized in early years and do not provide a total population estimate because the counts fail to determine the proportion of the total population included in the count (i.e., these numbers do not account for seals out to sea at the time of the count or movement among islands).
[11] 1997 marks the year the Navy vacated Midway Atoll.

various fish, wildlife, and resources of the islands and surrounding areas. In 2006 the islands and surrounding waters were incorporated into the Papahanaumokuakea[12] Marine National Monument (Monument) and the above three agencies are co-trustees in managing the area. Despite the increased protections and management of this area and the decreased disturbance, monk seal populations in the NWHI have continued to experience periods of decline and stability that vary both temporally and spatially throughout the NWHI (NMFS, 2007). Researchers found that this variation in abundance trends appears to reflect shifts in ocean productivity that are driven by various climate patterns (Polovina et al., 1995; Polovina & Haight, 1999; Antonelis et al., 2003; Baker et al., 2007; Baker et al., 2012). Generally, climate patterns (such as El Niño) drive changes in temperatures and/or ocean mixing that result in changes to ocean productivity. This influence extends up the food web, altering prey abundance for top predators like the Hawaiian monk seal, which eventually affects juvenile survival (J. D. Baker et al., 2012). The geographic reach and duration of influence of climate patterns varies; therefore, impacts felt in one portion of the Archipelago may not be experienced equivalently elsewhere in the chain. For example, Baker et al. (2012) found a relationship between shifts in the Pacific Decadal Oscillation and monk seal abundance for the most northerly sites in the NWHI (from Kure Atoll southeast to Lisianski Island); however, this relationship was not evident at FFS or Laysan Island.

Periods of poor juvenile survival degraded the age structures of the NWHI subpopulations. These unfavorable age structures in the NWHI subpopulations continue to influence the population, and monk seal declines in this region are predicted to continue for at least the next decade (Baker et al., 2011). Because these NWHI populations are strongly influenced by variability associated with climate-ocean factors, the effectiveness of management efforts will rely largely on recovery efforts capitalizing on periods and regions of higher productivity.

[12] Originally named Northwestern Hawaiian Islands Marine National Monument; name was changed in 2007.

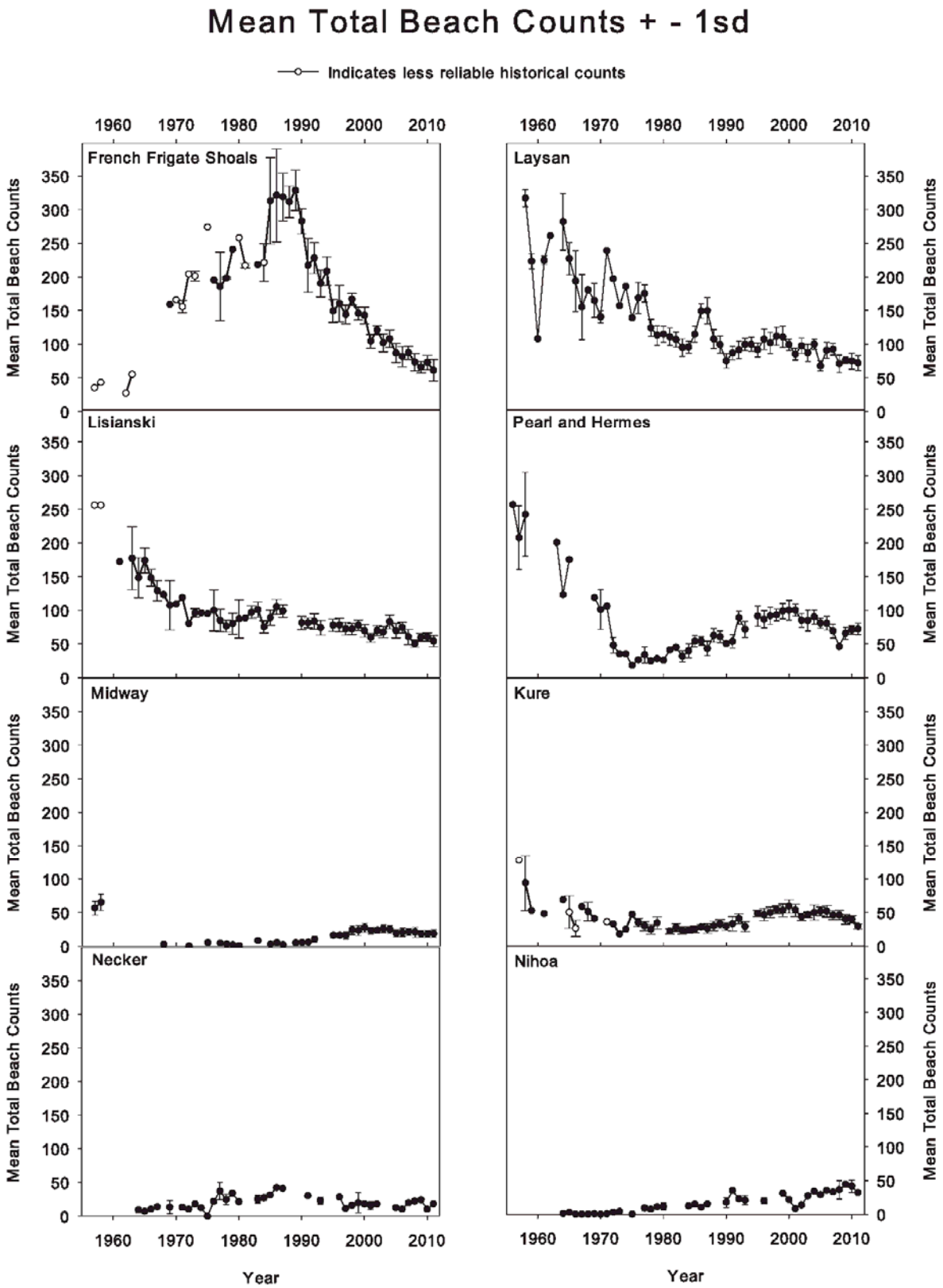

Figure 2. Northwestern Hawaiian Islands Mean Total Beach Counts.
Figure provided by NMFS Pacific Island Fisheries Science Center.

It has been generally accepted that Hawaiian monk seals colonized the islands of the NWHI; however, there are conflicting views regarding their historical use of the MHI. The culture and history of the Hawaiian Islands is described in Hawaiian oral tradition; however, disagreement exists over whether monk seals are represented in that history. The lack of apparent seal references in Hawaiian oral tradition has led some to believe that Hawaiian monk seal use of this region is a recent phenomenon. A fossil discovery of seal bones at an archeological site from the Island of Hawaii dating from 1,400 – 1,760 years ago (Rosendahl, 1994) indicates seal presence on the MHI well before any of the historically written accounts of seals there. The fossil evidence, in combination with the geological evolution of the islands, and historical accounts of extirpation of other species by early Polynesians (Athens et al., 2002; Diamond et al., 1989; Olson & James 1982) tend to support an alternate view. This view presents the possibility that the Hawaiian monk seal likely colonized and eventually utilized the entire Hawaiian Archipelago until the population was forced to NWHI habitat by exploitation or disturbance in the MHI (Baker et al., 2004;Baker & Johanos 2004; Ragen, 1993).

The Hawaiian Islands are often presented as a geological conveyor belt; where islands emerge over volcanic hotspots. As the Pacific Plate shifts islands from the hotspot, the islands subside and eventually erode over time into atolls and seamounts (Fleischer et al., 1998). Monk seals utilizing the early Hawaiian Archipelago likely used all available emergent coastal habitats. As the population grew and additional islands emerged, the wide-ranging nature of these animals would have allowed for dispersal throughout the entire chain to all available habitats. Polynesians' settlement of the Hawaiian Islands did not occur until approximately 1400 years ago, which is long after Hawaiian monk seals were recognized to be separated from other species of monk seals and located in the Pacific basin (Fyler et al., 2005; Kirch et al., 2004). Hawaiian monk seals may have been extirpated from the MHI in the same manner as many bird and plant species (Athens et al., 2002; Diamond et al., 1989; Olson & James, 1982), through hunting or disturbance, following Polynesian settlement, driving the species to the NWHI, where human settlements were limited by the lack of fresh water (Baker & Johanos, 2004; Ragen, 1999). Fossil evidence of seal use of terrestrial habitat, either in the NWHI or the MHI, is likely to be rare because these animals limit their use of terrestrial habitat to easily accessible shorelines (e.g., sandy or rocky shorelines with low relief) due to their decreased mobility on land. Near-shore coastal habitats are dynamic and subject to regular erosion and seal remains are likely to be washed away. In summary, this view presents the growth and dispersal of the Hawaiian monk seal population in the MHI as a re-colonization event.

During recent MHI history, the occasional presence of seals is indicated by historical accounts of seal sightings. In 1900, Hilo residents reported that solitary monk seals were seen in the area about once every 10 years (Bailey, 1952). From 1928 to 1956, seven monk seal sightings were documented in the MHI (Kenyon & Rice, 1959) and Niihau residents reported that seals appeared regularly after 1970 (Baker & Johanos, 2004). While seal tagging efforts were becoming consistent in the NWHI in the 1980's, sightings of untagged individuals were beginning to be recorded in the MHI. From 1980-1986, 124 seal sightings were documented throughout the MHI (Table 2, includes multiple sightings on each of the main Hawaiian Island), all of which happened prior to, or in the same year as, the first critical habitat designation (NMFS, 2010e). These sightings do not represent a discrete number of seals, because seal identification is unknown for most seals and these incidental sightings provide no structured

survey method for estimating population size. Nonetheless, these sightings do reveal the presence of seals throughout the MHI in the early 1980s.

Table 2. MHI monk seal sightings from 1980-1986.
(Data provided by NMFS PIFSC)

Island	1980	1981	1982	1983	1984	1985	1986	Total
Niihau	2	1	2	1			2	8
Lehua				1	1			2
Kauai	4		7	1	11	2	8	33
Oahu			2		10	4	13	29
Molokai				2	15			17
Maui			4			4	6	14
Lanai					2		8	10
Kahoolawe							1	1
Hawaii			2			2	6	10
Total	6	1	17	5	39	12	44	124

As early as 1994, a small naturally-occurring population of male and female monk seals was present in the MHI. Since the mid-1990s, an increasing number of documented sightings and annual births of monk seal pups has occurred throughout the MHI, though sighting information indicates that the islands of Kauai, Oahu, and Molokai have been the most consistently used. A majority of the current information about seal identification and terrestrial habitat use in the MHI is provided through a volunteer network in which the general public provides information to NMFS' PIFSC regarding seals using MHI beaches, shorelines, and waters. Reporting from the general public is not systematic, thus population estimates are derived differently than in the NWHI. Generally, the information provided throughout the year identifies the number of unique individuals in the population[13], which provides a means for a minimum population estimate. The annual stock assessment reports for the species reveal that the number of individually-identifiable Hawaiian monk seals in the MHI has grown from 77 in 2005 to 146 in 2011 (Carretta et al., 2007; Carretta et al., 2009; Carretta et al., 2013).

Growth in seal numbers in the MHI is not considered to be a consequence of increased migration from the NWHI because only five seals have been documented to have migrated from the NWHI to the MHI since the 1980s when regular tagging efforts began (Baker et al., 2011). This growth in numbers is likely due to the increase in births (see Figure 3) throughout the MHI as well as due to dispersal of seals from under-documented areas, such as Niihau, to the rest of the chain (Baker & Johanos, 2004). The evolutionary, historical, and geological evidence, combined with the dispersion and increased numbers of Hawaiian monk seals throughout the MHI, suggests that monk seals have been re-colonizing the MHI in recent years. The exact catalyst for this re-colonization is unknown; however, the next section of this report discusses how favorable habitat conditions in the MHI may support this growing population.

[13] Sighting information received from the public may provide unique seal identification if the report provides information with a unique identifier such as flipper tag numbers, bleach marks, unique scars, or a photo that allows for matching in the PIFSC identification database. Not all public reports are able to provide this level of detail.

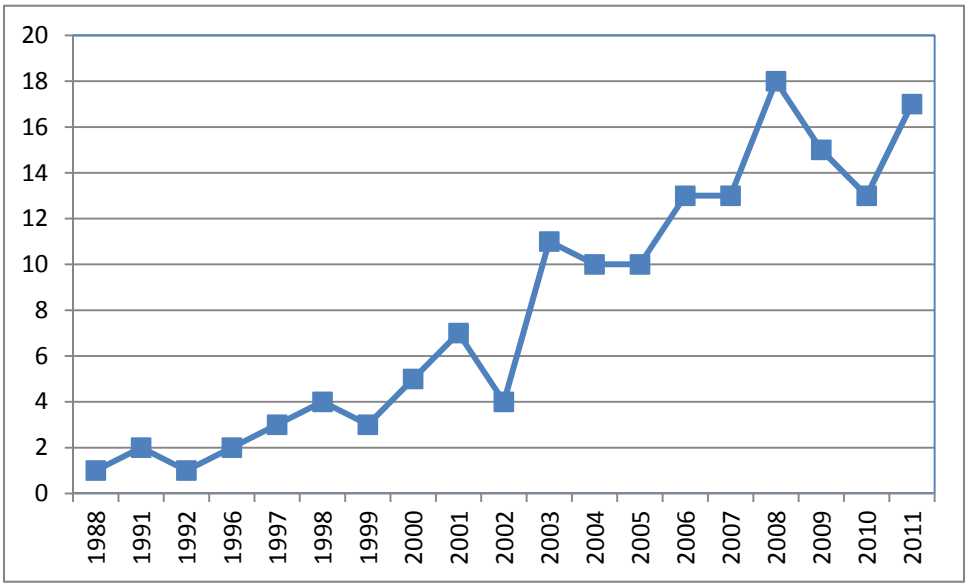

Figure 3. Hawaiian monk seal births reported in the MHI from 1987 – 2011, not including reports from Niihau[14]. Data provided by NMFS PIFSC.

Northwestern Hawaiian Islands (NWHI) and Main Hawaiian Islands (MHI)

The Hawaiian monk seal population is often described as two subpopulations, one in the NWHI and one in the MHI, but this is solely for management and research purposes, since there is no evidence that monk seals occurring in any part of the archipelago are genetically distinct from monk seals elsewhere in the range (Schultz et al., 2009). Differences between Hawaiian monk seal population status, habitat, research efforts, and threats to the species in these two regions support the separate approach to management and conservation efforts (Baker et al., 2011). The following discussion summarizes some of the differences between the two management areas and separately refers to information about seals in these portions of the geographic range to highlight these differences.

Recruitment trends differ between the NWHI and MHI. In the NWHI, some of the six reproductive subpopulations are experiencing long-term declines, while others show limited or slow recovery from past declines. Lack of recovery in the NWHI has been primarily attributed to food limitation (NMFS, 2007). Evidence supporting this conclusion has been demonstrated by evaluating seal health, growth, survival, and fecundity in various regions of the NWHI. Poor juvenile survival was first associated with food limitation by Craig and Ragen (1999), who noted that decreasing juvenile survival correlated with decreasing pup size at FFS (Craig & Ragen, 1999). Juvenile food limitations also became evident at Laysan Island in 2001 when necropsies of six juvenile seals indicated emaciation with no evidence of disease (Baker, 2008). As declining trends continued at FFS, females began expressing signs of food limitations as well. Females demonstrated delayed reproduction, achieved adult size at an older age, and showed overall lower age-specific reproductive rates compared to females of the relatively stable Laysan

[14] Including reports from Niihau would provide an inconsistent view of monk seal pup growth, because monk seal births were not consistently reported from this island in earlier years.

Island subpopulation (Baker, 2008; Harting et al., 2007). Intensified size-selected mortality during years with poor survival in the NWHI subpopulations suggests that poor juvenile survival is related to food limitations (Baker, 2008). Although it appears counterintuitive that monk seals should struggle to find sufficient prey resources in the vast protected areas of the NWHI, researchers suggest that climate-ocean variability leads to variable ocean productivity, which impacts these top predators (Polovina et al., 1995; Polovina & Haight, 1999; Antonelis et al., 2003; Baker et al., 2007; Baker et al., 2012).

In contrast, the MHI portion of the population is increasing, as discussed in the previous section. In addition to the difference in population growth, monk seals in the MHI appear to be in better physical condition than those in the NWHI. In general, MHI females begin reproducing at a younger age and attain higher birth rates than females in the NWHI (Baker et al., 2011). In 2008, a 4 year old MHI female became the youngest documented Hawaiian monk seal to pup (NMFS, 2010g). Females in the MHI are also producing robust pups. Measurements of axillary girths and standard lengths of weaned pups in the MHI were significantly greater in comparison to weaned pups from the NWHI; the larger size of MHI pups is believed to be a reflection of favorable foraging conditions for the MHI mothers (Baker & Johanos, 2004). The disparity in status between the two regions is reflected in recent estimates of MHI population growth in comparison to the decline of monk seal numbers in the NWHI (Baker et al., 2011). Based on current trends and knowledge of the subpopulations, survival for weaned pups in the MHI is estimated at 77 percent, which is much higher than the 42-57 percent survival estimates for pups in the six NWHI breeding areas (Baker et al., 2011). If demographic trends continued at the current rates, the MHI and NWHI portions of the population would equalize by 2023 (Baker et al., 2011).

Factors influencing foraging success may explain the disparity between the two regions. These factors may be attributed to an inequity in ecological competition on several levels. First, low numbers of monk seals in the MHI may point to a greater per capita availability of prey than in the NWHI (Baker & Johanos, 2004). Specifically, the lower number of seals in the MHI across a large expanse of available foraging habitat allows for less intra-specific competition (i.e., seals competing with other seals) for food resources. Secondly, the NWHI are located within the Monument, one of the largest and best-protected marine areas in the world, where commercial fishing efforts are now prohibited, and all other human activities require a permit. The protected ecosystem of the NWHI, in comparison to the MHI, has a greater number of large predators. The sharks, jack fishes and other demersal fishes that occur in the NWHI that have been observed to compete directly with monk seals in the NWHI are much less abundant in the MHI and inter-specific competition (i.e., competition with other species feeding on similar prey) is thus likely lower in the MHI (Baker & Johanos, 2004; Parrish et al., 2008). Additionally, competition between humans and monk seals may be limited in the MHI because seals prefer small (usually less than 20 cm or 8 in.) eels, wrasses, and other benthic species not commonly sought by fishermen (Parrish et al., 2000). All of these factors appear to positively influence the population status of monk seals in the MHI at this time.

Additional differences between the two regions are further reflected in the threats to the species and, consequently, in the management priorities and activities for each population. The Hawaiian Monk Seal Recovery Plan (NMFS, 2007) outlines threats to the species and discusses

in which locations those threats are most prevalent, as well as the differences in those threats. One of these threats is habitat loss. The low-lying islets and islands of the NWHI are particularly susceptible to the global threat of sea level rise, which results from several factors associated with climate change, including thermal expansion of the warming oceans and melting of glaciers and ice caps (Baker et al., 2006). In the 20th century, sea levels rose 15 cm (6 inches) and increases are expected to continue (J. D. Baker, Charles L. Littnan, David W. Johnston, 2006; IPCC, September 2013). As a result of sea level rise, important pupping and haul-out habitat may be lost (Baker et al., 2006). While the threat of sea level rise may be accelerated by anthropogenic forces, activities that influence this threat are complex and global in scale. In the NWHI, management measures to support recovery may include regular monitoring for changes in elevation at the various islets and islands. Long-term mitigation planning at specific sites may also play a role in conserving habitat in the NWHI.

In the MHI, habitat loss is also a threat, although coastal anthropogenic development plays a pronounced role. Like most other coastal states, Hawaii's dependence on coastal resources has led to increased development along shorelines. In response to natural erosion processes, urban shorelines were often hardened to protect assets. Efforts to harden shorelines alter the natural hydrodynamic system of waves and currents, affecting sand transport rates that control the erosion-accretion process of beaches (Defeo et al., 2009). As the number of Hawaiian monk seals increases in the MHI and development continues, available habitat for hauling-out and parturition may become increasingly important.

Direct anthropogenic threats from activities within the Monument have been minimized through management measures aimed at protecting the unique resources within the NWHI. Despite being located in this highly protected area, Hawaiian monk seals continue to face threats in the NWHI that require management. The Monument describes three of the largest challenges to conservation for the ecosystems in the NWHI as marine debris, terrestrial pollution, and alien species. NMFS' 2007 recovery plan identifies the three most serious threats to monk seals in this region as food limitation, entanglement, and shark predation. Poor juvenile survival has focused management efforts towards positively influencing population trajectories by increasing efforts that support monk seal health during the vulnerable first years. These measures have included efforts to supplement the nutrition of animals in poor condition, remove parasitic loads from juvenile animals, as well as relocating newly weaned animals to more protective and/or productive areas of the various atolls or islands in the NWHI. Thirty years of robust monk seal population monitoring data in the NWHI aids in making these management decisions.

In contrast to the NWHI, the coastal and marine habitats used by monk seals in the MHI overlap with numerous areas that have been used for a variety of human activities for many years. While people and monk seals are able to coexist in these environments, management challenges do arise as a result of this habitat overlap. Due to the expansive amount of coastal habitat in the MHI, NMFS relies largely on a growing volunteer network to provide information about monk seal activity on the beaches and the near-shore areas of the MHI. Management efforts in the MHI focus largely on threats centered on anthropogenic influences to the population including; fishery interactions (hookings and entanglements[15]), disturbance and harassment of seals, as well

[15] A summary of mortality and serious injury of Hawaiian monk seals due to fisheries may be found in NMFS Annual Stock Assessment Report. (http://www.nmfs.noaa.gov/pr/sars/species.htm)

as preventing humans from feeding and socializing with these wild animals (Baker et al., 2011). Impacts from pollution and runoff into the aquatic environment (where water quality may be impacted) also pose health hazards to the species in the MHI (Littnan et al., 2006). In addition to these unintentional anthropogenic threats, three seals were illegally shot and killed in the MHI in 2009 and between 2010-2012 another five seal deaths were termed suspicious by enforcement officials.

As discussed above, differences between the NWHI and MHI portions of the population present unique research and management challenges for the Hawaiian monk seal. With the continued decline in numbers and the fragile status of reproductive age classes in the NWHI, the survival of the species as a whole may become increasingly dependent on the success of the portion of the population in the MHI and management efforts that can be taken to enhance population growth in the NWHI.

Habitat

While Hawaiian monk seals spend a majority of their time in the water, the terrestrial environment also plays a vital role throughout all life stages. Similar to other phocids, monk seals haul out on terrestrial habitat to rest, molt, give birth, nurse their young and avoid predators. Although Hawaiian monk seals do not congregate at rookeries, they do reliably return to islets or stretches of coastline that appear to be favored for resting, molting, and socializing. Favored islets or stretches of coastline are likely to be used at various points by multiple individuals. Since monk seals may remain at sea for several days or more at a time, resting on land is essential to conserve energy[16]. Resting commonly occurs on sandy beaches, and may also occur on other accessible areas such as rocky shores, rock ledges, emergent reefs, and even shipwrecks (George A. Antonelis et al., 2006). While on shore, monk seals may take shelter from wind and rain under shoreline vegetation (George A. Antonelis et al., 2006). When ocean conditions are rough, monk seals may spend more of their time resting on land. Resting on land is typically done for a few hours to several days at a time (George A. Antonelis et al., 2006). Hawaiian monk seals also use terrestrial habitat during their annual molt. The catastrophic molt process lasts approximately 1-2 weeks (Kenyon & Rice, 1959) and seals may remain on or near shore throughout this period. Prolonged increases in metabolic rate throughout the molting period have been observed in an immature monk seal held in captivity (Williams et al., 2011). During these periods of higher metabolic demand, monk seals may utilize terrestrial habitat for rest and to avoid predators or minimize thermoregulation costs. Generally, juveniles undergo their annual molt in the spring and summer; adult females molt 5-6 weeks post mating (T. C. Johanos et al., 1994; NMFS, 2007), and males generally start to molt in the fall (Johanos & Kam, 1986).

Terrestrial habitat is also essential for birthing (parturition) and nursing of pups. Unlike pinnipeds in cooler climates that tend to be reproductively synchronized with milder seasons,

[16] Hauling out is considered a requisite behavior that provides energetic benefits to phocids by allowing these mammals respite from the energetically demanding marine environment; Brasseur et al. (1996) demonstrated the necessity of hauling out behavior by showing that captive harbor seals compensate for the loss in haul out time when deprived of haul out areas.

Hawaiian monk seals have been documented giving birth in all months of the year. The most common months for parturition are between February and August (T. C. Johanos et al., 1994; NMFS, 2007). Preferred pupping and nursing habitat are usually sandy beaches adjacent to shallow protected water (Westlake & Gilmartin, 1990) (e.g., reef protected coves). Individual females appear to exhibit philopatry or site fidelity, returning to the same pupping locations year after year. Pregnant females come ashore a few days before giving birth on land to a pup weighing approximately 16 kg (35 lb.). Pups nurse for 5-6 weeks (Johanos et al., 1994) and weigh 50–100 kg (110–220 lb.) at weaning. During the nursing period, mother and pup remain in close proximity to each other, and the mother is protective of her pup. Although the pup is able to swim at birth, nursing occurs on land and the mother-pup pair usually remains on land for the first few days after the pup is born. The mother gradually begins swimming with her pup in the shallows, returning to the general area around the pupping site. As weaning approaches, the mother-pup pair spends more time in the water, venturing farther away from the pupping site. After weaning, pups typically remain alone on the beach and in the shallows near the pupping site for several weeks before venturing into deeper foraging areas (Henderson & Johanos, 1988; Kenyon & Rice, 1959). The PIFSC reports that weaned pups tracked at Nihoa Island in the first two months post-weaning remain relatively close to the island with 100 percent of dives occurring in waters less than 40 m in depth (NMFS, 2012). At 3 months post-weaning and older, Nihoa tracking data indicates dispersal (NMFS, 2012) and Stewart et al. (2006) report diving behavior in weaned pups as similar to adults at some of the six main breeding areas of the NWHI.

Hawaiian monk seals utilize aquatic habitats to support normal seal behaviors, including thermoregulating[17], resting, interacting, mating and foraging. In the warm tropical environment, marine waters provide a greater capacity for heat loss by conduction than air and marine habitat allows monk seals to efficiently release heat in warm tropical temperatures (i.e., marine habitat allows for efficient thermoregulation). Resting may occur at sea or in shallow, submerged caves. Observations of 24 adult male monk seals wearing Crittercams[18] (animal-borne video cameras) showed that a great deal of time spent underwater was spent resting (34 percent) or interacting with other seals (9 percent); these activities occurred as deep as 80 m (262 ft) (F. A. Parrish et al., 2000). Interactions between seals include a variety of behaviors that support natural seal development including socializing, playing, and behaviors associated with finding a mate. Little is known about Hawaiian monk seals' mating behavior in the marine environment.

Gains in foraging research provide new insight into how monk seals use the marine environment to forage. Initial understanding of monk seal foraging assumed monk seals fed on localized prey species in near shore coral reef structures and offshore banks surrounding the haul-out areas in the NWHI (NMFS, 1983). Although transit and deeper diving behavior was acknowledged in the 1983 recovery plan, little was known regarding monk seal foraging behavior at deeper depths, and the extent and frequency of foraging transits were not well understood. Information from satellite transmitter studies began to transform earlier concepts by demonstrating that seals

[17] Thermoregulation is the ability of an organism to keep its body temperature within certain boundaries, even when the surrounding temperature is very different.

[18] Crittercams are animal-borne cameras (i.e., cameras strapped to animals) developed by National Geographic to record animal behaviors in the wild. Video footage allows researchers to observe behaviors from the animal's point of view.

were transiting to neighboring[19] banks to feed (F. A. Parrish & Littnan, 2007). A better understanding of monk seal digestion[20] revealed that scat analysis might only represent prey from close reefs and not the seals' entire diet (Goodman-Lowe et al., 1999; Goodman-Lowe, 1998; Parrish & Littnan, 2007). Additionally, Crittercam footage revealed seals ignoring reef fish in the coral shallows in favor of foraging on deeper atoll slopes and neighboring banks, and depth recordings demonstrated foraging at depths greater than 500 m (1640 ft), i.e., greater than previously recognized (Parrish et al., 2000; Stewart et al., 2006). Combined, these data have reshaped the knowledge of how seals utilize their foraging habitat and where seals are feeding.

Today, Hawaiian monk seals are known as foraging generalists because they feed on a wide variety of prey species. Crittercam footage and dietary analysis reveals that seals forage along the bottom, primarily on benthic or bottom-associated prey species (Goodman-Lowe, 1998; Longenecker et al., 2006; Parrish, 2004). Goodman and Lowe (1998) identified inshore, benthic, and offshore teleost or bony fishes, as the most represented prey items in monk seal scat, followed by cephalopods and crustaceans; from the 940 scats sampled, the study identified 31 families of teleosts or bony fishes and 13 families of cephalopods. Increased resolution of regurgitation samples reveals prey such as morid cod, which are a bottom-associated species typically found at subphotic depths (depths greater than 95 m (312 ft) (Longenecker et al., 2006). Fatty acid analysis of monk seal dietary composition indicated that an even broader number of prey species may be utilized by Hawaiian monk seals (Iverson, 2006). Iverson et al. (2006) also demonstrated substantial variation in diet among individuals, demographic groups (between juveniles and adults/sub adults), and locations, indicating that individual monk seal foraging preferences and capabilities play a role in their selection of foraging habitat. The findings are consistent with seal foraging ecology studies evaluating seal movement in the marine environment discussed in more detail below.

Studies using recent advances in technology provide a new look into Hawaiian monk seal foraging habitat, demonstrating that Hawaiian monk seals may forage in marine habitats anywhere from depths of one meter out to depths exceeding 550 m (1804 ft) (Stewart et al., 2006). From 1996–2002 the movement and diving of 147 Hawaiian monk seals were monitored throughout the NWHI (Abernathy, 1999; Stewart et al., 2006). Stewart et al. (2006) found that for all six major breeding areas a majority of diving behavior occurred at depths less than 150 m (492 ft). Patterns varied between and among the subpopulations, and at five of the six main reproductive sites (Kure Atoll, Midway Islands, Lisianksi Island, Laysan Island and FFS) dive depth patterns displayed distinct peaks (modes) at deeper depth ranges where foraging efforts appeared to be focused. These modes occurred beyond the 20 fathom (36 m) depth range used to delineate the 1988 critical habitat designation (Stewart et al., 2006). Many of these modes occurred at less than 200 m (656 ft), although additional dive effort was also focused in even deeper areas. For example, at Midway and Laysan, a mode was displayed in the 200-400 m ((656 -1312 ft) range and at Kure Atoll a distinct mode was displayed at 500 m (1640 ft) (Stewart et al., 2006). While these data suggest some focus around particularly deeper depth

[19] From 1996 – 2002 the movement of 147 Hawaiian monk seals were monitored throughout the NWHI. Seals at all Islands and Atolls foraged at sites outside of the Island or Atoll where they were tagged; the distance from the colony ranged from 24.1 to 322 km (14.98-200 mi) (Stewart et al. 2006).

[20] Studies of captive seals demonstrated that prey may be digested within eight hours, indicating that onshore scat samples may only be representative of recent foraging.

ranges in some areas, the proportion of dives occurring at depths past 200 m (656 ft) are lower. Data from Kure Atoll, Laysan, and FFS demonstrate that less than 10 percent of all diving effort recorded in these areas occurred in depths greater than 200 m (Abernathy, 1999; Stewart & Yochem, 2004a, 2004b).

Crittercam observations from FFS revealed that seals displayed active foraging behavior at various depths. At deeper depths behaviors were more focused towards foraging, (i.e., seals spent more time actively searching along or near the bottom for prey at deeper depths) (Parrish et al., 2000). Parrish et al. (2000) observed most feeding between 60-100 m (197 – 328 ft). Parrish and Abernathy (2006) describe a majority of NWHI seal diving beyond the 40 m (131 ft) range as corresponding with slope habitats found between 50 and 300 m (164 – 984 ft). This coincides with the habitat used by prey species often identified in monk seals' diet (Parrish, 2004; Parrish & Abernathy, 2006). Studies describe these preferred foraging habitats as areas of habitat uniformity with low-relief substrates such as sand and talus[21] (Parrish et al., 2008; Parrish & Littnan, 2007). In these habitats adult seals are able to dig out cryptic prey hiding in the bottom substrate or flip over large, loose talus fragments to reach the prey hiding underneath (Parrish et al., 2000). Although these sites are often greater distances from haul-out sites, it appears that the less sheltered prey in the uniform habitat may make this area energetically preferable to the seals (Parrish et al., 2000).

Parrish et al. (2002) and Stewart et al. (2006) also revealed that monk seals forage in subphotic zones, or depths greater than 300 m (984 ft), sometimes visiting patches of deep corals (Parrish, 2004; Parrish et al., 2002). A summary of telemetry data from 37 male and female adults tagged throughout the NWHI revealed that 17 seals (46 percent of those sampled) appeared to be using subphotic foraging habitat (Parrish, 2004). Parrish (2004) extrapolated this percentage out to suggest that a fourth of the entire population does some foraging in the subphotic habitat. As noted earlier, the proportion of dives at these deeper depths appears to be relatively low. Nonetheless, the use of these deeper habitats may reflect some monk seals taking advantage of readily available prey in a habitat with decreased inter-specific competition (Parrish et al., 2008).

Foraging studies at FFS with instrumented juvenile monk seals (1 – 3 years old) illustrated foraging behavior similar to that of adult monk seals. Feeding occurred both within shallow atoll lagoons 10–30 m (33-98 ft) and on deep reef slopes 50–100 m (160–325 ft), usually over sand rather than talus (Parrish et al., 2005). Crittercam footage of juvenile seals foraging showed seals moving along the bottom, flushing prey with a variety of techniques, including probing the bottom with their nose, using their mouth to squirt streams of water at the substrate, and flipping small rocks with their heads and shoulders (Parrish et al., 2005). While juvenile seals are able to dive to depths similar to adults, the smaller seals likely do not yet have the size or experience to engage in the successful large talus-foraging behavior exhibited by adults (Parrish et al., 2005). Parrish (2004) noted that of the sand fields and coral reefs were used as primary foraging habitat for these young seals and that limited data also indicate that juvenile seals also forage at the deeper ranges used by adults (Parrish, 2004).

Geographic foraging patterns also vary among Hawaiian monk seals. Stewart (2006) described the geographic foraging patterns of NWHI seals as complex and varied among the six main

[21] Rock debris.

subpopulations by season and age and sex. For example, at some atolls and islands seals ranged hundreds of kilometers from the island or atoll to forage, while other foraging seals remained almost exclusively within their home atoll (Stewart et al., 2006)[22]. Some core foraging areas varied for individual seals over the tracking time period, while others did not (Stewart et al., 2006). Although studies were not conducted simultaneously across the NWHI subpopulations, monk seal foraging ranges and diving patterns likely remain dynamic, adjusting to variations in environmental conditions (Stewart et al., 2006).

Recent foraging ecology studies focused on the MHI provide new insight into the foraging preferences and behavior of Hawaiian monk seals and better explain the divergence in population trends between the NWHI and the MHI. The foraging behavior of 18 MHI seals was examined between 2004 and 2008 by Cahoon (2011), using two types of satellite-linked time-depth recorders. Monk seal foraging behavior was generally similar to the behavior of seals in the NWHI. For example, seals exhibited core areas over submerged banks, and most seals stayed close to their island of instrumentation with some seals traveling to nearby islands (Cahoon, 2011). However, comparison of data from the two regions is also consistent with Baker and Johanos (2004) suggesting that MHI habitat offers favorable foraging conditions to seals. On average, foraging trip duration was shorter and foraging distance was less for MHI seals compared to their NWHI counterparts (Cahoon, 2011). The healthy condition of seals in the MHI, coupled with this foraging behavior data comparison, indicates that MHI seals are able to acquire sufficient resources close to shore and are not limited by prey resources (Cahoon, 2011). Cahoon (2011) also indicated that MHI monk seals were predominantly diving to shallow depths in the MHI, but cautioned that behavior at these depths may not indicate foraging behavior, because seals may be participating in other behaviors unrelated to foraging, such as searching for rest areas or travelling, as noted by Parrish et al. (2000). Cell phone tags have been used to track seals in the MHI in order to provide better spatial and temporal resolution to seal foraging behavior. Data from these tags demonstrate MHI seals dive at depths up to 489 m (1,604 ft); although most dives are take place at depths less than 100 m (328 ft) (NMFS, 2012). NMFS' PIFSC reports 95.4 percent of all recorded dives in the MHI have occurred at 100 m (328 ft) or less and 97.7 percent of dives occur at 200 m (656 ft) or less (NMFS, 2012).

In general, the selection of foraging habitat by monk seals may be influenced by many factors, including environmental conditions that affect abundance and composition of prey assemblages, conditions that influence prey availability and capture success, such as intra-specific and inter-specific competition. Selection of foraging habitat is also influenced by individual differences among seals including, variation in size and age class, prey preferences, and favored foraging tactics. These variables all influence where, how and when Hawaiian monk seals utilize foraging habitat within the marine environment. The Hawaiian monk seal has survived millions of years as a marine mammal in a low producing tropical environment by foraging across a wide expanse of habitat and by feeding on a wide-variety of bottom-associated prey species. Although knowledge of monk seal foraging has increased tremendously in the last 20 years, there is no information to indicate that particular prey species are of higher relative importance or singular foraging areas are more significant to the recovery of this species. Variation in individual

[22] At Pearl and Hermes all but two seals foraged exclusively within the barrier reef or on the immediate seaward slopes.

foraging preferences and patterns, coupled with environmental variability, indicates that this species requires expansive areas of foraging habitat to support recovery.

In summary, habitat features or areas that support resting, reproduction, and foraging are essential for the conservation of this species. Hawaiian monk seal critical habitat must, therefore, include both terrestrial and marine habitat. Terrestrial areas provide haul-out sanctuary for resting, molting, pupping, nursing and avoiding predators. Terrestrial habitat consists of near shore or emergent surfaces where monk seals can haul out. Areas preferred for pupping consist of a subset of haul-out habitat and are usually on sandy beaches with adjacent shallow marine areas. These areas provide protection for pups while they become accustomed to unaccompanied life in the marine environment and learn to forage successfully on their own. The marine habitat includes areas used for thermoregulating, resting, interacting, mating and foraging.

PHYSICAL OR BIOLOGICAL FEATURES ESSENTIAL FOR CONSERVATION

As noted earlier in this report, Section 3(5)(A) of the ESA (16 U.S.C. 1532 (5)(A)) describes the defining factors for identifying both occupied and unoccupied critical habitat. Areas meeting the statutory definition within the occupied range of the listed species must contain physical or biological features essential to the conservation of the species. The ESA does not specifically define physical or biological features; however, consistent with recent designations, the Services have proposed defining the physical or biological features as those habitat features that support the life-history needs of the listed species. This may include for example, specific prey species, water characteristics, temperatures, or sites that support reproduction, rearing of offspring or shelter (See also 79 FR 27066; May 12, 2014). Accordingly, the description of physical and biological features varies from one listed species to another and may be described simply by a single element or by a complex combination of characteristics depending on the ecological needs of the species.

For the purposes of this report the physical and biological features essential to the conservation of Hawaiian monk seals are referred to as the essential features.

Members of the CHRT were tasked with determining the essential features for Hawaiian monk seal critical habitat using the best scientific and commercial information available. The CHRT recognized that essential features for the Hawaiian monk seal must include features that support resting, reproduction, and foraging in both terrestrial and marine areas. The CHRT also recognized that revisions to the essential features should incorporate the best available information that has been gained since the 1988 designation with regards to Hawaiian monk seal habitat use. For the 2011 proposed designation (76 FR 32026; June 2, 2011), six essential features[23] were described to support important areas: 1) pupping and nursing areas, 2) terrestrial

[23] The proposed essential features included: 1) Areas with characteristics preferred by monk seals for pupping and nursing, 2) Shallow, sheltered aquatic areas adjacent to coastal locations preferred by monk seals for pupping and nursing, 3) Marine areas from 0 to 500 m in depth preferred by juvenile and adult monk seals for foraging, 4) Areas

haul-out areas, and 3) marine foraging areas. However, upon review of comments received form the 2011 proposal, the team identified problems with the six separate descriptions of three habitat areas of importance. Specifically, comments received voiced criticism about the features' ecological significance to Hawaiian monk seal conservation and how overlapping features related to one another. To provide greater clarity for the designation and in response to public comments, the CHRT made adjustments to the originally proposed essential features[24] to better describe the three types of areas that serve an essential service or function to Hawaiian monk seal conservation. The CHRT then used the best scientific information available to refine the description of these areas to better describe those characteristics, consistent with ESA requirements that make these features (or areas) essential to the conservation of the species, as follows:

(1) ***Terrestrial areas and the adjacent shallow sheltered aquatic areas with characteristics preferred by monk seals for pupping and nursing***.

Hawaiian monk seals have been observed to give birth and nurse in a variety of terrestrial coastal habitats. However, certain beaches may be preferred for pupping at the various atolls and islands within the range. Preferred pupping areas generally include sandy, protected beaches located adjacent to shallow sheltered aquatic areas, where the mother and pup may nurse, rest, swim, thermoregulate, and shelter from extreme weather. Additionally, this habitat area provides relatively protected space for the newly weaned pup to acclimate to life on its own. The newly weaned pup utilizes these areas for swimming, exploring, socializing, thermoregulatory cooling and the first attempts at foraging. Terrestrial pupping habitat may include various substrates accessible to seals for hauling out, such as sand, shallow tide-pools, coral rubble, or rocky substrates. Some preferred sites may also include areas with low lying vegetation utilized by the pair for shade or cover, or relatively low levels of anthropogenic disturbance. The adjoining sheltered aquatic sites may include reefs, tide pools, gently sloping beaches, and shelves or coves that provide refuge from storm surges and predators. Certain coastal areas with these characteristics may attract multiple mothers to the same area year after year for birthing. Due to the solitary nature of the species, some mothers may prefer to return to a lesser-used location year after year. Preferred areas that serve an essential service or function for Hawaiian monk seal conservation by supporting reproduction and population growth are defined as those areas where two or more females have given birth or where a single female chooses to return to the same site more than one year.

(2) ***Marine areas from 0-200 m (0-656 ft) in depth that support adequate prey quality and quantity for juvenile and adult monk seal foraging.***

Hawaiian monk seals are considered foraging generalists that feed on a wide variety of bottom-associated prey species and utilize a wide range of benthic foraging habitat to maximize foraging efficiency in a tropical ecosystem,

with low levels of anthropogenic disturbance, 5) Marine areas with adequate prey quantity and quality, and 6) Significant areas used by monk seals for hauling-out, resting or molting.

[24] The *Critical Habitat Review Team* section of this report provides more detail regarding comments received from the June 2011 proposed rule and revisions that have been made to this report.

characterized by low and variable productivity. Inshore, benthic and offshore teleosts or bony fishes, cephalopods, and crustaceans commonly occur in monk seal scat, with 31 families of bony fishes and 13 families of cephalopods currently identified (Goodman-Lowe, 1998). Relative importance of particular prey species is uncertain. This may vary between individuals and/or according to environmental conditions which influence productivity. Knowledge of foraging habits of seals helps identify areas and habitat types that are regularly utilized for foraging, including sand terraces, talus slopes, submerged reefs and banks, nearby seamounts, barrier reefs, and slopes of reefs (Parrish et al., 2002; Parrish et al., 2000). Preferred foraging techniques vary among individuals, however monk seals feed on bottom-associated prey species and foraging techniques concentrate on flushing prey from hiding spots close to the bottom or pinning desired prey to the bottom. Habitat types of importance to monk seals are spread across a wide expanse, however, the use of these areas is limited in vertical height from the bottom (i.e., monk seals forage in a limited portion of the water column above the substrate). Although monk seals may forage at deeper depths, most diving behavior occurs at depths of less than 200 m (656 ft) in the NWHI and in the MHI (Abernathy, 1999; Stewart & Yochem 2004a, 2004b; Stewart et al., 2006; NMFS, 2012). Within these habitats, conditions such as water quality, substrate composition and available habitat affect the growth and recruitment of bottom-associated prey species to the extent that monk seal populations are able to successfully forage. The Hawaiian monk seal has adapted to a tropical system defined by low productivity and environmental variability by feeding on wide variety of bottom-associated prey species across a wide range of depths. Foraging areas essential to this species, therefore, incorporate a wide range of benthic habitats, which includes the seafloor to 10 m in depth, from 0-200 m in depth.

(3) ***Significant areas used by monk seals for hauling out, resting, or molting.***

Hawaiian monk seals utilize terrestrial habitat to haul out for resting and molting. Although many areas may be accessible for hauling out and are occasionally used, observed haul-out patterns demonstrate that certain areas of coastline are more often favored by Hawaiian monk seals for these activities. These favored areas may be located in close proximity to preferred foraging areas, allow for relatively undisturbed periods of rest, or allow small numbers of Hawaiian monk seals to socially interact as young seals and/or reproductive adults. These haul-out sites are generally characterized by sandy beaches, sand spits, low rocky shelves and reef, or rocky areas accessible to seals. Significant and favored haul-out areas should accommodate the ecology of this species, as a solitary and wide-ranging pinniped and should reflect the frequency with which local populations of seals use a particular atoll, island, stretch of coastline, or particular beach. Thus, significant haul-out areas are defined as natural coastlines that are accessible to Hawaiian monk seals and are frequented by Hawaiian monk seals at least 10 percent as often as the highest used haul-out site(s) on individual islands, or islets. Significant haul-out areas are essential to Hawaiian monk seal conservation, because these areas provide space that supports natural behaviors important to health and development, such as resting, molting, and social interactions.

GEOGRAPHICAL AREA OCCUPIED BY THE SPECIES AND SPECIFIC AREAS WITHIN THE GEOGRAPHICAL OCCUPIED AREA

One of the first steps in identifying critical habitat is determining the geographical area occupied by the species. As discussed previously and in the 12-month finding, Hawaiian monk seals are found throughout the Hawaiian Archipelago and on Johnston Atoll. This geographic range may be considered occupied throughout the NWHI and MHI based on systematic surveys and sighting information from these areas. Having discussed the range of the species in the 12-month finding (74 FR 27988; June 12, 2009), the next step NMFS identified was to determine "specific areas" within the occupied geographical area that possess features essential for the conservation of the species.

For an area to meet the criteria of critical habitat, it must have one or more of the essential features which may require special management or protection. The CHRT identified areas that met the criteria of critical habitat within the range of the species, including areas in the NWHI and the MHI. The CHRT discussed the possibility of incorporating areas of Johnston Atoll, and determined that this area lacked the essential features of monk seal critical habitat. Specifically, the area lacked preferred pupping and nursing areas and significant haul-out areas, since there has been no seal use of the Atoll in recent years (the last sighting in the area was a single seal in 2004 (NMFS, 2010m)).

As previously described, Hawaiian monk seals depend on both terrestrial and marine habitat, therefore, the CHRT delineated the specific areas of critical habitat to incorporate both habitat types. Each area was selected to reflect current seal use as well as habitat needed to support a recovered population. Although specific areas are identified across the range, areas have been grouped according to the NWHI and MHI management units to express similarities in population status, presence of essential features, and the activities that may affect the essential features such that special management and considerations or protections are needed. Figures depicting the specific areas may be found in Appendix I to this report.

Appendix A. Essential Features and Size of Areas

Table 8-15 provides more detail regarding the presence of essential features within specific areas. Figure 6 also depicts the location of preferred pupping areas within the MHI.

Northwestern Hawaiian Islands (NWHI)

The majority of the Hawaiian monk seal population currently concentrates in the NWHI. The six main reproductive sites within the NWHI include Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, and FFS. Smaller reproductive sites are located at Necker and Nihoa Islands. Seals have also been sighted regularly at Maro Reef and Gardner Pinnacles.

The 1988 critical habitat designation for the Hawaiian monk seal includes all beach areas, sand spits and islets, including all beach crest vegetation to its deepest extent inland, lagoon waters, inner reef waters, and ocean waters out to a depth of 20 fathoms (36.6 m) around Kure Atoll, Midway Islands (except Sand Island due to modifications to the habitat by the Navy), Pearl & Hermes Reef, Lisianski Island, Laysan Island, Maro Reef, Gardner Pinnacles, FFS, Necker Island, and Nihoa Island in the NWHI (53 FR 18988; May 26, 1988). The CHRT recognized that the 1988 designated areas continue to contain all of the identified revised essential features that fit the current proposed criteria for Hawaiian monk seal critical habitat. The team also identified that Sand Island at Midway Islands supports preferred pupping and nursing (since the mid-1990s), as well as significant haul-out habitat, and should be included in the designation. Over twenty years of data indicate that Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, FFS, Necker Island, and Nihoa Island provide preferred pupping and nursing areas. The data also indicate that these areas support significant haul-out areas preferred by all age classes of Hawaiian monk seals for resting, interacting, and molting. The marine waters that surround the aforementioned islands and atolls provide foraging habitat and prey for foraging. The marine waters that incorporate and surround Maro Reef and Gardner Pinnacles are utilized by Hawaiian monk seals for foraging and, as such, these areas continue to fit the criteria of Hawaiian monk seal critical habitat.

After considering public comments, the CHRT recommended revising the boundaries that delineate Hawaiian monk seal foraging areas to focus protections on the bottom-associated habitat that supports monk seal foraging out to depths that will support the survival and recovery of this wide-ranging predator (see the *Habitat* and the PHYSICAL OR BIOLOGICAL FEATURES ESSENTIAL FOR CONSERVATION sections). This includes incorporating the seafloor and marine habitat 10 m from the bottom out to a depth of 200 meters (656 ft) surrounding each area identified in the 1988 designation. The islands of the NWHI are unlikely to support new or larger development, however the low-lying areas experience movement throughout the year due to storm activity and are anticipated to be easily affected by future storm activities and/or future variations in sea level (Baker et al., 2006). The CHRT recommended continuing to include all beach areas, sand spits and islets, including all beach crest vegetation to its deepest extent inland in the specific areas of the NWHI, because these areas provide characteristics (e.g., sandy sheltered beaches, low-lying vegetation, and accessible shoreline) that support terrestrial essential features for preferred pupping and significant haul-out areas. Some areas of coastline in the NWHI lack the essential features of monk seal critical habitat, because

these areas are inaccessible to seals for hauling out, or lack the natural areas necessary to support monk seal conservation (e.g., cliffs on Nihoa and Necker, buildings on Tern Island, Sand Island, and Green Island). Accordingly, cliffs, manmade structures (and the land on which they are located), and hardened shorelines in existence prior to the effective date of the rule, do not meet the definition of critical habitat and are not included in the designation. This includes the entirety of Midway Harbor and hardened shorelines along Sand Island.

Specific areas identified by number in the NWHI for consideration as critical habitat include all beach areas, sand spits and islets, including all beach crest vegetation to its deepest extent inland, and including marine habitat through the water's edge, including the seafloor and all subsurface waters and marine habitat within 10 meters (m) of the seafloor, out to the 200-m (656.4 ft) depth contour line (relative to mean lower low water), but not including cliffs, manmade structures and hardened shorelines in existence prior to the effective date of the final rule:

Area 1. Kure Atoll
Area 2. Midway Islands (not including Midway harbor)
Area 3. Pearl and Hermes Reef
Area 4. Lisianski Island
Area 5. Laysan Island
Area 6. Maro Reef
Area 7. Gardner Pinnacles
Area 8. French Frigate Shoals
Area 9. Necker Island
Area 10. Nihoa Island

Main Hawaiian Islands (MHI)

The minimum abundance estimate for the MHI in 2011 was 146 seals (Carretta et al., 2013). Seal distribution decreases from the northwest to the southeast along the MHI island chain (Baker & Johanos, 2004) and resident seal numbers on the southeastern islands remain low. Seals in the MHI utilize available coastal and marine habitat throughout the chain including using terrestrial habitats on all major islands and many offshore islands and islets with accessible haul-out area. Sighting and tracking data indicate that seals may use habitat on multiple islands. Based on increasing numbers of identified individuals, seal numbers in the MHI appear to be steadily growing from initial low levels.

The 1988 monk seal critical habitat designation did not incorporate the MHI. At that time a limited number of seal sightings were recorded annually from the MHI and research and recovery efforts were concentrated on the larger numbers of seals in the NWHI. As noted earlier, since that time seal numbers have begun to increase in the MHI, an encouraging sign for the conservation of this endangered population. The CHRT recognized that habitat throughout the MHI contains the identified essential features that fit the criteria for Hawaiian monk seal critical habitat. With the overall monk seal population numbers remaining low, the CHRT agreed that these essential features require protection from certain activities to support the survival and recovery of the species as a whole. In 2011, NMFS announced a proposed revision

to Hawaiian monk seal critical habitat (76 FR 32026; June 2, 2011). This proposal was inclusive of much of the shorelines in the MHI and marine waters out to depths of 500 m. The proposal generated strong public criticism and comments focused on the sufficiency of the analysis and the accuracy of the description of the essential features. Due to this substantial disagreement, NMFS announced a 6-month extension to the final rule and committed to further analyze the available data and consider concerns raised by State, Federal, and other entities, to better inform the determinations for the final revision of Hawaiian monk seal critical habitat (77 FR 37867; June 25, 2012).

After considering public comments critical of the proposed rule's approach in identifying the actual location of essential features, and role of those features in seal ecology (i.e., whether they are essential to conservation of the species), the CHRT reevaluated the best available data to delineate the specific areas in the MHI, where the essential features may actually be found. This includes 1) voluntary sighting information, data collected by NMFS scientists, and monk seal tracking data (from 2007-2012) to identify significant haul-out areas; 2) MHI birth records from the PIFSC database to identify preferred pupping and nursing areas; and 3) reviewing dive information collected from monk seals to identify essential foraging areas.

In 2011, NMFS proposed critical habitat (76 FR 32026; June 2, 2011) to include all natural shorelines along the MHI accessible to Hawaiian monk seals, so that all significant haul-out, and pupping areas would be included in the proposed designation. Comments pertaining to terrestrial essential features suggested that the 2011 proposed designation was too broad, and that all areas of MHI coastline could not possess the features "essential" to Hawaiian monk seal conservation. Some comments suggested that there was insufficient analysis to support the identification of all areas of coastline, as monk seal habitat use indicates that not all coastlines in the MHI can be accessed by seals and should not be considered essential. Other comments suggested that the analysis was insufficient because the designation does not match known habitat use patterns of Hawaiian monk seals in various areas of the MHI. In reviewing these comments and considering the available data, the CHRT agreed that the 2011 proposal was too broad for stakeholders to be able to distinguish those features that are essential to Hawaiian monk seal conservation from other areas of coastline that connect significant areas. The CHRT also agreed that available data suggests that significant haul-out areas may be described with more precision. As acknowledged in the *Habitat* section of this report and the proposed rule, Hawaiian monk seals reliably return to stretches of coastline that appear to be favored for resting, molting, and socializing and multiple individuals are likely to use the same stretches of coastline around a particular island. To be responsive to comments requesting more precision in identifying the essential features, the CHRT used the available tracking data (from 2007-2012) coupled with past voluntary sighting information, and data collected by NMFS scientists (including aerial surveys) to identify more specifically where significant haul-out areas exist within the MHI.

The CHRT previously expressed concerns about relying on voluntary sighting information (which makes up a majority of the sighting data) as a proxy to identify significant haul-out areas because this data set may not reveal areas that are significant to monk seals and are seldom used by people (NMFS, 2011). However, since the delineation of the 2011 proposed designation the number of seals tracked in the MHI doubled and this provided a larger set of data that is unbiased by human reporting. Generally, MHI haul-out information suggests that patterns exist in

terrestrial habitat use and that some areas are frequently used by Hawaiian monk seals while others are infrequently used as acknowledged by some public comments. The CHRT acknowledged that the islands of Kauai, Oahu, and Molokai (where recent cell phone tags were deployed on MHI monk seals) have well established monk seal populations and well-established haul-out patterns. Information from voluntary sightings is considered consistent on these islands, since voluntary reports are likely to be received if monk seals haul out on locally used beaches. To address the prior concerns about the sufficiency of the voluntary sighting data (described above) the CHRT compared impartial data collected from tracking seals in the MHI (from 2007-2011) and aerial surveys, against sighting information received through voluntary reporting. Comparisons of monk seal tracking data with voluntary monk seal sighting information in these areas demonstrates that the voluntary sighting data reliably captures areas frequented by monk seals (i.e., gaps in the data are not apparent). Additionally, seals that visited islands farther east of the areas of original tag deployment captured more information about habitat use on other islands by providing additional data for areas with lower numbers of seals and lower numbers of voluntary sighting reports.

The CHRT agreed that significant haul-out areas differ among islands. For example, seals may utilize relatively discrete locations in some areas, while in other areas seals may utilize long stretches of habitat based on the environmental characteristics that are present throughout the specific area. To account for this variation, significant haul-out areas were described relative to seal habitat use on each particular island. Significant areas were defined as stretches of coastline where seal-sighting information is recorded at least 10 percent as often as the highest used site on that Island. This definition responds to public comments that suggested that all areas of MHI coastline could not equally support Hawaiian monk seal conservation and allows us to more precisely identify those areas that are recognized to be frequented by seals and important to resident animals in each specific area. Further, similar to the proposed rule, this delineation still reflects the ecology of this wide-ranging and relatively solitary species, and conservatively incorporates areas that are necessary to support Hawaiian monk seal conservation in areas where seal numbers remain low.

As described above, public comments were critical of the proposed rule's approach in identifying the actual location and significance of terrestrial essential features, including preferred pupping and nursing sites. The proposed rule (76 FR 32026; June 2, 2011) stated that preferred pupping areas that are essential to Hawaiian monk seal conservation include those pupping areas that support multiple females year after year as well as those areas that support females that prefer a more solitary location, but which may be used throughout her reproductive life-time to birth and rear pups. In response to public comments requesting a more accurate location for these areas in the MHI, the CHRT refined the definition of "preferred" to match the description from the proposed rule (see CRITICAL HABITAT REVIEW TEAM PROCESS for more details) and reviewed NMFS data on Hawaiian monk seal births in the MHI to identify where the essential features are located within the specific areas. Monk seal births have been recorded on Niihau, Kauai, Oahu, Molokai, Maui, Kahoolawe, and Hawaii; however, no preferred pupping locations have been identified for Maui. Areas of proposed terrestrial critical habitat within the MHI were then delineated by including all significant haul-out areas and preferred pupping and nursing sites within the designation. The end points for the stretches of coastline were identified by using the haul-out data, pupping and nursing data, natural geographic features, and/or hardened

shorelines (which lack the features of monk seal critical habitat). Along some of these stretches of identified coastline, inaccessible areas and hardened shorelines or structures are not considered part of the specific area because they do not have the essential features for conservation, and thus, do not meet the definition of critical habitat. Along stretches of coastline possessing the essential features (see orange coastal areas in Figure 17 - 22), smaller hardened areas or structures lacking the essential features may occur, but these existing hardened area or structures are not considered to be part of the areas under consideration for critical habitat.

Although the frequency of use of deeper foraging areas currently differs from the NWHI, seal foraging behavior in the MHI is similar to their NWHI counterparts in that seals' core areas focused over submerged banks and most seals focus efforts close to their resident islands (Cahoon, 2011). Baker and Johanos (2004) suggest that monk seals in the MHI area are experiencing favorable foraging conditions due to decreased competition in these areas. For this revision, the CHRT recommended that the proposed boundary under consideration for critical habitat in the MHI include deeper areas like those areas of importance in the NWHI population, because these deeper areas support features essential to Hawaiian monk seals and are anticipated to become increasingly important as the numbers of monk seals in the MHI grows and as the population increases across the eastern portion of the range.

Specific areas to be considered for proposed designation in the MHI include marine habitat from the 200-m (656.4 ft) depth contour line (relative to mean lower low water), including the seafloor and all subsurface waters and marine habitat within 10 m of the seafloor, through the water's edge into the terrestrial environment where the inland boundary extends 5 m (16 ft)(in length) from the shoreline between identified boundary points (listed in the tables below) around Kaula, Niihau, Kauai, Oahu, Maui Nui (including Molokai, Lanai, Kahoolawe, and Maui), and Hawaii. The specific areas incorporate the seafloor and include marine habitat to 10 m (32.8 ft) above the ocean bottom from the 200 m (656.4 ft) depth contour (relative to mean lower low water), to the shoreline and including terrestrial areas extending 5 m (16 ft) inland from the shoreline between the identified boundary points. In areas where critical habitat does not extend inland, the designation ends at a line that marks mean lower low water. The shoreline is defined by the upper reaches of the wash of the waves, other than storm or seismic waves, at high tide during the season in which the highest wash of the waves occurs, usually evidenced by the edge of vegetation growth or the upper limit of debris. Bounded areas of terrestrial habitat described under each specific area are identified by island in the tables below. Similar to the NWHI, cliffs, manmade structures (and the land on which they were located), and hardened shorelines in existence prior to the effective date of the rule, do not have the essential features necessary for conservation and are therefore, not considered critical habitat.

Area 11. Kaula Island
Area 12. Niihau
Area 13. Kauai
Area 14. Oahu
Area 15. Maui Nui
Area 16. Hawaii

Table 3. Specific area 12, Niihau coastal habitat points.

Area 12. Niihau Coastal Habitat Points						
Textual Description of Segment	**Boundary Point 1**	**Latitude**	**Longitude**	**Boundary Point 2**	**Latitude**	**Longitude**
Poleho Beach through Puuwai area	NI11	21°57'15"N	160°04'37"W	NI12	21°54'10"N	160°12'25"W
Kiekie area	NI21	21°53'55"N	160°12'38"W	NI22	21°53'23"N	160°13'31"W
Nonpapa through Makahauena	NI31	21°52'05"N	160°13'59"W	NI32	21°50'53"N	160°14'36"W
Kamalino Bay area	NI41	21°50'27"N	160°14'43"W	NI42	21°50'13"N	160°14'37"W
Kahaino area	NI51	21°48'50"N	160°14'38"W	NI52	21°48'48"N	160°14'34"W
Keanahaki Beach through Poooneeone Beach	NI61	21°47'15"N	160°12'12"W	NI62	21°52'03"N	160°09'22"W
Lehua	NIi1	22°01'10"N	160°05'50"W			

Table 4. Specific area 13, Kauai coastal habitat points.

Area 13. Kauai Coastal Habitat Points						
Textual Description of Segment	**Boundary Points**	**Latitude**	**Longitude**	**Boundary Points**	**Latitude**	**Longitude**
Southeast coast of Kauai (Nomilu Fishpond area through Mahaulepu)	KA 11	21°53'08"N	159°31'48"W	KA 12	21°53'34"N	159°24'25"W
Kawelikoa Point to Molehu	KA21	21°54'26"N	159°23'26"W	KA22	21°54'48"N	159°23'08"W
Lydgate Park through Wailua canal	KA 31	22°02'11"N	159°20'08"W	KA 32	22°02'41"N	159°20'11"W
Wailua canal through Waikaea canal	KA 41	22°02'45"N	159°20'10"W	KA 42	22°04'14"N	159°18'60"W
Waikaea canal through Kealia	KA 51	22°04'15"N	159°19'01"W	KA 52	22°05'59"N	159°18'08"W
Kuaehu Point through Opana point	KA 61	22°07'46"N	159°17'35"W	KA 62	22°09'28"N	159°18'18"W
Moloaa Bay through Kepuhi Point	KA 71	22°11'38"N	159°19'46"W	KA 72	22°12'52"N	159°21'14"W
Southeast of Kilauea	KA 81	22°13'48"N	159°23'52"W	KA 82	22°13'55"N	159°24'06"W
Wainiha Beach Park through Kee Beach Park	KA 91	22°12'60"N	159°32'30"W	KA 92	22°13'13"N	159°35'01"W
Milolii State Park Beach Area	KA101	22°09'13"N	159°42'52"W	KA102	22°08'59"N	159°43'21"W

Table 5. Specific area 14, Oahu coastal habitat points.

Area 14. Oahu Coastal Habitat Points						
Textual Description of Segment	**Boundary Points**	**Latitude**	**Longitude**	**Boundary Points**	**Latitude**	**Longitude**
Keana Point Area	OA 11	21°34'43"N	158°15'37"W	OA 12	21°32'45"N	158°14'25"W
Maili Beach through Kalaeloa Barbers Point Harbor	OA 21	21°25'43"N	158°10'48"W	OA 22	21°19'24"N	158°07'20"W
Kalaeloa Barbers Point Harbor through Iroquois Point	OA 31	21°19'18"N	158°07'17"W	OA 32	21°19'20"N	157°58'17"W
Diamond Head area	OA 41	21° 15' 27"N	157°49'05"W	OA 42	21°15'24"N	157°47'45"W
Hanauma Bay through Sandy Beach	OA 51	21°16'05"N	157°41'50"W	OA 52	21°17'45"N	157°39'27"W
Makapuu Beach Area	OA 61	21°18'36"N	157°39'31"W	OA 62	21°18'58"N	157°39'55"W
Lori Point through Waimea Bay	OA 71	21°40'26"N	157°56'00"W	OA 72	21° 38' 18"N	158°03'56"W
Kapapa Island (Kaneohe Bay)	OAi1	21°28'36"N	157°47'55"W			
Mokulua - Moku Nui	OAi2	21°23'30"N	157°41'56"W			
Mokulua - Moku Iki	OAi3	21°23'16"N	157°41'52"W			
Manana (Rabbit Island)	OAi4	21°19'44"N	157°39'24"W			

Table 6. Specific area 15, Maui Nui, coastal habitat points.

Area 15. Maui Nui - Molokai Coastal Habitat Points						
Textual Description of Segment	**Boundary Points**	**Latitude**	**Longitude**	**Boundary Points**	**Latitude**	**Longitude**
Laau Point Area	MO 11	21°07'49"N	157°17'47"W	MO 12	21°05'21"N	157°15'50"W
Kalaupapa Area	MO 21	21°12'33"N	156°58'52"W	MO 22	21°11'28"N	156°59'06"W
Moku Hooniki	MOi1	21°07'59"N	156°42'10"W			
Area 15. Maui Nui - Lanai Coastal Habitat Points						
Shipwreck Beach Area	LA 11	20°54'45"N	156°53'45"W	LA 12	20°55'20"N	156°56'45"W
Northwest Lanai (Including Polihua Beach)	LA 21	20°55'42"N	156°59'47"W	LA 22	20°52'02"N	157°02'33"W
North of Kamalapau Harbor	LA 31	20°48'38"N	156°59'15"W	LA 32	20°47'17"N	156°59'24"W
Kamalapau Harbor through Kaholo Pali	LA 41	20°47'13"N	156°59'27"W	LA 42	20°46'59"N	156°59'31"W
Kaholo Pali through Manele Harbor	LA 51	20°44'13"N	156°58'01"W	LA 52	20°44'29"N	156°53'15"W
Manele Harbor through Nakalahale Cliff	LA 61	20°44'35"N	156°53'14"W	LA 62	20°44'49"N	156°52'16"W
Nakalahale Cliff through Lopa Beach	LA 71	20°45'07"N	156°51'50"W	LA 72	20°48'21"N	156°48'24"W
Puupehe	LAi1	20°44'04"N	156°53'25"W			
Area 15. Maui Nui - Kahoolawe Coastal Habitat Points						
Mid-North coast (including Kaukamoku and Ahupuiki)	KH 11	20°34'36"N	156°37'36"W	KH 12	20°34'10"N	156°38'15"W
Eastern coast of Kahoolawe (Honokoa through Sailer's Hat)	KH 21	20°33'08"N	156°40'35"W	KH 22	20°30'04"N	156°40'23"W
Area 15. Maui Nui - Maui Coastal Habitat Points						
Pepeiaolepo Bay through Hana Wharf and Ramp	MA 11	20°40'02"N	156°02'27"W	MA 12	20°45'21"N	155°58'54"W
Hana Wharf and Ramp through Kainalimu Bay	MA 21	20°45'20"N	155°58'56"W	MA 22	20°46'08"N	155°59'04"W
West coast of the Keanae Pennisula	MA 31	20°51'56"N	156°08'46"W	MA 32	20°51'41"N	156°08'55"W
West of Maliko Bay to east of Papaula Point	MA 41	20°56'11"N	156°21'11"W	MA 42	20°54'30"N	156°25'06"W
Kahului Harbor West through Waihee Beach Park	MA 51	20°53'53"N	156°28'47"W	MA 52	20°56'04"N	156°30'15"W
Punalau Beach through to Mala Wharf	MA 61	21°01'20"N	156°37'28"W	MA 62	20°53'09"N	156°41'10"W
Southeast of Mala Wharf through to Lahaina Harbor	MA 71	20°53'04"N	156°41'12"W	MA 72	20°52'26"N	156°40'43"W
Southeast of Lahaina Harbor through to Papalaua	MA 81	20°52'12"N	156°40'39"W	MA 82	20°47'34"N	156°34' 00"W
East of Maalaea Harbor through to Kihei boat ramp	MA 91	20°47'32"N	156°30'34"W	MA 92	20°42'29"N	156°26'46"W
South of Kihei Boat Ramp through Ahihi Bay	MA 101	20°42'27"N	156°26'47"W	MA 102	20°37'39"N	156°26'40"W
La Perouse Bay from Kalaeloa Point through Kanaio Beach	MA 111	20°35'43"N	156°25'33"W	MA 112	20°34'45"N	156°23'29"W
Molokini Crater	MAi1	20°37'51"N	156°29'43"W			

Table 7. Specific area 16, Hawaii, coastal habitat points.

Area 16. Hawaii Coastal Habitat Points						
Textual Description of Segment	**Boundary Points**	**Latitude**	**Longitude**	**Boundary Points**	**Latitude**	**Longitude**
Waimanu through Laupahoehoenui	HA 11	20°08'35"N	155°37'59"W	HA 12	20°09'54"N	155°39'18"W
Keokea Bay through Kauhola Point	HA 21	20°13'39"N	155°44'49"W	HA 22	20°14'44"N	155°46'18"W
Kapaa Beach County Park to Mahukona Harbor	HA 31	20°12'16"N	155°54'06"W	HA 32	20°11'04"N	155°54'05"W
South of Mahukona Harbor	HA 41	20°10'60"N	155°54'03"W	HA 42	20°10'51"N	155°54'07"W
Pauoa Bay to Makaiwa Bay area	HA 51	19°57'03"N	155°51'49"W	HA 52	19°56'38"N	155°52'10"W
Anaehoomalu Bay area through Keawaiki Bay area	HA 61	19°54'42"N	155°53'26"W	HA 62	19°53'09"N	155°54'34"W
Puu Alii Bay Area through Mahaiula Bay	HA 71	19°47'37"N	156°01'33"W	HA 72	19°46'53"N	156°02'18"W
Keahole Point through Kaloko-Honokohau National Historic Park	HA 81	19°43'54"N	156°03'26"W	HA 82	19°40'28"N	156°01'34"W
South of Oneo Bay area through to Holualoa Bay area	HA 91	19°38'10"N	155°59'29"W	HA 92	19°36'31"N	155°58'41"W
Kahaluu Bay Area through Keauhou Bay Area	HA 101	19°34'49"N	155°57'59"W	HA 102	19°33'43"N	155°57'43"W
Kealakekua Bay Area	HA 111	19°28'38"N	155°55'13"W	HA 112	19°28'25"N	155°55'10"W
Honaunau Bay Area	HA 121	19°25'35"N	155°55'02"W	HA 122	19°25'01"N	155°54'42"W
Milolii Bay Area through Honomalino Bay Area	HA 131	19°11'07"N	155°54'29"W	HA 132	19°10'04"N	155°54'35"W
Ka Lae National Historic Landmark District through Mahana Bay	HA 141	18°54'54"N	155°40'59"W	HA 142	18°55'00"N	155°40'09"W
Papakolea Green Sand Beach Area	HA 151	18°56'10"N	155°38'47"W	HA 152	18°56'11"N	155°38'45"W
Kaalualu Bay Area	HA 161	18°58'14"N	155°37'01"W	HA 162	18°58'18"N	155°36'49"W
Whittington Beach Area through Punaluu Beach Area	HA 171	19°05'04"N	155°33'03"W	HA 172	19°08'06"N	155°30'09"W
Halape Area through Keauhou Point Area	HA 181	19°16'14"N	155°15'20"W	HA 182	19°15'45"N	155°13'59"W
Kapoho Bay Area	HA 191	19°29'38"N	154°49'01"W	HA 192	19°30'10"N	154°48'46"W
Lehia Beach Park through to Hilo Harbor	HA 201	19°44'07"N	155°00'38"W	HA 202	19°43'56"N	155°03'02"W
Papaikou Area	HA 211	19°46'39"N	155°05'18"W	HA 212	19°46'43"N	155°05'18"W
Onomea Bay Area	HA 221	19°48'33"N	155°05'34"W	HA 222	19°48'37"N	155°05'22"W
Hakalau Area	HA 231	19°54'02"N	155°07'32"W	HA 232	19°54'05"N	155°07'43"W

UNOCCUPIED AREAS

Section 3(5)(A)(ii) of the ESA authorizes the designation of "specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of Section 4 of this Act, upon a determination by the Secretary that such areas are essential for the conservation of the species." Further guidance in 50 CFR 424.12(e) stipulates that areas outside the geographical area occupied may be designated "only when a designation

limited to its present range would be inadequate to ensure conservation of the species." No unoccupied areas outside the geographical range of the species were identified.

ESA PROTECTIONS

Once listed, the ESA protects endangered species in several ways. Protective measures include restrictions on "take[25]," transport, or sale of a species (under Section 9 of the ESA); the development and implementation of recovery plans by the USFWS and/or NMFS (under section 4 with the help of stakeholders); and protective measures taken by Federal agencies (through consultations under section 7 of the ESA) to prevent adverse effects when authorizing, funding, or carrying out activities. Hawaiian monk seals have been listed under the ESA since 1976 (41 FR 51611; November 23, 1976) and recovery efforts include all research and management aimed at understanding and addressing the threats to Hawaiian monk seals throughout their range. Historically, management measures have been directed towards the majority of the population in the NWHI. However, the recent increase in monk seal numbers in the MHI has brought to the forefront management issues related to coexisting with seals along Hawaii's beaches and in near-shore waters. Ongoing management efforts, aligned with the Hawaiian monk seal recovery plan (NMFS, 2007), focus on providing the public with appropriate information to prevent disturbance and interactions, and to promote seal health and well-being. In other words, management activities concentrate on preventing actions that may result in take of the species or situations that could pose a risk to human safety. NMFS responds to seals in distress, and enforcement issues in the MHI; however, day to day management issues on the beach, which involve providing information and education, are largely handled by a growing number of monk seal response volunteers. Issues undertaken by volunteers include: providing educational "seal protection zones[26]" for seals hauled out in areas where disturbance is likely; offering beachgoers information about the Hawaiian monk seal and its status; monitoring monk seal pupping events; and reporting seals in distress (due to fish hook injury, entanglement, or otherwise). Although some of these management efforts occur in areas under consideration for critical habitat, they are independent of a critical habitat designation and are aimed at preventing disturbance and promoting wild seal behaviors to support recovery of the species. These types of management efforts will remain in effect as necessary, and strategies will be adapted as new interaction or disturbance issues arise. NMFS' recovery planning includes developing a MHI Hawaiian monk seal management plan with participation from local stakeholders to foster coexistence on Hawaii's beaches and in near-shore waters.

The protections associated with critical habitat are implemented under section 7 of the ESA and are specific to those activities that are authorized, funded, or carried out by a Federal agency (see *Section 7 Consultation* below). Under this section of the ESA, the USFWS and NMFS evaluate the extent of impacts that a Federal activity might have on a listed species or its designated critical habitat. The terms jeopardy and adverse modification, used during Section 7 consultation and described below, identify thresholds at which impacts may be too great and where

[25] Take is defined under the ESA as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt such activities.

[26] Seal protections zones refers to areas of the beach that may be temporarily roped off with signs to identify to beach goers that a seal is in the area and that caution should be taken to prevent disturbance.

modifications to the activity may be necessary to ensure conservation for the species or its habitat. A critical habitat designation does not set up a preserve or refuge and critical habitat requirements do not apply to citizens engaged in activities on private land, that do not involve a federal agency.

Section 7 Consultation

Under Section 7 of the ESA, all Federal agencies are directed to work to conserve listed species. Federal agencies must insure that actions they authorize, fund, or carry out (projects with a Federal nexus) are not likely to; 1) jeopardize the continued existence of a listed species or 2) destroy or adversely modify the listed species' designated critical habitat. Called "Interagency Cooperation," this section of the ESA, also establishes the Section 7 consultation process through which the Services (USFWS or NMFS) assist Federal agencies in fulfilling their duties to avoid jeopardy and destruction of critical habitat, and to otherwise minimize the impacts of their activities.

The first protections associated with not jeopardizing the continued existence of a listed species are enacted upon listing the species. This protection ensures that Federal agencies avoid actions that would be expected to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species. Thus, actions (or activities) that may affect the listed species must be evaluated during Section 7 consultation to insure there is no threat of jeopardy to the species. The second protections, associated with destruction or adverse modification of critical habitat, are enacted once critical habitat is designated. Actions that may reduce the quantity, quality, or availability of one or more essential features of critical habitat are evaluated to determine if the impacts from this action are likely to reduce the conservation value of the designated critical habitat (i.e., result in destruction or adverse modification). Some Federal actions may impact both the species and its essential features of critical habitat. During a section 7 consultation, these actions are evaluated under both provisions, to ensure protections for the species and its critical habitat.

Since the listing of the Hawaiian monk seal in 1976, Federal agencies have undergone Section 7 consultation for activities that they authorize, fund, or carryout throughout the Hawaiian monk seal's range to ensure that activities would not result in jeopardy. Since 1986, Section 7 consultations in the NWHI have also incorporated any Hawaiian monk seal critical habitat related concerns. In areas where Hawaiian monk seal critical habitat is designated, the consultation focuses on analyzing how Federal activities will alter the habitat, and how that will affect the ability of the essential features to support the species' conservation.

For the section below we consider how the essential features of Hawaiian monk seal critical habitat may require special management considerations or protections by focusing on those activities that pose a threat to the essential features. By identifying the activities which pose a threat to the essential features, we also identify those activities where Federal agencies may undergo Section 7 consultation to avoid destruction or adverse modification.

SPECIAL MANAGEMENT CONSIDERATIONS OR PROTECTION

Joint NMFS and USFWS regulations at 50 CFR 424.02(j) define "special management considerations or protection" to mean "any methods or procedures useful in protecting physical and biological features of the environment for the conservation of listed species."

Activities that may require special management or protection were identified by reviewing the threats from the Hawaiian Monk Seal Recovery Plan (NMFS, 2007). These threats were grouped as either impacting the seal (jeopardy threats), the essential features of the habitat (destruction and adverse modification threats), or both. Only those threats impacting the essential features were considered to be potential threats to Hawaiian monk seal critical habitat. Human activities that have the potential to generate or contribute to these critical habitat-related threats were then identified in order to determine special management considerations or protections that may be necessary to protect the essential features. Past Pacific Island Regional Office (PIRO) Section 7 consultations were also reviewed to further identify activities that occur in the monk seal's geographic range that may impact the essential features. Additionally, threats recognized in the Petition (Center for Biological Diversity, 2008) were reviewed for potential associated activities.

For the purposes of the 4(b)(2) analysis, several forms of human activities were identified that have the potential to threaten the features that are essential to the conservation of the Hawaiian monk seal such that special management considerations or protection may be necessary. Major categories of activities that are related to habitat were defined as the following (1) in water and coastal construction (including development); (2) dredging and disposal of dredged materials; (3) energy development (including renewable energy projects); (4) activities that generate water pollution; (5) aquaculture/mariculture; (6) fisheries; (7) environmental response activities (to oil spills, vessel groundings response, and marine debris clean-up activities); and (8) military activities. All of these activities have the potential to affect one or more of the essential features by altering the quantity, quality or availability of terrestrial or marine habitat that Hawaiian monk seals use. This is not an exhaustive or complete list of potential effects, rather a description of the primary concerns and potential effects that we are aware of at this time and that should be considered in accordance with Section 7 of the ESA when Federal agencies authorize, fund, or carry out these activities.

Each year Federal agencies work with NMFS to identify appropriate mitigation or management measures to ensure that their actions do not jeopardize the Hawaiian monk seal population throughout their range (i.e., throughout the entire Hawaiian Archipelago). Currently, only those projects with a federal nexus and which may impact the essential features in the NWHI are required to ensure that their actions do not cause destruction or adverse modification. The revision of Hawaiian monk seal critical habitat creates this additional obligation for projects with a Federal nexus that have the potential to impact the essential features within newly designated areas. In some cases mitigation or management measure may be required to prevent destruction or adverse modification. These measurements are determined during the Section 7 consultation processes and are project specific. Modifications may vary from project to project depending on such factors as location; the scope or extent of the project; number and type of essential features potentially impacted; or project duration.

Many other activities occur in areas being considered for Hawaiian monk seal critical habitat including common recreational activities such as surfing, swimming, or boating. Activities, such as these, with no federal nexus, are not subject to the Section 7 consultation process and are not subject to the prohibitions of Section 7. NMFS places no additional prohibitions or restrictions on areas as a result of designating areas as critical habitat; however, nonfederal entities may choose to use information from critical habitat designations to protect and conserve Hawaiian monk seal habitat.

In-Water and Coastal Construction

This category consists of a broad range of activities associated with construction and development in marine habitats or along the coast and may include any activities that would alter the quantity, quality, or availability of preferred pupping and nursing areas, significant haul-out areas, or foraging areas. In-water or coastal structures (such as breakwaters, docks, piers, bridges, marinas, pilings, bulkheads, boat ramps, rip-rap[27], jetties, groins, revetments or seawalls) may reduce the amount of accessible coastline available for preferred haul-out or pupping areas. Some of these structures may also have the potential to alter coastal dynamics and the surrounding coastal environments, resulting in increased erosion or loss of nearby shorelines. The quality of preferred pupping and haul-out areas may be impacted by coastal construction activities that greatly alter the remote characteristics of the area (or change the current accessibility to that area). Increased development in remote coastal areas may result in increased anthropogenic disturbance to preferred pupping or nursing areas, significant haul-out areas, or foraging areas, which may result in abandonment of the site if not properly managed. Additionally, the quantity or quality of prey resources in foraging areas may be reduced by in-water construction. The placement of large structures in the marine environment may reduce the amount of available foraging habitat or may alter marine dynamics in these areas. Changes to the ocean dynamics such as increased turbidity or sedimentation may alter the quality of benthic foraging habitats and subsequently the quantity of available prey resources.

Most in-water and coastal construction activities are associated with the maintenance of existing structures in Hawaii. Existing hardened structures do not have the essential features and are not part of the critical habitat designation; however, routine maintenance to existing structures or beach nourishment projects have the potential to impact nearby foraging essential features. Existing best management practices (such as those that minimize sedimentation, or protect water quality) for federal permits may provide protections for these features; therefore, additional modifications are not anticipated to result from this critical habitat designation for these routine projects. Plans for new in-water structures or coastal development may require some modifications depending on the location and the type or number of essential features present in the project area. Modifications would be intended to reduce the likelihood of impacts to the quantity and quality of essential features present. This may include restrictions on the spatial extent of the project, increased educational efforts with an emphasis on habitat protection, monitoring efforts to identify impacts to the benthic community (for in-water projects), monitoring efforts to identify impacts to monk seal use (for coastal projects), or limitations on

[27] Rock or other material used to armor shoreline structures.

providing new or increased access to remote preferred pupping and nursing areas or significant haul-out areas.

Dredging

Dredging activities, which include the disposal of dredged material, may affect the foraging area essential feature. This activity may remove prey habitat, with the removal of substratum or the macrobiotic community, along the path of the dredge. Subsequently, the quantity of available prey resources may be affected by this loss of habitat. Additionally, this activity may alter the quantity or quality of prey resources in areas adjacent to the dredging due to sedimentation or the re-suspension of contaminants into the water column. The risk and severity of the impacts from dredging to adjacent benthic communities is related to the intensity, duration and frequency of exposure to increased turbidity and sedimentation (Erftemeijer et al., 2012). Impacts from this activity may result from deposition of materials or spillover associated with the movement of sediment and are likely to be confined to distances within a few hundred meters of the dredged areas (Newell et al., 1998). Sensitivity to turbidity and sedimentation varies widely based on the type of benthic habitat being disturbed. For example, some marine communities are well adapted to sudden changes and may reestablish within several months of the disturbance, while others may take several years. Sensitivity to dredging disturbance from deposition may also vary by species, based on the size of the sediment being deposited, especially in species such as coral (Erftemeijer et al., 2012). Outside of the zone of immediate deposition, organic materials released may enhance species diversity and population density[28], provided contaminants are not associated with the site being dredged (Newell et al., 1998). If contaminants are released into the water column, the quality of prey resources may be reduced within foraging areas. In addition to impacts to foraging areas, prolonged dredging activities in areas adjacent to preferred pupping and nursing areas or significant haul-out areas may cause avoidance of sites during periods of increased dredging activity.

Given the range of sensitivities across communities and species, the effects of dredging and disposal activities on critical habitat would depend on factors such as location, scale, frequency, method of dredging and disposal, local oceanographic and physical characteristics, and duration of these activities. In Hawaii, dredging activities primarily occur within the harbors and navigable waterways along the coastline. Most large harbor dredging projects and ocean disposal sites for the dredged materials do not overlap with areas under consideration for Hawaiian monk seal critical habitat. Areas that are routinely dredged, which fall within the boundaries identified as under consideration for critical habitat, are unlikely to support essential features for Hawaiian monk seals; therefore, additional modifications are not anticipated for these routine projects. However, in the event modifications are needed, they are likely to be similar to those recognized above, including restrictions on the spatial extent of the project, monitoring efforts to identify impacts to the benthic community, or monitoring efforts to identify impacts to monk seal use (for adjacent coastal essential features). Activities that require new

[28] Enhancement of benthic communities outside of the deposition area decreases with increasing distance from the dredged area up to a distance of approximately 2km (Newell, Seiderer et al. 1998). Impacts associated with the release of organic materials into the area is dependent on the frequency of dredging occurring within this area, but are generally considered short-term.

dredging (such as the establishment of a new harbor along the coast) may require modifications to protect the essential features, such as those listed above.

Energy Development

Energy development activities are similar to in-water construction activities or coastal construction projects, however they are separated in this report due to the variation in the types of projects, and the uncertainties associated with some of the potential impacts from the on-going operations of certain newer technologies. The state and national focus on energy independence has brought increased attention to renewable sources of energy. Activities that may impact the quantity or quality of foraging areas include the use of offshore wind energy, ocean thermal energy, and wave energy. All three types of projects may require the construction or placement of a structure in the marine environment, anchoring of the structure to the ocean floor, the installation of cables to conduct electricity ashore, possible anchors for those cables, and/or periodic maintenance of any associated structures. While some projects have been tested on a small scale, the impacts associated with the on-going operations of some of these projects on the marine environment have yet to be realized on a commercial scale. Impacts associated with construction, such as structures or cables placed in the marine environment by these projects include alterations of ocean currents or waves, alterations of bottom substrates and sediment transport or deposition, emission of electromagnetic fields, or long term release of chemicals (Department of Energy, 2009). In addition to the structural impacts identified above, Ocean Thermal Energy Conversion (OTEC) projects may also include impacts associated with the large transfer of water, which may disturb the thermal structure of the ocean near the plant, change the salinity gradients, and change the amounts of dissolved gases, dissolved minerals, and turbidity (Department of Energy, 2009). These types of changes may alter productivity in an area, and may be detrimental to certain sensitive habitats (Department of Energy, 2009). In addition to these in-water projects, onshore facilities located adjacent to preferred pupping or haul-out areas may present the same impacts identified for coastal development projects.

The State of Hawaii is focused on a clean energy economy, and renewable energy projects are encouraged to meet the State's goals. Renewable energy projects and planning are expected to increase within the State. Project locations may depend on the resource generating the energy; however, strict federal and State regulations and review increasingly emphasize the importance of avoiding sensitive habitats. The *Report to Congress on the Potential Environmental Effects of Marine and Hydrokinetic Energy Technologies* identifies projects and studies where impacts, such as those described above, have been acknowledged. The report identifies project location as playing the biggest role in minimizing potential effects (Department of Energy, 2009). Energy projects will need to be addressed on a project-specific basis to determine the nature of potential impacts to Hawaiian monk seal critical habitat. Modifications to projects resulting from the critical habitat designation are considered to be the same as those suggested for in-water and coastal construction projects.

Activities that Generate Water Pollution

Point source and nonpoint source pollution[29] (including but not limited to, polluted storm water runoff, agricultural pesticide applications, and industrial discharge) have the potential to degrade the water quality in foraging areas and may subsequently impact the quantity or quality of available prey resources. Runoff from storms may carry a variety of pollutants into coastal waters including dirt (sediment), nutrients (from fertilizers), bacteria (from animal waste), oil, trash, and other wastes. Alterations to the nutrient composition in marine communities may change prey species abundance and diversity, and has been linked to an array of problems including harmful algal blooms, coral reef die-offs, as well as health and disease issues in various larger species (Lapointe & Bedford, 2011). Industrial and agricultural activities may also degrade water quality in foraging areas by introducing contaminants to coastal waters, such as additional nutrients, pesticides or industrial byproducts. Persistent organic pollutants or their derivatives (from pesticides, industrial chemicals and their byproducts) may accumulate in local food chains, altering the quality of prey resources in foraging areas. With stricter regulations many of these types of chemicals are no longer in production in the U.S., however, impacts continue to be a reality from global and past use of these persistent chemicals. Marine mammals may accumulate these toxins through their food sources (bioaccumulation); bioaccumulation of some persistent organic pollutants has been linked to impaired immunological response or reproductive impairment in some marine mammal species (de Swart et al., 1996; Willcox et al., 2004).

Nonpoint source pollution remains a problem for the management of most coastal areas, including Hawaii, because multiple sources often times inadvertently contribute to this problem. To prevent pollution of waterways, most federal involvement with nonpoint source pollution includes funding programs or encouraging initiatives that will better control or minimize nonpoint source pollution to coastal waterways. As these programs are aimed at improving habitat, and are likely to incorporate best management practices to protect sensitive habitat and improve water quality, it is unlikely that this designation will result in modifications to activities associated with preventing or minimizing nonpoint pollution.

Point source pollution is regulated through National Pollutant Discharge Elimination System permits (sometimes referred to as NPDES permits), and permitting authority has been granted to the State of Hawaii's Department of Health Clean Water Branch (CWB) by the United States Environmental Protection Agency (EPA). General water quality standards within the State of Hawaii require that permitted effluent does not cause degradation to local waterways and resources. These standards are monitored and enforced to meet the requirements of the Clean Water Act. Although these are State issued permits, the EPA maintains oversight over CWB actions that fall under the Clean Water Act. Currently, there is no information to indicate that existing State water quality standards are insufficient to protect the quality of Hawaiian monk seal prey resources, and NMFS does not anticipate recommending modifications to the USEPA regarding Hawaii's State water quality standards.

Aquaculture/Mariculture

Aquaculture and mariculture activities include impacts similar to both construction and to water pollution activities. Aquaculture activities that include the placement of cages or structures that

[29] Nonpoint source pollution comes from diffuse sources.

are anchored in the marine environment have the potential to alter the quantity and quality of foraging areas or marine areas adjacent to pupping and nursing areas; Potential impacts are similar to in-water construction projects. The operation of in-water structures may impact water quality in foraging areas, subsequently impacting prey resources. Water quality or the adjacent marine ecosystem may be altered through waste disposal, the introduction of exotic species or pathogens, or release of pesticides or antibiotics. Facilities may also impact local prey resources, because farms may use wild stock seeding, or feed made from wild fish (Naylor et al., 2000). Alternatively, aquaculture activities may also positively impact wild stocks by decreasing commercial fishing pressure by lowering the demand on commercial fish species.

Commercial aquaculture farms exist on the islands of Kauai, Oahu, Molokai, Maui and Hawaii. The United States Department of Agriculture's 2007 Census of Agriculture reported 74 farms that sold aquaculture products for the State of Hawaii. Hawaii's commercial aquaculture sector has expanded over the last few decades and interest in aquaculture technology and industries continues. With ocean resources readily available for farming, and the high demand for fish in the island communities, new technologies are being tested to farm pelagic species offshore. NMFS permitted experimental activities include harvest operations in deeper ocean waters using either anchored or unanchored oceanspheres or pens. Offshore activities that are unanchored appear to be less likely to impact the benthic community where monk seals forage and modifications to these projects are not anticipated as a result of this designation. Existing near-shore aquaculture applications off of Hawaii have undergone Section 7 consultation to address "jeopardy" concerns for Hawaiian monk seals. Similar projects in the future would likewise be subject to the same consideration. However, depending on factors such as location, size of operations, and the scale and frequency of chemical use, additional modifications may be necessary to address concerns associated with impacts to foraging areas or marine areas adjacent to pupping and nursing sites. Modifications may be similar to in-water construction projects including: restrictions on the spatial extent of the project, increased educational efforts with an emphasis on habitat protection, or monitoring efforts to identify impacts to the benthic community (for in-water projects).

Fisheries

Fishery-seal interactions are generally categorized as direct and indirect within the *Hawaiian Monk Seal Recovery Plan* (NMFS, 2007). Direct interactions include interactions with active fishing gear of various fisheries, feeding of fishing discards, and entanglement in derelict fishing gear or debris. Indirect interactions are defined as those that result in a reduction of prey availability, impacts of fisheries to important habitat, and impacts to feeding or other behavioral changes. Hookings and entanglements threaten the individual animals and may threaten the viability of the population; protections associated with these threats were established when the Hawaiian monk seal was listed as endangered in 1976. For Federal agencies, this includes the obligation under section 7 to avoid jeopardy to the Hawaiian monk seal population, which is already considered in consultations with fishery activities with a Federal nexus. Indirect interactions may also have the potential to impact individual animals and/or Hawaiian monk seal essential features. Fishing activities that may affect essential features include those that reduce prey availability, or impact the quantity and quality of the foraging areas. Thus, fisheries that may impact Hawaiian monk seal critical habitat are those which directly or indirectly (through bycatch) remove Hawaiian monk seal prey species from foraging habitat, or those that have the

potential to impact the quantity or quality of available prey species (e.g., modifications to ecosystems that causes reductions in habitat or decreases the amount of available prey resources).

The decline in Hawaiian monk seal populations of the NWHI has been attributed to food limitations; however, this threat does not appear to be impacting the MHI population (see *Northwestern Hawaiian Islands (NWHI) and Main Hawaiian Islands (MHI)*section of this report). Hawaiian monk seal prey species in the NWHI are not currently being extracted by commercial fisheries operations since recent management measures halted commercial fishing activity in this region. In the MHI, fisheries are quite diverse ranging from shore-based harvesting to large vessel-based offshore operations. A majority of these fisheries are not federally managed and are not subject to the Section 7 consultations associated with a critical habitat designation. Federally managed pelagic fisheries provide a majority of the landings and value for commercial fisheries in the MHI. However, these fisheries target larger pelagic species such as tuna and swordfish, which do not overlap with Hawaiian monk seal diet and are not consider a component of the Hawaiian monk seal foraging areas essential feature. Accordingly, modifications to these pelagic fisheries are not anticipated as a result of the critical habitat designation.

Based on available data there does not appear to be a high degree of prey overlap between Hawaii's commercial and recreational fisheries and the Hawaiian monk seal diet (Sprague et al., 2013). However, overlap may exist in the species targeted by monk seals and some of the fisheries managed under the Hawaiian Archipelago Fisheries Ecosystem Plan (FEP), which manages the bottomfish, precious corals, crustacean, and coral reef fisheries (NMFS, 2007). Current analyses identify areas of prey overlap to the family taxonomic level, and are unable to determine if overlap between the monk seal diet and fishery targets actually extends to the same species, or size of fish (Cahoon, 2011; Sprague et al., 2013). Furthermore, available data are insufficient to determine if fishers and monk seals are targeting similar species in the same geographic areas, the same depths, or at the same time (Sprague et al., 2013).

Unlike the NWHI, the Hawaiian monk seals in the MHI are increasing and are considered to be generally more robust. The divergence in population status between the NWHI and the MHI regions, and the difference in fishing activities between these two areas appears to indicate that extraction impacts associated with fisheries are having little to no appreciable impact on the MHI foraging areas. Modifications to the current management of fisheries is not anticipated as a result of this designation, because there is insufficient information to indicate that additional management is necessary to provide protection for Hawaiian monk seal foraging areas and prey species in these foraging areas. However, the broad diet of these seals or the factors currently ecologically favoring seals in the MHI (including low intra-specific and inter-specific competition) may be concealing fishery impacts to Hawaiian monk seal prey communities. Additional management needs may be identified as more information is gained about monk seal foraging ecology, or a better understanding of the relative importance of certain prey species to the health and recovery of a larger monk seal population is gained. At this time, there is insufficient information to predict with confidence if, and at what point, food resources within MHI foraging areas may become a limiting factor for seals in the MHI and to what extent fisheries impacts will contribute to any future food limitations. However, if future management

were necessary, based on current fisheries management systems, NMFS retains broad authority to make modifications to federally managed fisheries to address impacts to ESA-listed species like monk seals, including restrictions to fishery efforts.

Other impacts from fisheries may include physical, chemical, or biological alterations of the substrate that would result in loss of prey species and/or their habitat. Potential sources for fishery-related impacts to benthic habitat may include anchor damage from vessels attempting to maintain position, or the transmission of invasive species to sensitive benthic habitats, lost gear which may entangle prey species or disturb benthic habitat. The combination of prevailing ocean currents (in the North Pacific Subtropical Gyre) and wind patterns deposit fishing gear from fisheries throughout the Pacific Rim onto the shallow reef environments of the islands, islets, reefs and atolls of Hawaii[30]. Federal managed fisheries under Hawaii FEP minimize impacts to the benthic habitat by prohibiting the use of bottom trawls, bottom-set nets, explosives, and poisons. Although some gear is lost from Hawaii's fisheries, a majority of the gear observed from the NWHI marine debris removal efforts includes trawl netting, monofilament gillnet, and maritime line from fisheries found outside of Hawaii (Donohue et al., 2001), which are lost from other Pacific Rim fisheries. Similar gear also accumulates and has been removed from around the main Hawaiian Islands; areas of heavy accumulation include the windward coasts of many of the islands (PIFSC, 2010). Due to the widespread nature of these problems NOAA Marine Debris Response Program encourages partnerships among agencies to address marine debris response. Regional response to marine debris removal and associated Section 7 consultation considerations are discussed below. At this time, there is no information to indicate that Hawaii's FEP managed fisheries will require additional management above current efforts to address impacts to critical habitat.

Environmental Response Activities (to oil spill, vessel grounding, and marine debris)

Oil-spill response activities may negatively impact the quality of foraging areas, pupping and nursing areas, or haul-out areas for Hawaiian monk seals. The severity of oil spill impacts on the marine environment depend on the volume of the spill, duration, and the type of petroleum product, in combination with the physical factors at the location of the spill such as wind, wave and current conditions. Minimization of impacts from oil spills depends on the ability to respond to the spill and the effectiveness of methods used to remove, or disperse the oil. The emergency nature of these events requires that general response activities are planned in advance and that protocols are adjusted to ensure that methods selected to disperse or remove oil reduce, to the extent possible, additional destruction to the site of the spill or destruction to nearby habitats.

Throughout the nation the response and recovery efforts associated with oil spill events are planned in advance to provide protection to environmental and economic interests (Commander U.S. Coast Guard, 2010). Plans to protect Hawaiian monk seal critical habitat may include contacting appropriate NMFS staff during a spill event, identifying the essential features present in the area of the spill, and identifying the appropriate response to protect those features during the recovery efforts. However, Hawaii's Area Contingency Plan (ACP) already calls for the

[30] See NMFS' PIFSC Coral Reef Ecosystem's Division website for more information: http://www.pifsc.noaa.gov/cred/marine_debris.php

protection of listed species "as well as listed species' habitat not yet designated as critical," (Commander U.S. Coast Guard, 2010) to ensure that habitat impacts will not affect the listed species themselves. Accordingly, response activities associated with the protection of essential features for Hawaiian monk seals, such as protecting important pupping and haul-out areas are already considered a priority under the ACP. Hawaii's ACP attempts to identify sensitive areas and define the sensitivity of the area to provide specific response strategies to protect the site (Commander U.S. Coast Guard, 2010). The ACP may be updated to provide information about monk seal critical habitat and strategies to protect the habitat during spill response activities. Regardless, response efforts will likely be unique to each area and multiple variables will play into the most appropriate protocol for response.

Similar to oil spills, the severity of impacts due to vessel grounding events are determined by the surrounding substrate, the possible release of fluid, methods or plans for removal, and the physical factors at the location. Groundings (and subsequent removal of vessels) in marine areas have the potential to disrupt habitat important to prey species and to increase sediment deposition in nearby areas, impacting water quality, and, potentially, prey health. Vessel groundings also have the potential to release toxic chemicals (such as oil or petroleum products) into the marine environment which, in turn, may impact the quantity and quality of prey species available. Groundings causing damage to coral reefs have also been linked to incidence of ciguatera outbreaks that are caused by blooms of toxic algae (de Sylva, 1994); such algal blooms may impact Hawaiian monk seals through consumption of prey. Vessel grounding response activities must be planned to minimize the likelihood of further impacts to monk seal foraging areas. Since most activities associated with removing grounded vessels from the marine environment already attempt to minimize the amount of damage to the surrounding habitat, it is unlikely that further modifications will be necessary for these activities.

As noted in the 2007 Hawaiian Monk Seal Recovery Plan, marine debris remains an ongoing entanglement threat to monk seals. Additionally, marine debris or fishing gear may be snagged in coral reefs and continue to trap fish in monk seal foraging areas as noted above. Marine debris removal efforts currently occur to alleviate these threats to local wildlife. In Hawaii, the PIFSC Coral Reef Ecosystem Division leads Marine Debris Response efforts, partnering with other divisions and agencies, to collect and remove marine debris both in the NWHI and the MHI. These activities are subject to Section 7 consultation, because debris is often removed from sensitive habitat areas where listed species may be present. Modifications to this activity to prevent impacts to Hawaiian monk seal critical habitat are not likely to differ from best management practices already recommended and practiced by staff to prevent impacts to the listed species or to sensitive coral reef habitats.

Military Activities

For the purposes of this report, military activities include a wide variety of training and research activities that may have the potential to impact the essential features of Hawaiian monk seal critical habitat. Activities of concern include those that may alter the quality, quantity, or availability of preferred pupping and nursing areas, significant haul-out areas, or monk seal foraging areas.

The DOD consults with the NMFS to ensure their activities are not likely to jeopardize listed species or cause destruction or adverse modification to designated critical habitat. Many of these activities are consulted on for a five year time period and an annual review of monitoring reports and activities is conducted to minimize impacts to listed and protected species as well as the environment. The location, essential features present, and the specific activity (including other variables regarding scope and duration) will determine whether the essential features of critical habitat may be impacted. Thus, military projects will need to be addressed on an activity-specific basis to determine the nature of potential impacts to Hawaiian monk seal critical habitat.

Additional Threats addressed in the 2008 Petition to Revise Hawaiian Monk Seal Critical Habitat

The petitioners identified global warming as an overarching threat to the habitat of the Hawaiian monk seal (Center for Biological Diversity, 2008). In describing this threat, the petitioners identified sea level rise, ocean acidification and warming ocean temperatures as having the potential to alter the terrestrial and marine habitat of the Hawaiian monk seal. These threats are discussed below with respect to the relevance to Hawaiian monk seal critical habitat and may be considered processes associated with the threat of global climate change.

Rises in sea level will decrease terrestrial haul-out areas utilized by Hawaiian monk seals for: refuge from predators, birth, nursing, resting, and molting; especially in the low lying areas of the Northwest (Baker et al., 2006). Additionally, there is a general consensus that the intensity of tropical storms may increase as a result of global warming (IPCC, 2007). This increase in intensity may lead to dramatic shifts in the coastlines and changes to available haul-out sites, due to erosion from intensified storm activity. Changes that may occur to the coastline are not predictable at this time. Overcrowding at haul-out sites or competition for suitable haul-out areas from land loss could result in demographic changes for the species. However, these changes would be difficult to understand or predict, since density dependence in terms of the amount of terrestrial habitat available has not been documented for the species (Baker et al., 2006). In the MHI, habitat loss resulting from sea level rise may be less extreme. The loss of suitable haul-out areas may increase interaction with humans, as monk seals and humans compete for viable coastal habitat and available resources.

Changes in ocean biochemistry and currents, coupled with increased ocean temperatures and ocean acidification, and sea level rise, may impact Hawaiian monk seal foraging habitat by impacting the abundance and/or diversity of prey species. Climatic changes are likely to result in changes to the range and distribution of prey species as well as to the composition and dynamics of the surrounding marine system (Parmesan, 2006b). Marine life in the Antarctic has already exhibited changes resulting from warming temperatures ranging from declines in species that are losing important ice habitat (ice algae, krill, Emperor penguins, *Aptenodytes forsteriis*) to range expansions in open-ocean feeding penguins (Chinstrap, *Pygoscelis antarcticus,* and Gentoo, *Pygoscelis papua*) (Parmesan, 2006b). Warming trends in tropical systems may be associated with range shifts towards more temperate areas (Parmesan, 2006b). The bathymetric features and isolation of the Hawaiian Islands may not provide the additional available habitat for large-scale dramatic shifts. Therefore, the impacts to the Hawaiian ecosystem are not well known. Impacts may be seen locally in changes in species composition and distribution. The biological

diversity of tropical systems may be at stake as the combined forces of warming temperatures and ocean acidification put additional stress on ecosystems built around coral reefs (Hoegh-Guldberg et al., 2007; Parmesan, 2006a, 2006b). With increased acidification, calcium-dependent species seem to be at the highest risk. When entire systems are built around those species (e.g., coral) then habitat loss for the reef-dependent species could result in broad scale shifts that, in turn, may be felt by higher predators (Hoegh-Guldberg et al., 2007). The varied diet of the Hawaiian monk seal is likely to be impacted by changes in prey diversity, abundance or dynamics. However, the effect on the overall health and recovery of Hawaiian monk seals is unclear due to the uncertainty regarding these shifts in biodiversity.

Ocean warming in tropical climates raises additional concern with regards to disease. Growth rates of marine bacteria and fungi are positively correlated with temperature and increased ocean temperatures may also increase the range of pathogens (Harvell et al., 2002; Parmesan, 2006a). These increases in pathogens could result in toxic prey for foraging Hawaiian monk seals. The complexity of ecological interactions in these marine systems makes it difficult to predict what these large scale global changes will do to the dynamics and demographics of species in these systems.

The impacts of global climate change threaten Hawaiian monk seal habitat and, therefore, may threaten the survival and conservation of the Hawaiian monk seal. While all of the processes associated with global climate change are recognized as threats to the essential features of the Hawaiian monk seal, activities which influence these threats are considered to be of a complex global scale. Current limitations in predicting the specific changes that will occur within these ecosystems impede NMFS' ability to predict the resultant impacts to Hawaiian monk seals habitat with any certainty. As impacts from these forces are demonstrated or better understood, activities that exacerbate impacts to the essential features (e.g., changes to water quality) will be further scrutinized and associated management efforts may be pursued. At this time, no single activity has been identified as contributing specifically to these threats in the economic analysis (Industrial Economics, 2014). Climate change impacts will be addressed through the individual consultation process when individual project details are known. Management efforts that are within the scope of an ESA Section 7 consultation dealing with a single action or activity would likely focus on the preservation of specific terrestrial areas preferred for pupping and significant for hauling out as well as marine foraging areas. In this manner NMFS will be able to incorporate special management considerations to specific activities as the extent of impacts from global climate change are demonstrated or better understood.

Summary of Special Management Considerations or Protections

The NWHI areas under consideration for critical habitat in this revised proposal fall within the Papahanaumokuakea Marine National Monument (Monument). This remote area of the Hawaiian Archipelago has been largely protected since the 2006 designation of the Monument, however anthropogenic stressors still have environmental impacts on the area. Despite protections, the Papahanaumokuakea Marine National Monument Plan identifies some of the stressors to the habitat including activities such as coastal development, marine pollution, terrestrial pollution, dredging, invasive species, fisheries debris, climate change, and vessel groundings (Monument, 2008). At all of the specific areas in the NWHI research activities and

environmental response activities could affect the quantity, quality or availability of preferred pupping areas, significant haul-out areas, and foraging areas and such activities may require special management or considerations. Additionally infrastructure building or maintenance activities that may occur at Kure, Midway, Laysan, or FFS and visitor activities that may occur at Midway may require special management considerations or protections to ensure that the essential features are protected.

In contrast to the remote nationally protected areas in the NWHI, the specific areas under consideration for critical habitat in the MHI overlap with populated areas. The MHI have a human population estimated at over one million in 2009 (NMFS, 2010i) with over 6 million tourists visiting the MHI in 2008 alone (State of Hawaii Department of Business, 2008). The increased population, development, and resource utilization in these areas creates many stressors on the marine and the coastal environments. Pupping and nursing areas and significant haul-out areas may be affected by various development activities which have the potential to alter the quantity, quality, or availability of these features across all six areas under consideration for critical habitat. Additionally, marine foraging habitat and prey quantity and quality may be impacted by activities such as water pollution, fishing, dredging, in-water and coastal construction, energy development, aquaculture/mariculture, and environmental response activities across all six areas under consideration for critical habitat.

In summary, throughout the sixteen areas under consideration for critical habitat, special management considerations or protections may be required to protect the essential features for the conservation of Hawaiian monk seals. Once designated, only those activities that are authorized, funded or carried out by a Federal agency are subject to the requirements to not destroy or adversely modify critical habitat (in accordance with Section 7 of the ESA). The impacts associated with the designation of the areas under consideration for critical habitat are further examined in the Economic Analysis of Critical Habitat Designation for the Hawaiian Monk Seal (Industrial Economics, 2014) and the Revision of Critical Habitat for Hawaiian Monk Seals ESA Section 4(b)(2) Report (2014). Information from the biological report, economic report and 4(b)(2) report are used to identify areas for this revision of Hawaiian monk seal critical habitat.

CRITICAL HABITAT REVIEW TEAM PROCESS

A critical habitat review team (CHRT) consisting of seven NMFS biologists, involved in monk seal research and management, was convened to evaluate critical habitat for the Hawaiian monk seal. The CHRT used the best available scientific and commercial data and their professional judgment to (1) verify the geographical area occupied by the Hawaiian monk seals at the time of listing; (2) identify the physical or biological features essential to the conservation of the species; (3) identify areas within the geographical area occupied by the species that contain these features, and that may require special management considerations or protections; (4) identify any areas outside of the geographical area occupied by the species that are essential for the conservation of the species; (5) identify areas that may be ineligible for designation under 4(a)(3) of the ESA; and (6) determine if areas exist within the specific areas identified under 3 or 4 where the impacts (economic, national security, or other relevant impacts) of designation outweigh the benefits of designation and where the exclusion of such area will not result in extinction of the species such that these areas may be excluded in accordance with 4(b)(2) of the ESA.

In our 12-month finding (74 FR 27988; June 12, 2009) NMFS determined that the petition to revise Hawaiian monk seal critical habitat was warranted because of the new information on monk seal foraging and habitat use and announced the intention to move forward with the revision process through a proposed rulemaking. The sections below describe the various stages of the regulatory process, identify the role of the CHRT during the stages, and provide detail on the key considerations involved.

12-month finding

For the 12-month finding, NMFS convened a preliminary meeting of PIFSC and PIRO staff involved in Hawaiian monk seal research and management to discuss the best available scientific and commercial data relevant to critical habitat for the Hawaiian monk seal. The geographical area occupied by the species was identified during this meeting and preliminary essential features were drafted to provide the public with a better idea of areas that may be considered for a proposed rule. The preliminary features included (1) *sandy beaches preferred by monk seals for pupping and nursing;* (2) *marine areas less than 20 m (or 66 ft) depth adjacent to pupping and nursing beaches where young pups learn to forage*; (3) *marine areas approximately 20-200 m (or 66–656 ft) depth in the MHI, and approximately 20-500 m (or 66–1,640 ft) depth in the NWHI, preferred by juvenile and adult monk seals for foraging*; (4) *low levels of unnatural disturbance*; *and* (5) *high prey quantity and quality* (74 FR 27988; June 12, 2009).

Proposed Rule

Following the 12-month finding, the CHRT was officially convened to introduce members to the critical habitat designation process, identify and synthesize the best available scientific and commercial data relevant to critical habitat for Hawaiian monk seals, identify the geographical area occupied, and delineate the specific areas within the geographical area occupied. First the CHRT was given a brief overview of the statutory and regulatory requirements under the ESA regarding critical habitat. Next, the CHRT reviewed and discussed the preliminarily essential

features announced in the 12-month finding and available information on Hawaiian monk seal biology and ecology from the extensive monitoring in the NWHI available information from the MHI, as well as account for the long term recovery goals for the species. The CHRT then defined the list of essential features for the Hawaiian monk seal, verified the geographic range of the species, and identified the specific areas within the occupied range.

To delineate the specific areas the CHRT focused on using the new information (since 1988) regarding monk seal habitat use and on the recovery goals for the species. For terrestrial boundaries in the NWHI, the CHRT agreed that over thirty years of population assessment data collected by the PIFSC identifies that the islands, islets, and sand spits support Hawaiian monk seal essential features including preferred pupping habitat, and significant haul-out areas. In contrast, the CHRT expressed concerns associated with the reliability of MHI data, because a majority of the information is received through the voluntary sighting network. Specifically, the CHRT was concerned that haul-out data from the MHI may be biased towards highly trafficked areas, where human activities are concentrated, and that remote areas may be underrepresented. Additionally, the CHRT expressed concern that locations frequently used by monk seals may be a reflection of a small number of animals making use of a large area and may not take into account the needs of a growing population in the MHI, especially on the outer islands where seal numbers remain low (NMFS, 2007). The CHRT recommended including all coastlines to ensure that areas with essential features present were included in the designation and to conservatively plan for the recovery needs of 500 animals in the MHI (NMFS 2007). Large stretches of shoreline that did not include the essential features including hardened shorelines (such as seawalls, rock revetments, rip-rap or bulkheads), sheer cliffs, lava flows, large commercial harbors, and some larger bays were identified as not being included in the designation for presentation clarity. Marine boundaries were set to include all foraging behavior captured in the NWHI diving data, in other words at 500 m depth. The MHI boundary was set as the same as the NWHI, because preliminary dive information from MHI data demonstrated deeper dives occasionally and the CHRT identified that frequency of use of deeper areas was likely to expand with the increasing population. The CHRT did not identify any areas of unoccupied areas (See UNOCCUPIED AREAS

A proposed rule was prepared and published in the Federal Register on June 2, 2011 (76 FR 32026). The proposed rule was based on the CHRT recommendations from the draft biological report, in accordance with NMFS 4(a)(3)(b)(i) determinations for INRMPs that overlap with the designation, and NMFS weighing of impacts of the proposed designation reported in the Draft 4(b)(2) report. The draft economic analysis report (ECONorthwest, 2010), the draft biological report (NMFS, 2010a), and the draft 4(b)(2) report (NMFS, 2010b) were also made available for public comment.

Public Comments from the 2011 Proposed Rule

The public comment period was established for 90-days and then reopened on November 7, 2011 (76 FR 68710) for an additional 60 days. Public hearings were held on the islands of Kauai, Oahu, Molokai, Maui and Hawaii. We received 20,898 submissions in response to the proposed rule (including public testimony during the six hearings). All comments received between June 2, 2011 and January 6, 2012 were accepted for consideration. These included 20,595 form letters submissions and 303 unique submissions. In addition, the draft biological

report and draft economic analysis report were each reviewed by three independent peer reviewers.

The CHRT was re-convened to review issues raised from public and peer review comments received on the 2011 proposed critical habitat designation and supplemental draft biological report (NMFS 2010a), as well as any new information identified that was not considered in the development of the proposed designation. The CHRT's consideration of specific comments pertaining to information from the biological analysis and report is summarized below and revisions have been made to this report to reflect any necessary changes. Response to public and peer review comments from the 2011 proposed rule will be published in the federal register notice announcing the final designation to monk seal critical habitat.

Movement of monk seals to the MHI

Some commenters questioned the accuracy of the description of monk seal use of MHI habitat. Comments ranged widely, with some comments disputing the presence of monk seal in the MHI prior to the first critical habitat designation, while others suggested that monk seals were translocated to the MHI by NMFS. Additional comments received questioned whether monk seal population growth was occurring in the MHI. The *Population Status and Trends,* and the *Northwestern Hawaiian Islands (NWHI) and Main Hawaiian Islands (MHI)* sections of the draft biological report (NMFS 2010a) provided a summary of information regarding the known presence of monk seals in the MHI (both historically and during the time period of the first critical habitat designation), past translocation efforts, as well as population growth in the MHI. To clarify and to make information summarized in the report more accessible, information about monk seal translocations that include movement from one portion of the range to another, NMFS records of monk seal sightings in the MHI prior to the first critical habitat designation, and monk seal births in the MHI have been added respectively (Tables 1 and 2 and Figure 3).

Decline of monk seals in the NWHI

Several comments expressed divergent views about the population trends in the NWHI and the MHI. Based on these comments, the *Population Status and Trends* and the *Northwestern Hawaiian Islands (NWHI) and Main Hawaiian Islands (MHI)* sections of this report were updated to further discuss climate-ocean factors that have been found to greatly influence subpopulation trends in different portions of the NWHI.

Monk seal foraging information

Reviewers made requests to provide additional information about monk seal foraging habits, from both the NWHI and the MHI. Additionally, some public comments suggested misinformation or questioned aspects of monk seal foraging ecology. The *Habitat* portion of the report has been updated to provide additional detail about past foraging studies, as well as new information about monk seal foraging from the MHI that has become available since the September 2010 preparation of the draft biological report.

Revisions to the essential features

During the public comment periods, we received comments that suggested substantial disagreement exists regarding the sufficiency and accuracy of the data and analyses used to

identify the essential features and support the scope of the proposed critical habitat designation in the MHI. Comments pertaining to essential features suggested that the 2011 proposed designation was too broad, did not accurately identify where the features were located, how the essential features relate to one another (for features that overlap), or what role these features play in Hawaiian monk seal ecology (i.e., did not describe how the features are essential). Commenters also raised questions regarding the foraging ecology of Hawaiian monk seals in the MHI and whether the areas proposed for designation address the foraging needs and preferences in this habitat. To address comments regarding the six essential features proposed in 2011 (76 FR 32026; June 2, 2011) the CHRT reevaluated information available for the proposed rule, information presented in public comments, and considered new information that has become available since the 2011 publication (including published literature and tracking information). During this evaluation, the CHRT recognized, and NMFS agreed, that the six essential features from the proposed rule describe three types of areas that are ecologically important to Hawaiian monk seal conservation: preferred pupping and nursing areas, significant haul-out areas, and foraging areas. To clarify the role these features play in monk seal ecology, the CHRT recommended combining the elements of the proposed essential features that overlap such that preferred pupping and nursing areas, haul-out areas, and foraging areas are described as only three essential features. The CHRT also reviewed the information that supports the description of the essential features. Revisions to the essential features are discussed below.

Areas with low levels of anthropogenic disturbance

In the 2011 proposed rule, *areas with low levels of anthropogenic disturbance* were included as an essential feature to protect Hawaiian monk seal habitat areas, which may be sensitive to changes in human activity. Information from the NWHI indicates that human activities influenced monk seal habitat use after the 1950s at Midway Islands and Kure Atoll (Kenyon, 1972; Ragen, 1999). For example, at Kure Atoll, during periods of high human occupancy seals were observed to abandon haul-out and pupping habitat because beachcombing residents and their dogs patrolled shorelines daily, disturbing resting seals (Kenyon, 1972). However, managing human activities to mitigate disturbance has encouraged seals to use formerly abandoned habitats at both Kure Atoll and Midway Islands (NMFS, 2007; Ragen, 1999). Public comments received about this essential feature requested clarification about what role this feature plays in Hawaiian monk seal ecology. Some comments noted that this feature does not appear to align with monk seal behavior or habitat use in the MHI, as some seals regularly use highly trafficked areas. Other comments questioned the protections that would be necessary for proposed critical habitat areas that are not used by monk seals. Specifically, the commenter questioned whether development or access would be restricted in areas with low anthropogenic disturbance that are not used by seals.

To consider the significance of this feature to Hawaiian monk seal conservation, the CHRT reexamined the information that was used to support this feature in the NWHI and considered the information available regarding monk seal habitat use in the MHI. The examples from the NWHI highlight that chronic disturbance in sensitive monk seal habitat, such as pupping and nursing sites or important haul-out areas, can alter the conservation value of important habitat used by seals. Additionally, these examples provide evidence that these important areas may require special management considerations or protections. However, this information does not identify that *areas with low levels of anthropogenic disturbance* themselves provide a service or

function for monk seal conservation. Baker and Johanos (2004) note that three aerial surveys of the MHI in 2000 and 2001 indicate that seals show a preference for more remote areas. However, seal use of the MHI continue to increase since that time period and review of more recent sighting and cell phone tracking data indicate that monk seals regularly haul out in both highly trafficked and relatively remote areas of the MHI. For example, Kaena Point and White Plains Beach on Oahu experience different degrees of human activity, yet both of these areas remain important haul-out sites for seals on Oahu. Many important preferred pupping and nursing areas experience relatively low levels of anthropogenic use, however the existence of this feature alone does not guarantee monk seal use of an area as the area may still lack the sheltered-shallow aquatic areas for the successful rearing of pups.

Upon further consideration of available information, the CHRT was unable to define the service or function areas with low levels of anthropogenic disturbance would provide to Hawaiian monk seal conservation as an independent feature. In other words, low levels of anthropogenic disturbance may be a characteristic that defines certain preferred pupping and nursing areas or significant haul-out areas in the species range, yet this feature has no role or value to Hawaiian monk seal conservation unless it exists in an area that monk seals use for reproduction or rest. In summary, the CHRT recommended that *Areas with low levels of anthropogenic disturbance* be removed as an essential feature while recognizing that this characteristic may be important to some preferred pupping and nursing areas or significant haul-out areas.

Areas with characteristics preferred by monk seals for pupping and nursing* and *shallow sheltered aquatic areas adjacent to coastal locations preferred by monk seals for pupping and nursing

To address criticism expressed in public comments regarding the location of shallow, sheltered aquatic areas and to better express the association between terrestrial *areas with characteristics preferred by monk seals for pupping and nursing* and *shallow sheltered aquatic areas adjacent to coastal locations preferred by monk seals for pupping and nursing* the CHRT recommended that these two features be combined. Thus the two proposed essential features are now described as one continuous habitat area that is essential to support monk seal reproduction and growth. The feature is now described as: *Terrestrial areas and the adjacent shallow sheltered aquatic areas with characteristics preferred by monk seals for pupping and nursing.*

The proposed rule (76 FR 32026; June 2, 2011) identified that preferred pupping areas that are essential to Hawaiian monk seal conservation include those pupping areas that support multiple females year after year as well as those areas that support females that prefer a more solitary location, but which may be used throughout her reproductive life-time to birth and rear pups. Public comment expressed concern that areas all along the coast of the MHI may exhibit characteristics of pupping habitat and that areas that are significant to monk seals may not be easily identified for protection purposes. In addition comments requested that well known preferred pupping areas be identified clearly in the designation and on the maps. The CHRT identified that both of the types of favored reproductive sites (ones used by multiple females and solitary females) identified in the proposed rule are essential to Hawaiian monk seal conservation to support reproduction and population growth. Monk seal pupping data throughout the range provides the best available information to define where preferred pupping and nursing areas exist and the CHRT reviewed this information to consider how these two types of reproductive sites

may better be described. In the NWHI pupping areas are well defined by 30 years of data and often located along side significant haul-out areas or interspersed between significant areas. In the MHI, data indicates that some mothers have pupped in one location and never returned to the site. To avoid applying unnecessary protections to areas that monk seals found unsuitable for repeat pupping and to meet the intentions of the description provided in the proposed rule, the CHRT recommended that "preferred" pupping and nursing areas are defined as those areas where multiple females have given birth or where a single female has given birth in more than one year. This allows us to be responsive to public comments requesting that we provide clarity regarding where these essential feature exist and provides for the protection of both areas that are used by multiple mothers year after year, and also protects those areas where individual females have selected a more solitary pupping site to support their life-time reproductive efforts.

Marine areas from 0- 500 m (0-1640 ft) in depth preferred by juvenile and adult monk seals for foraging, and Marine areas with adequate prey quantity and quality

Comments received on the 2011 proposed designation raised questions regarding how foraging areas were described. Some comments identified that *marine areas from 0-500 m (0-1640 ft) in depth preferred by juvenile and adult monk seals for foraging* and *marine areas with adequate prey quantity and quality* are two features describing the same area and should be combined. Other comments expressed disagreement with the scope of the designation in the MHI. Among these, comments offered alternate approaches to identifying foraging habitat based on the amount of available resources within a given area, or by limiting foraging habitat to those areas that would support foraging juvenile Hawaiian monk seals.

The CHRT agreed these features may be simplified and clarified by describing essential marine foraging areas as one feature, similar to the preferred pupping and nursing areas described above. However, the CHRT disagreed with alternate approaches of protecting habitat for a subset of the population or a set amount of resources within a smaller area, because these approaches would fail to take into account habitat which reflects the foraging ecology of Hawaiian monk seals and would not provide protection for features that support monk seals throughout their life time or during periods of ocean-climate variability. Hawaiian monk seals exhibit individual foraging preferences and capabilities (Iverson et al., 2006), and the species has adapted to the low productivity of a tropical marine ecosystem by feeding on a wide variety of bottom-associated prey species across a wide expanse of habitat. The 2011 proposed rule relied on maximum dive depths demonstrated in the NWHI and limited diving data available from the MHI to identify the outer boundaries of where foraging areas exist. The designation focused on incorporating adequate areas for a food-limited population in the NWHI and a growing population in the MHI. Recent MHI tracking information, derived from tags utilizing cell phone technology, suggests that areas identified for the proposed rule may have been overly broad in describing the areas that are necessary to support monk seal conservation. This information and consideration of comments received lead to a re-evaluation of the available data regarding Hawaiian monk seal foraging.

In the NWHI the best available information indicates that monk seals are regularly feeding at depths that are deeper than the 1988 designation of 20 fathoms (approximately 37 m). From 1996-2000, 147 seals were tracked in the NWHI using satellite-linked radio transmitters with satellite-linked dive recorders (Stewart et al., 2006). Hawaiian monk seal dive data from Stewart

et al. (2006) indicates that seals from 5 of the 6 breeding areas are regularly diving at depths greater than 40 m (131 ft), sometimes even exceeding depths of 550 m (1804 ft). At FFS, Parrish et al. (2000) observed foraging behavior with Crittercams (or animal borne cameras) and described greater than 50 percent of seal behavior as sleeping or socially interacting at depths as deep as 80 m (262 ft). Seals spent more time actively searching, or actively foraging, along or near the bottom for prey at deeper depths, mostly between 60-100 m (197 – 328 ft) (Parrish et al., 2000). At these depths seals foraging behaviors focused on the more uniform habitat along the slopes of the atoll and neighboring banks. Across the NWHI, Stewart et al. (2006) described a majority of diving behavior occurring at depths less than 150 m (492 ft), however they describe various depth peaks that suggest feeding depths surrounding and exceeding the 150 m (492 ft) depth where foraging efforts may be focused. At Kure Atoll, Midway Islands, Lisianski Island, Laysan Island and FFS seals displayed various modes at deeper depth ranges, many of which are in less than 200 m (656 ft) in depth (Abernathy, 1999; Stewart & Yochem 2004a, 2004b). However, modes also occurred at 200 to 400 m (656 – 1312 ft) at Midway and Laysan and at 500 m (1640 ft) at Kure Atoll (Abernathy, 1999; Stewart & Yochem 2004a, 2004b). Although these modes demonstrate a focus around particular depth ranges, these depths are used less frequently. Data from Kure Atoll, Laysan, and FFS demonstrates that less than 10 percent of all diving effort recorded in these areas was focused towards depths greater than 200 m (656 ft) (Abernathy, 1999; Stewart & Yochem 2004a, 2004b). The NWHI data demonstrate that seal foraging behavior is focused beyond the boundary of the 1988 designation and that depths beyond 100 m (328 ft) provide important foraging habitat for this species. While the CHRT was in agreement that foraging areas past 100 m (328 ft) remain important to the species' conservation, the variation in diving behavior displayed between the NWHI subpopulations made the significance of foraging areas past 200 m (656 ft) difficult to determine.

Information from the MHI indicates that monk seal foraging behavior is similar to the behavior of seals in the NWHI; even though, foraging trip duration and average foraging distance in the MHI is shorter (Cahoon, 2011). Recent tracking data, received within the last two years from 12 instrumented seals, in the MHI indicates that approximately 95 percent of all recorded dives in the MHI have occurred at 100 m (328 ft) or less and approximately 98 percent of dives occur at 200 m (656 ft) or less (NMFS, 2012). These numbers indicate a relatively low frequency of use for foraging areas between 100- 200 m (328-656 ft) and even lower frequency of habitat use past the 200 m depth boundary. The MHI seal population is estimated to be 153 individuals with a majority of those individuals commonly using the islands of Niihau, Kauai, Oahu, and Molokai (Carretta et al., 2013). This number is acknowledged to be low, but has been increasing since the mid-1990s. Baker et al. (2011) estimate the intrinsic growth rate in the MHI as 1.07 (using conservative estimates of MHI abundance). If this rate is sustained, current trends in the MHI population can be extrapolated to reach just over 400 seals in 2030 (Baker et al., 2011)(Baker et al. 2011). Baker and Johanos (2004) suggest that monk seals in the MHI area are experiencing favorable foraging conditions due to decreased competition in these areas (both intraspecific and interspecific competition). This theory is supported by Cahoon's (2011) recent comparisons of foraging trip duration and average foraging distance data between the two regions. The CHRT acknowledged the difference in the frequency of use of deeper habitat between the MHI and the NWHI, however they noted that as seal numbers increase in the MHI, competition for resources between individuals will alter seal foraging patterns. The CHRT agreed that deeper areas (between 100-200 m) are anticipated to become increasingly important to MHI monk seals as the number of monk seals using each MHI grows in size and as the population increases across the

eastern portion of the range. For this revision the CHRT recommended amending the boundary in the MHI to include those deeper areas (between 100-200 m) that are important to the NWHI population to incorporate essential features which are capable of supporting a recovered population in the MHI. This change in depth from the 2011 proposed rule does reduce the size of the proposed designation in many areas; figures 4 and 5 below illustrate this difference for two specific areas within the MHI.

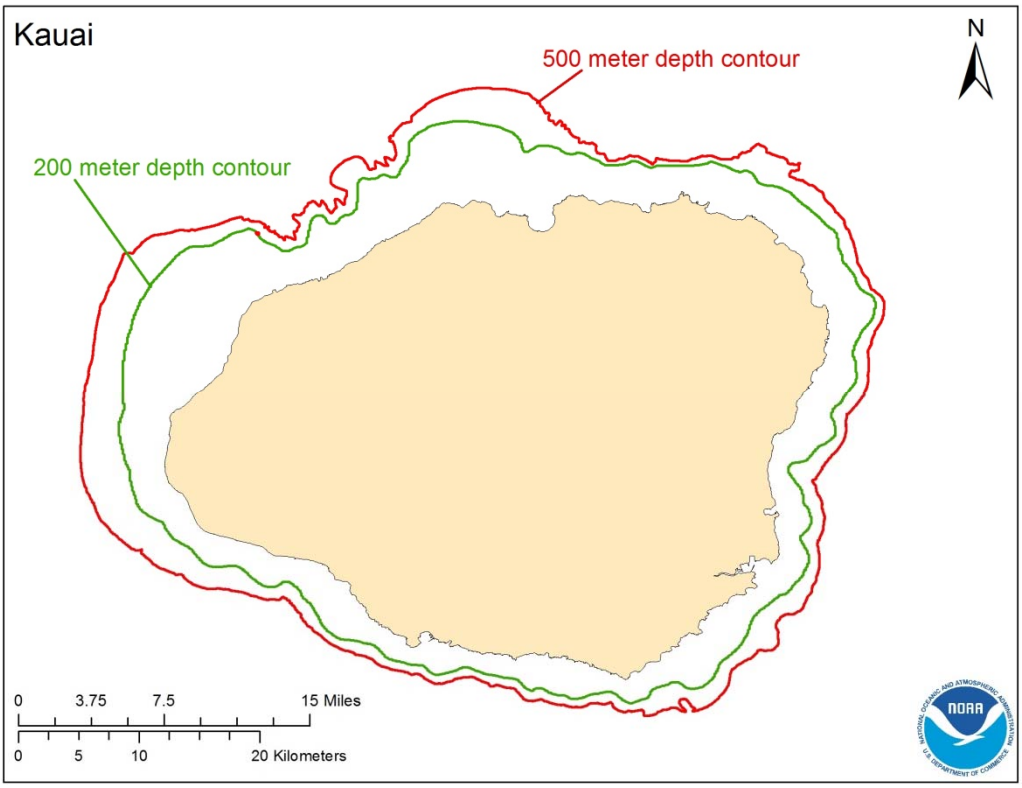

Figure 4. 200 and 500 m depth contour around Kauai

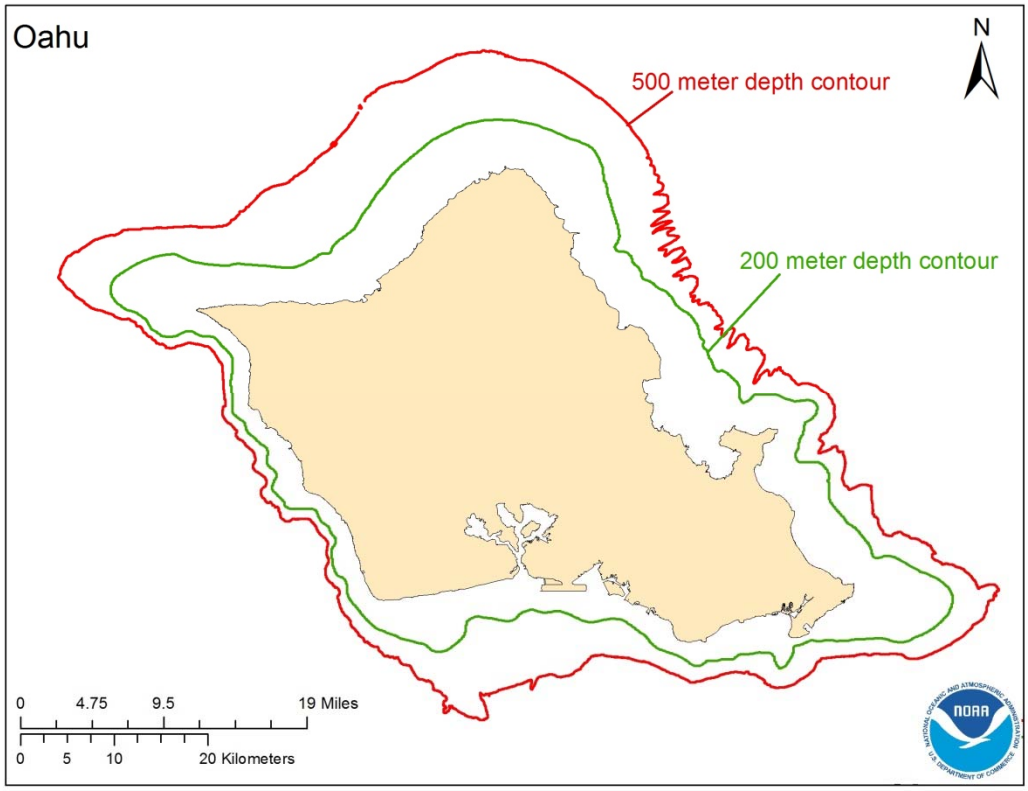

Figure 5. 200 and 500 m depth contour around Oahu

In light of the supplementary information about the MHI, information derived from public comments, and after review of existing information from the NWHI, the CHRT was unable to determine that deeper foraging areas past 200 m (656 ft) may be essential to Hawaiian monk seals. Accordingly, the foraging areas essential features have been revised as one essential feature that reflects the best available information about monk seal foraging: *marine areas from 0 -200 m (0-656 ft) in depth that support adequate prey quality and quantity for juvenile and adult monk seal foraging*.

Several comments also expressed concern and requested further information about the types of management that would be necessary to protect Hawaiian monk seal foraging areas in and around the MHI. Among these comments, we noted that several of the federally-linked activities seldom come in contact with or engage in actions that would potentially harm bottom-associated habitat where Hawaiian monk seal foraging is focused. To clarify, additional details have been added to the description of this feature to emphasize the importance of bottom-associated habitat and bottom-associated prey species which are important to monk seals.

Significant areas used by monk seals for hauling out, resting and molting

Public comments also expressed concerns regarding what constitutes *significant areas used by monk seals for hauling out, resting and molting* and how those areas were to be protected. In preparation for the 2011 proposed rule, the CHRT discussed the possibility of identifying key beaches and areas on each MHI island currently utilized by the Hawaiian monk seal as requested by the petitioner. However, in deliberation for the 2011 proposal the CHRT found it difficult to partition the habitat in this fashion, due to concerns associated with the areas of the MHI where

seal numbers are still low and concerns with the reliability of the MHI data received through the voluntary sighting network (due to biases towards highly human-trafficked areas). First, the CHRT identified that Hawaiian monk seal behavior does not support defining discrete areas, because Hawaiian monk seals are unlike pinniped species that congregate in large numbers at specific or discrete sites (e.g., rookeries or colonies). The species is considered solitary and wide ranging, with individuals spreading out and utilizing a large range of areas in the terrestrial and marine environment. Monk seal habitat preferences vary greatly between individuals and may also change throughout the life span of the animal. With this consideration in mind, the CHRT was concerned that the number of seals currently utilizing the MHI is small and employing current Hawaiian monk seal information to determine areas for designation may only reflect individual monk seal preference rather than accurately characterize essential features and habitat for the species as a whole. Of larger concern to the CHRT was the ability to correctly characterize Hawaiian monk seal terrestrial habitat use in the MHI, because available data for the MHI was dependent mostly on voluntary sighting information. As explained earlier in this report, voluntary sighting data is not systematic and sighting reports may be biased towards areas with high human activity, where monk seal occurrence is more likely to be reported by everyday beach goers. Conversely, information may be lacking from remote areas that people seldom frequent. The CHRT expressed concerns that using this data as a proxy for the essential feature could result in missing significant haul-out areas along coastlines where monk seal sightings are unlikely to be reported by people. For the 2011 proposed rule, the CHRT recommended, and NMFS agreed, that delineating all coastal areas that are accessible to seals would incorporate any preferred pupping and nursing areas and significant haul-out areas that existed, and this approach would ensure protection for areas that may support essential features where data is deficient. The 2011 proposed designation included coastal areas around each of the main Hawaiian Islands 5 m (16.4 ft) inland from the shoreline <u>not</u> including those areas of hardened shoreline or areas that were inaccessible to seal (e.g., cliffs) where essential features did not exist. This delineation did incorporate all existing essential features, however as noted by the comments received, provided little specificity as to where the essential features exist within these stretches.

This proposal generated public criticism about where and whether the terrestrial essential features (both haul-out areas and pupping areas) exist within the boundaries of the designation. Some comments suggested that the designation was too broad, and that all areas of MHI coastline could not possess the terrestrial essential features for Hawaiian monk seal conservation. Others questioned whether the identified features within MHI habitat are essential to Hawaiian monk seal conservation or why some areas that are used by Hawaiian monk seals were not included in the designation. Still others questioned how protections would be applied across such a wide range of habitat that did not appear to equally support Hawaiian monk seal habitat needs.

In review of these public comments and considering the available data, the CHRT agreed that not all areas of the coastline are of the same value to Hawaiian monk seals. Although this species does not congregate in large numbers at particular sites, they do reliably return to stretches of coastline that are favored for resting, molting, and socializing and this habitat use could be utilized as a proxy for identifying the location of significant haul-out areas. The CHRT recognized that providing additional clarity in defining this essential feature would allow for better protection of those areas of importance and be responsive to public comments received

regarding the location of the essential features. Identifying those characteristics that are common to coastline areas which are preferred by monk seals for hauling out is difficult, because characteristics are not uniform from location to location. For example, the relatively remote stretches of beaches along Laau point on Molokai do not display all of the same characteristics as the beaches along Oahu's busy southwestern shoreline. However, both of these areas are consistently used by monk seals for hauling out and are recognized by scientists, managers, and some members of the public as important areas. Accordingly, stretches of coastline that maintain a combination of characteristics important to monk seals for resting, molting and socializing may be better identified by evaluating actual monk seal usage of the coastlines of each island.

Since the June 2, 2011 publication of the proposed rule (76 FR 32026), additional information has become available which supplements information about monk seal habitat use in the MHI. This includes new surveys conducted by NMFS scientists throughout the MHI[31] and additional monk seal tracking information from seals that have been instrumented in the MHI. The islands of Kauai, Oahu, and Molokai (where cell phone tags were deployed) have well established monk seal populations, and these areas receive relatively consistent voluntary monk seal sighting reports. To evaluate the breadth of the voluntary sighting data, terrestrial locations from monk seal tracking data and aerial survey data were compared spatially with voluntary monk seal sighting information. These comparisons demonstrated that the voluntary sighting data successfully captures areas frequented by monk seals (i.e., comparison of the data did not reveal gaps in the voluntary sighting information as previously feared). Additionally, seals that visited islands farther east (of the areas of original tag deployment) captured more information about habitat use east of Molokai.

This comparison provided certainty to the CHRT that the voluntary sighting data, which makes up a majority of the sighting information for the MHI, could be used to identify significant haul-out areas. To better define where significant haul-out areas exist within the proposed designation, the CHRT reviewed spatial patterns of monk seal locations by mapping the tracking data coupled with past voluntary sighting information and PIFSC survey data across the MHI[32]. Spatial review of the monk seal location data displayed patterns in seal haul-out information. The CHRT recognized that limitations remained in using this data to describe significant areas for Hawaiian monk seals across the MHI. The voluntary sighting information, which makes up a majority of the information used, provides low resolution[33] regarding the location of a seal that is hauled out along the coastline. To address this limitation and to ensure that adequate space is provided for this wide-ranging species, blocks divided into five kilometer grid cells were created and placed over maps of each island to create a standardized grid. Seal location data was joined to grid cells along the coast of each island and counts within coastal grids were then evaluated to determine frequency of monk seal use within these squares. The CHRT identified that the

[31] With the exception of Niihau.

[32] Pupping and nursing data was removed from the regular sighting information to demonstrate only sightings associated with seals hauling out. Five years of voluntary sighting information was used.

[33]Because NMFS seldom receives GPS locations with voluntary sighting reports, a generic beach location is assigned by NMFS based on details provided in the report. Specificity in reporting varies widely based on the reporter's knowledge of the area. For example, long stretches of coastline may be recognized and reported by some members of the public by a singular name; however, other members of the public may report sightings along the same stretch of beach by multiple names that represent more discrete locations along the same stretch.

number of seals using each particular island varies. The description of significant haul-out areas should therefore, be island dependent to reflect seal use of each island. Areas of significance were defined as those coastal grid cells where the count equaled 10 percent or more of the grid cell with the highest count value for each island, respectively. This description of significant haul-out areas allows stretches of coastline used contiguously by monk seals to be included in the description of essential features, accommodates for data that may be underrepresented in frequency due to a lower likelihood of reporting, and in areas with lower seal numbers provides adequate habitat for monk seals to use as the population expands.

Delineation of specific areas considered for designation

Comments were also received about the size and scope of the designation. These comments varied greatly. Some suggested that the designation was too broad, while others suggested that the designation was not fully inclusive of areas used by monk seals. Because the delineation is based on the essential features and the essential features have been refined using the best available information, we have revised the delineation in this report. NMFS PIFSC records indicate that seals in the NWHI have preferred pupping and nursing sites and significant haul-out areas on the islands and islets of eight of the ten areas designated in the in the 1988 designation. Since the low-lying islands and islets of the NWHI provide characteristics (e.g., sandy sheltered beaches, low-lying vegetation, accessible shoreline) that support terrestrial essential features the CHRT recommended including the entire land areas (with the exception of hardened man-made sites). Preferred pupping and nursing sites in the MHI were identified using NMFS PIFSC records. Significant haul-out areas were identified using sighting and tracking information mapped across the MHI displaying frequency of seal use as described above. Final areas of terrestrial critical habitat within the MHI were then delineated such that significant haul-out areas and pupping and nursing sites were included in the terrestrial portion of the designation. Boundaries along stretches of coastline that were identified for designation were delineated using the haul-out data, pupping and nursing data, natural geographic features, and/or hardened shorelines (which lack the features of monk seal critical habitat). Along some of these stretches of identified coastline, inaccessible areas and hardened shorelines or structures occur. Consistent with the proposed rule, these areas are not considered part of the designation because they do not have the essential features and do not meet the definition of critical habitat.

For marine areas the CHRT identified foraging areas essential to Hawaiian monk seal conservation are those bottom habitats out to 200 m, where the majority of monk seal foraging efforts are captured. In addition to the comments noted above regarding marine foraging areas depths, we also received comments that questioned the types of protection that would be necessary across marine foraging areas. Some of these comments focused on activities that occur in the marine environment which are unlikely to cause modification to the bottom-associated habitat and prey that make up essential Hawaiian monk seal foraging areas. As noted in the proposed rule and the biological report (NMFS 2014), monk seals focus foraging efforts on the bottom, capturing prey species located on the bottom, within the substrate of the bottom environment, or within a short distance of the bottom (such that the prey may be easily pinned to the bottom for capture). In other words, the features that support Hawaiian monk seal foraging exist on and just above the ocean floor and the water column above 10 m in height from the ocean floor does not serve the same function in supporting Hawaiian monk seal ecology. The

proposed rule identified foraging areas as essential to Hawaiian monk seal ecology and not those marine areas where monk seals travel and socialize. To better reflect these known foraging strategies, to clarify to the public where Hawaiian monk seal essential features exist, and where protections should be applied, the CHRT recommended incorporating the seafloor and a 10 m height boundary (from the sea floor). Thus, in waters deeper than 10 m, the portion of the water column above 10 m from the bottom is not included in the critical habitat designation.

Comments on activities

We made several changes to the description of the activities that may affect the essential features and Hawaiian monk seal critical habitat, based on the comments received requesting additional detail about the potential modifications that would be necessary; this information is found in the SPECIAL MANAGEMENT CONSIDERATIONS OR PROTECTION section of this report.

Appendix A. Essential Features and Size of Areas

Table 8. Essential features within each specific area.

Specific Area	Presence of Essential Features		
	Pupping and Nursing beaches	Significant Haul-out Areas	Marine Foraging Areas
Area 1. Kure Atoll	Yes	Yes	Yes
Area 2. Midway Islands	Yes	Yes	Yes
Area 3. Pearl and Hermes Reef	Yes	Yes	Yes
Area 4. Lisianski Island	Yes	Yes	Yes
Area 5. Laysan Island	Yes	Yes	Yes
Area 6. Maro Reef	No	No	Yes
Area 7. Gardner Pinnacles	No	No	Yes
Area 8. French Frigate Shoals	Yes	Yes	Yes
Area 9. Necker Island	Yes	Yes	Yes
Area 10. Nihoa Island	Yes	Yes	Yes
Area 11. Kaula Island	No	No	Yes
Area 12. Niihau	Yes	Yes	Yes
Area 13. Kauai	Yes	Yes	Yes
Area 14. Oahu	Yes	Yes	Yes
Area 15. Maui Nui	Yes	Yes	Yes
Area 16. Hawaii	Yes	Yes	Yes

Table 9. Area 12, Niihau, essential features within coastal segments[34].
Reference Figure 19.

Area 12. Niihau				
Textual Description	**Boundary Point 1**	**Boundary Point 2**	**Preferred Pupping and Nursing Areas**	**Significant Haul-out Areas**
Poleho Beach through Puuwai area	NI11	NI12	Yes	Yes
Kuakamoku Rock Area (Kiekie Area)	NI21	NI22	Yes	Yes
Southwest Area (Nonpapa through Makahauena)	NI31	NI32	No	Yes
Kamalino Bay Area	NI41	NI42	No	Yes
Kahaino Area	NI51	NI52	No	Yes
Southeastern Coast (Keanahaki Beach through Poooneone Beach)	NI61	NI62	No	Yes
Lehua*	NIi1		No	Yes

Table 10. Area 13, Kauai, essential features within coastal segments[35].
Reference Figure 20 & Figure 21

Area 13. Kauai				
Textual Description	**Boundary Point 1**	**Boundary Point 2**	**Preferred Pupping and Nursing Areas**	**Significant Haul-out Areas**
Southeast coast of Kauai (Nomilu Fishpond area through Mahaulepu)	KA 11	KA 12	Yes	Yes
Kawelikoa Point to Molehu	KA 21	KA 22	Yes	No
Lydgate Park through Wailua canal	KA 31	KA 32	No	Yes
Wailua canal through Waikaea canal	KA 41	KA 42	No	Yes
Waikaea canal through Kealia	KA 51	KA 52	No	Yes
Kuaehu Point through Opana point	KA 61	KA 62	No	Yes
Moloaa Bay through Kepuhi Point	KA 71	KA 72	Yes	Yes
Southeast of Kilauea	KA 81	KA 82	No	Yes
Kee Beach Park through Wainiha Beach Park	KA 91	KA 92	No	Yes
Milolii State Park Beach Area	KA101	KA102	Yes	No

[34] Terrestrial coastal segments are identified using boundary points on each end. The latitude and longitude reference for boundary points are found in Tables 3-7. * Textual Descriptions refer to islets.
[35] Terrestrial coastal segments are identified using boundary points on each end. The latitude and longitude reference for boundary points are found in Tables 3-7. * Textual Descriptions refer to islets.

Table 11. Area 14, Oahu, essential features within coastal segments.
Reference Figure 22.

Area 14. Oahu				
Textual Description	**Boundary Point 1**	**Boundary Point 2**	**Preferred Pupping and Nursing Areas**	**Significant Haul-out Areas**
Keana Point Area	OA 11	OA 12	No	Yes
Maili Beach through Kalaeloa Barbers Point Harbor	OA 21	OA 22	No	Yes
Kalaeloa Barbers Point Harbor through Iroquois Point	OA 31	OA 32	No	Yes
Diamond Head area	OA 41	OA 42	No	Yes
Hanauma Bay through Sandy Beach	OA 51	OA 52	No	Yes
Makapuu Beach Area	OA 61	OA 62	No	Yes
Lori Point through Waimea Bay	OA 71	OA 72	Yes	Yes
Kapapa Island (Kaneohe Bay)*	OAi1		No	Yes
Mokulua - Moku Nui*	OAi2		No	Yes
Mokulua - Moku Iki*	OAi3		No	Yes
Manana (Rabbit Island)*	OAi4		Yes	Yes

Table 12. Area 15, Maui Nui - Molokai, essential features within coastal segments[36].
Reference Figure 24.

Area 15. Molokai				
Textual Description	**Boundary Point 1**	**Boundary Point 2**	**Preferred Pupping and Nursing Areas**	**Significant Haul-out Areas**
Laau Point Area	MO 11	MO 12	No	Yes
Kalaupapa Area	MO 21	MO 22	Yes	Yes
Moku Hooniki*	MOi1		No	Yes

[36] Terrestrial coastal segments are identified using boundary points on each end. The latitude and longitude reference for boundary points are found in Tables 3-7. * Textual Descriptions refer to islets.

Table 13. Area 15, Maui Nui - Lanai, essential features within coastal segments.
Reference Figure 25.

Area 15. Lanai				
Textual Description	**Boundary Point 1**	**Boundary Point 2**	**Preferred Pupping and Nursing Areas**	**Significant Haul-out Areas**
Northwest Lanai (Including Polihua Beach)	LA 11	LA 12	No	Yes
Shipwreck Beach Area	LA 21	LA 22	No	Yes
Lopa Beach through Nakalahale Cliff	LA 31	LA 32	No	Yes
Nakalahale Cliff through Manele Harbor	LA 41	LA 42	No	Yes
Manele Harbor through Kaholo Pali	LA 51	LA 52	No	Yes
Kaholo Pali through Kamalapau Harbor	LA 61	LA 62	No	Yes
North of Kamalapau Harbor	LA 71	LA 72	No	Yes
Puupehe	LAi1		No	Yes

Table 14. Area 15, Maui Nui - Kahoolawe, essential features within coastal segments.
Reference Figure 26.

Area 15. Kahoolawe				
Textual Description	**Boundary Point 1**	**Boundary Point 2**	**Preferred Pupping and Nursing Areas**	**Significant Haul-out Areas**
Eastern coast of Kahoolawe (Sailer's Hat through Honokoa)	KH 11	KH 12	Yes	Yes
Mid-North coast (including Ahupuiki and Kaukamoku)	KH 21	KH 22	No	Yes

Table 15. Area 15, Maui Nui - Maui, essential features within coastal segments[37].
Reference Figure 26.

Area 15. Maui				
Textual Description	**Boundary Point 1**	**Boundary Point 2**	**Preferred Pupping and Nursing Areas**	**Significant Haul-out Areas**
Pepeiaolepo Bay through Hana Wharf and Ramp	MA 11	MA 12	No	Yes
Hana Wharf and Ramp through Kainalimu Bay	MA 21	MA 22	No	Yes
West coast of the Keanae Pennisula	MA 31	MA 32	No	Yes
West of Maliko Bay to east of Papaula Point	MA 41	MA 42	No	Yes
Kahului Harbor West through Waihee Beach Park	MA 51	MA 52	No	Yes
Punalau Beach through to Mala Wharf	MA 61	MA 62	No	Yes
Southeast of Mala Wharf through to Lahaina Harbor	MA 71	MA 72	No	Yes
Southeast of Lahaina Harbor through to Papalaua	MA 81	MA 82	No	Yes
East of Maalaea Harbor through to Kihei boat ramp	MA 91	MA 92	No	Yes
South of Kihei Boat Ramp through Ahihi Bay	MA 101	MA 102	No	Yes
La Perouse Bay from Kalaeloa Point through Kanaio Beach	MA 111	MA 112	No	Yes
Molokini Crater*	MAi1		No	Yes

[37] Terrestrial coastal segments are identified using boundary points on each end. The latitude and longitude reference for boundary points are found in Tables 3-7. * Textual Descriptions refer to islets.

Table 16. Area 16, Hawaii, essential features within coastal segments[38].
Reference Figure 27 & Figure 28.

Area 16. Hawaii				
Textual Description	**Boundary Point 1**	**Boundary Point 2**	**Preferred Pupping and Nursing Areas**	**Significant Haul-out Areas**
Waimanu through Laupahoehoenui	HA 11	HA 12	Yes	Yes
Keokea Bay through Kauhola Point	HA 21	HA 22	No	Yes
Kapaa Beach County Park to Mahukona Harbor	HA 31	HA 32	No	Yes
South of Mahukona Harbor	HA 41	HA 42	No	Yes
Pauoa Bay to Makaiwa Bay area	HA 51	HA 52	No	Yes
Anaehoomalu Bay area through Keawaiki Bay area	HA 61	HA 62	No	Yes
Puu Alii Bay Area through Mahaiula Bay	HA 71	HA 72	No	Yes
Keahole Point through Kaloko-Honokohau National Historic Park	HA 81	HA 82	No	Yes
South of Oneo Bay area through to Holualoa Bay area	HA 91	HA 92	No	Yes
Kahaluu Bay Area through Keauhou Bay Area	HA 101	HA 102	No	Yes
Kealakekua Bay Area	HA 111	HA 112	No	Yes
Honaunau Bay Area	HA 121	HA 122	No	Yes
Milolii Bay Area through Honomalino Bay Area	HA 131	HA 132	No	Yes
Ka Lae National Historic Landmark District through Mahana Bay	HA 141	HA 142	No	Yes
Papakolea Green Sand Beach Area	HA 151	HA 152	No	Yes
Kaalualu Bay Area	HA 161	HA 162	No	Yes
Whittington Beach Area through Punaluu Beach Area	HA 171	HA 172	No	Yes
Halape Area through Keauhou Point Area	HA 181	HA 182	No	Yes
Kapoho Bay Area	HA 191	HA 192	No	Yes
Lehia Beach Park through to Hilo Harbor	HA 201	HA 202	No	Yes
Papaikou Area	HA 211	HA 212	No	Yes
Onomea Bay Area	HA 221	HA 222	No	Yes
Hakalau Area	HA 231	HA 232	No	Yes

[38] Terrestrial coastal segments are identified using boundary points on each end. The latitude and longitude reference for boundary points are found in Tables 3-7. * Textual Descriptions refer to islets.

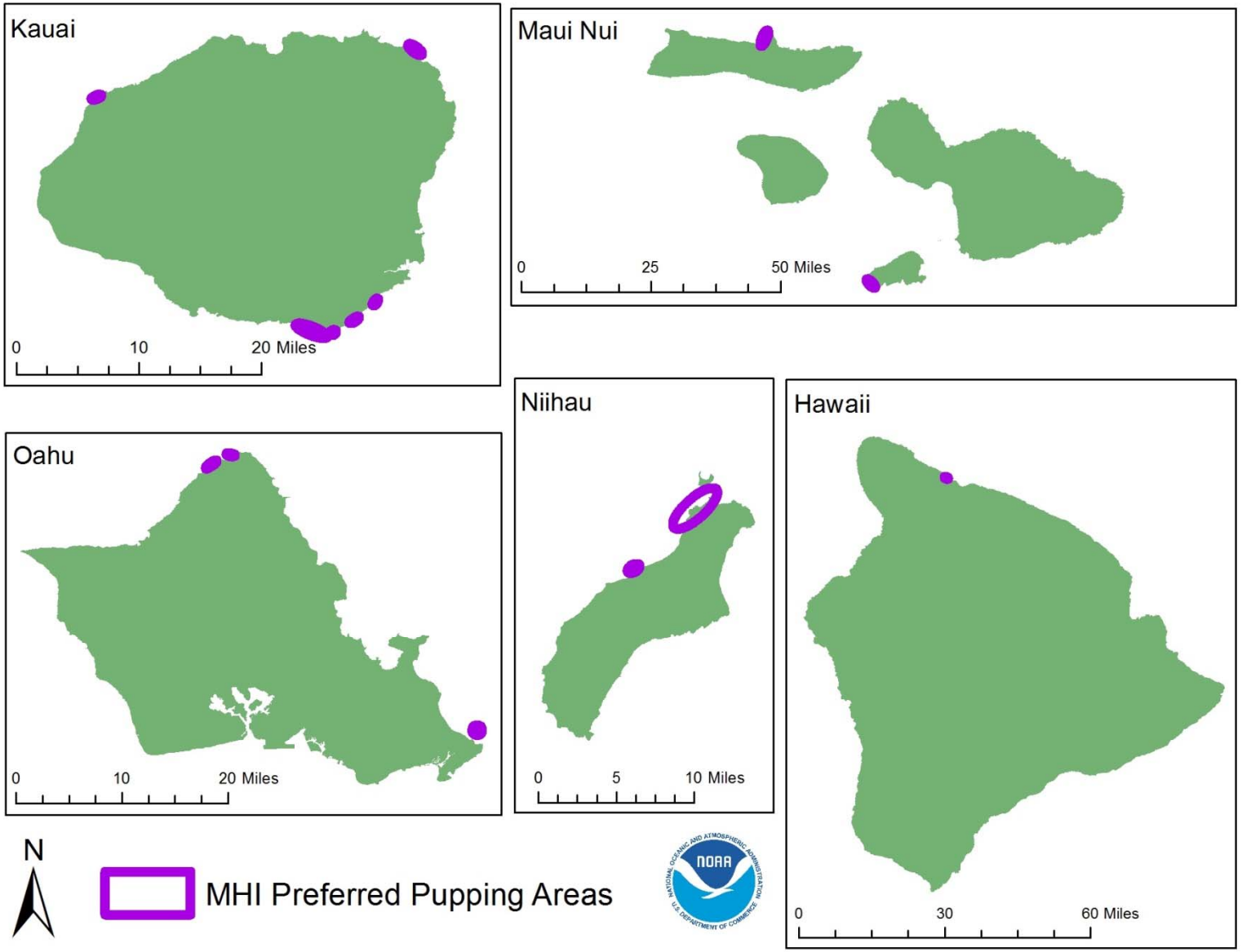

Figure 6. Preferred pupping areas in the MHI.

Table 17. Approximate area under consideration for critical habitat.[39]

Specific Area	Area (Square miles)	Area (Square Kilometers)
Area 1. Kure Atoll	123.95	321.04
Area 2. Midway Islands	136.76	354.2
Area 3. Pearl and Hermes Reef	289.38	749.49
Area 4. Lisianski Island	468.77	1214.11
Area 5. Laysan Island	220.18	570.26
Area 6. Maro Reef	775.6	2008.81
Area 7. Gardner Pinnacles	956.63	2477.65
Area 8. French Frigate Shoals	366.77	949.93
Area 9. Necker Island	591.92	1533.06
Area 10. Nihoa Island	214.06	554.42
Area 11. Kaula Island	25.66	66.47
Area 12. Niihau	115.24	298.47
Area 13. Kauai	215.08	557.05
Area 14. Oahu	362.96	940.07
Area 15. Maui Nui	1444.72	3741.82
Area 16. Hawaii	404.47	1047.57

Table 18. Sum of distances of coastal segments under consideration for critical habitat.

Specific Area	Miles	Kilometers
Area 11. Kaula	2.16	3.48
Area 12. Niihau	32.56	52.4
Area 13. Kauai	27.74	44.64
Area 14. Oahu	48.27	77.68
Area 15. Molokai	7.30	11.76
Area 15. Lanai	30.68	49.37
Area 15. Kahoolawe	7.36	11.84
Area 15. Maui	72.17	116.15
Area 16. Hawaii	48.78	78.51
Total	277.02	445.83

[39] NWHI areas include all terrestrial habitat components. MHI areas include only marine areas, coastal segments are estimated separately in Table 19.

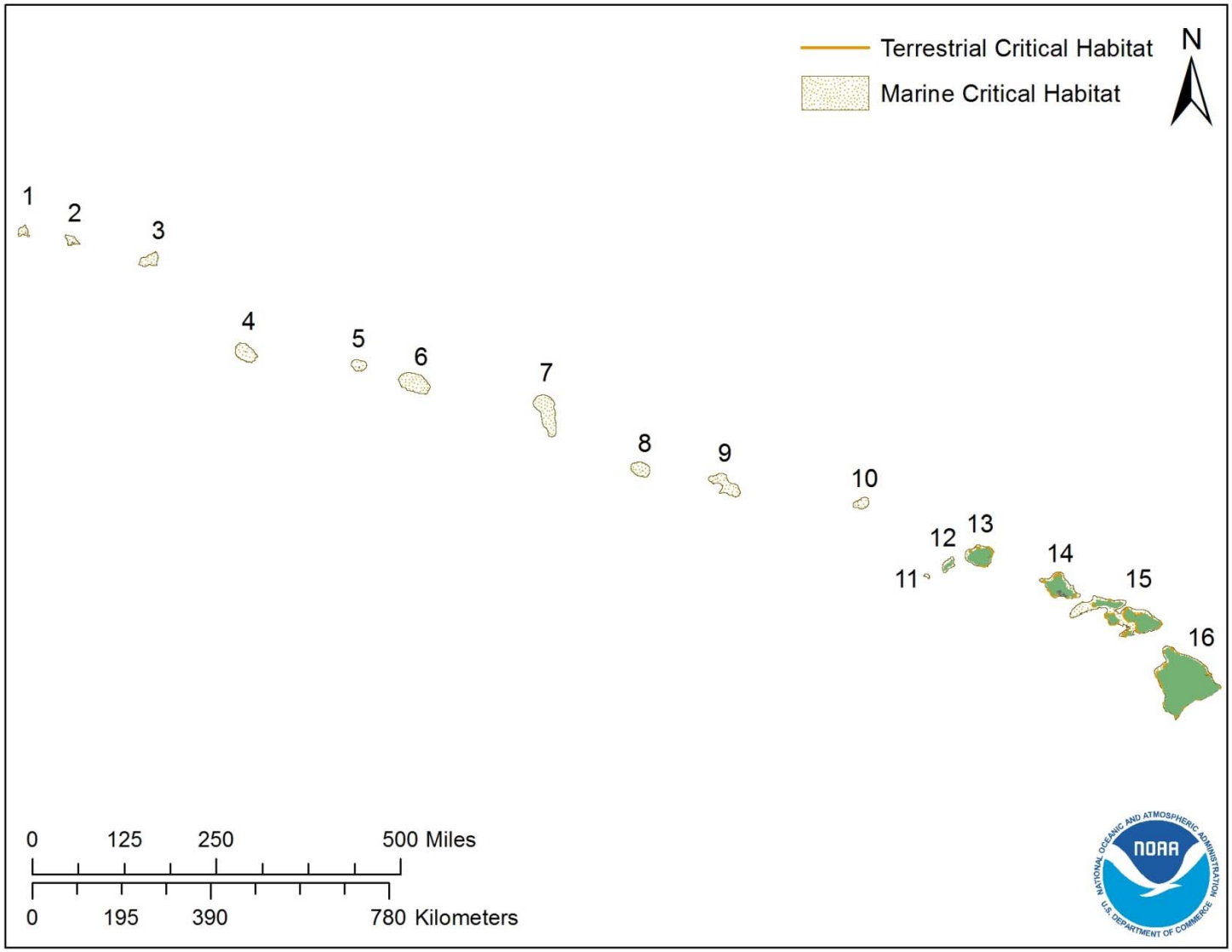

Figure 7. Archipelago map.

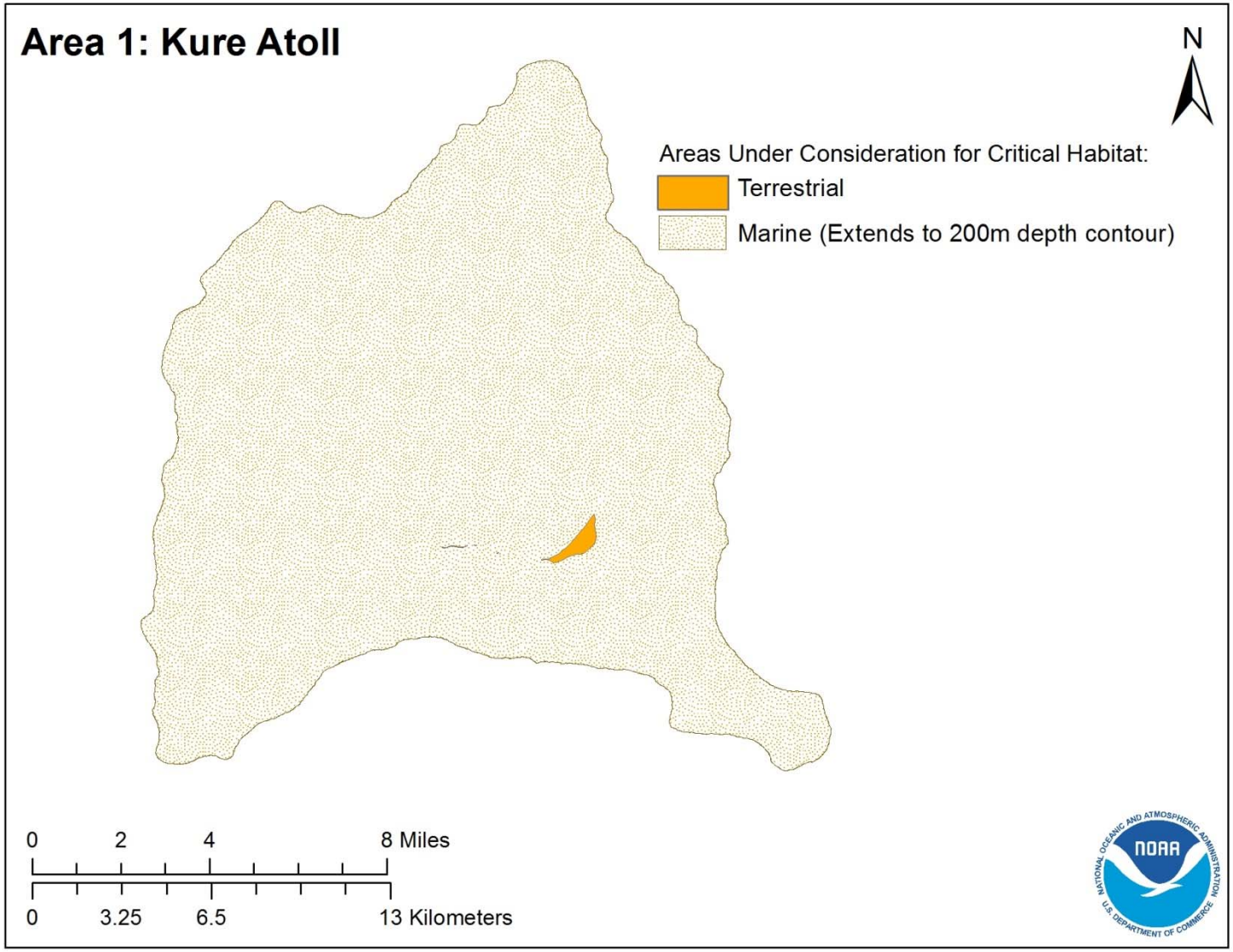

Figure 8. Kure Atoll areas under consideration for critical habitat.

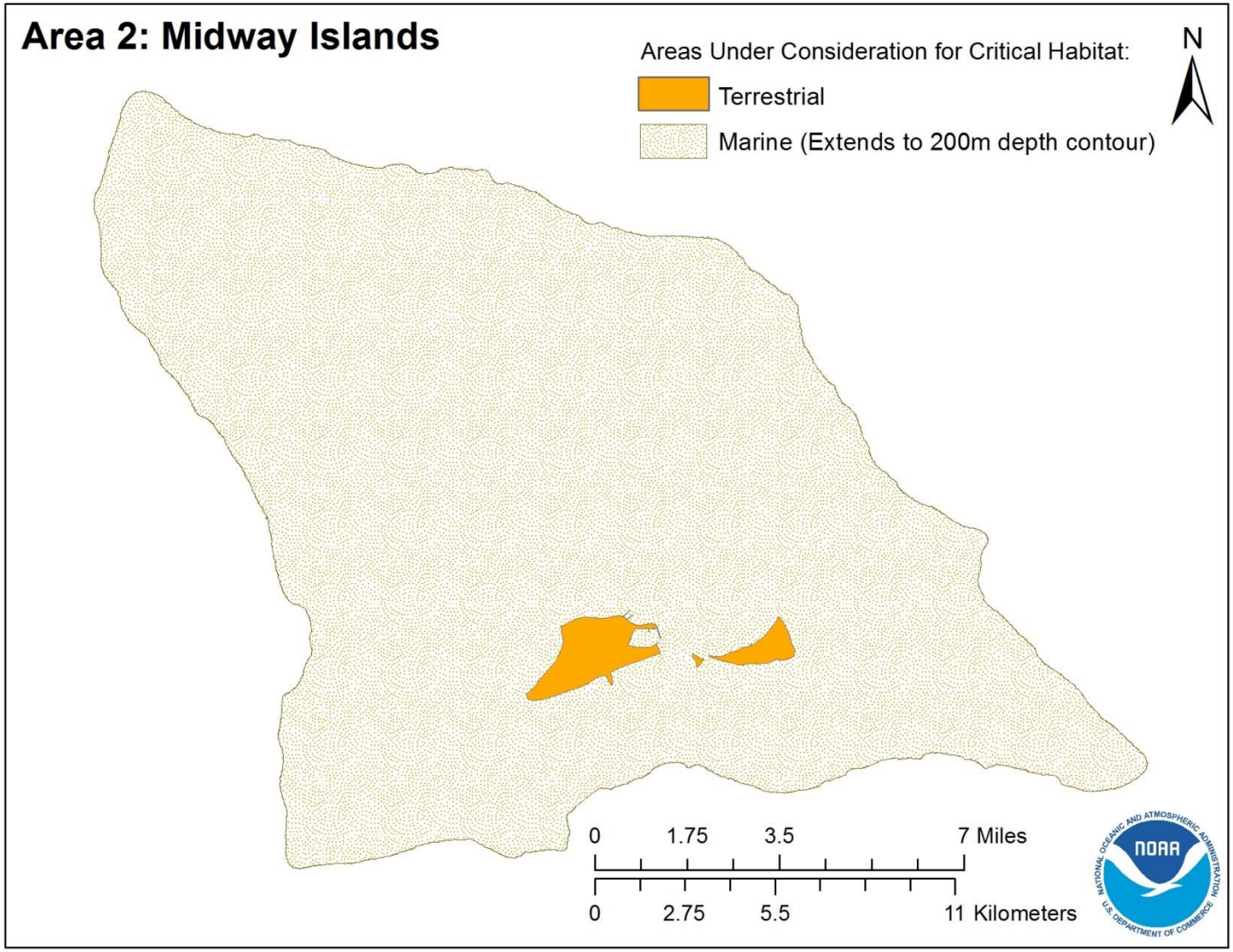

Figure 9. Midway Islands areas under consideration for critical habitat.

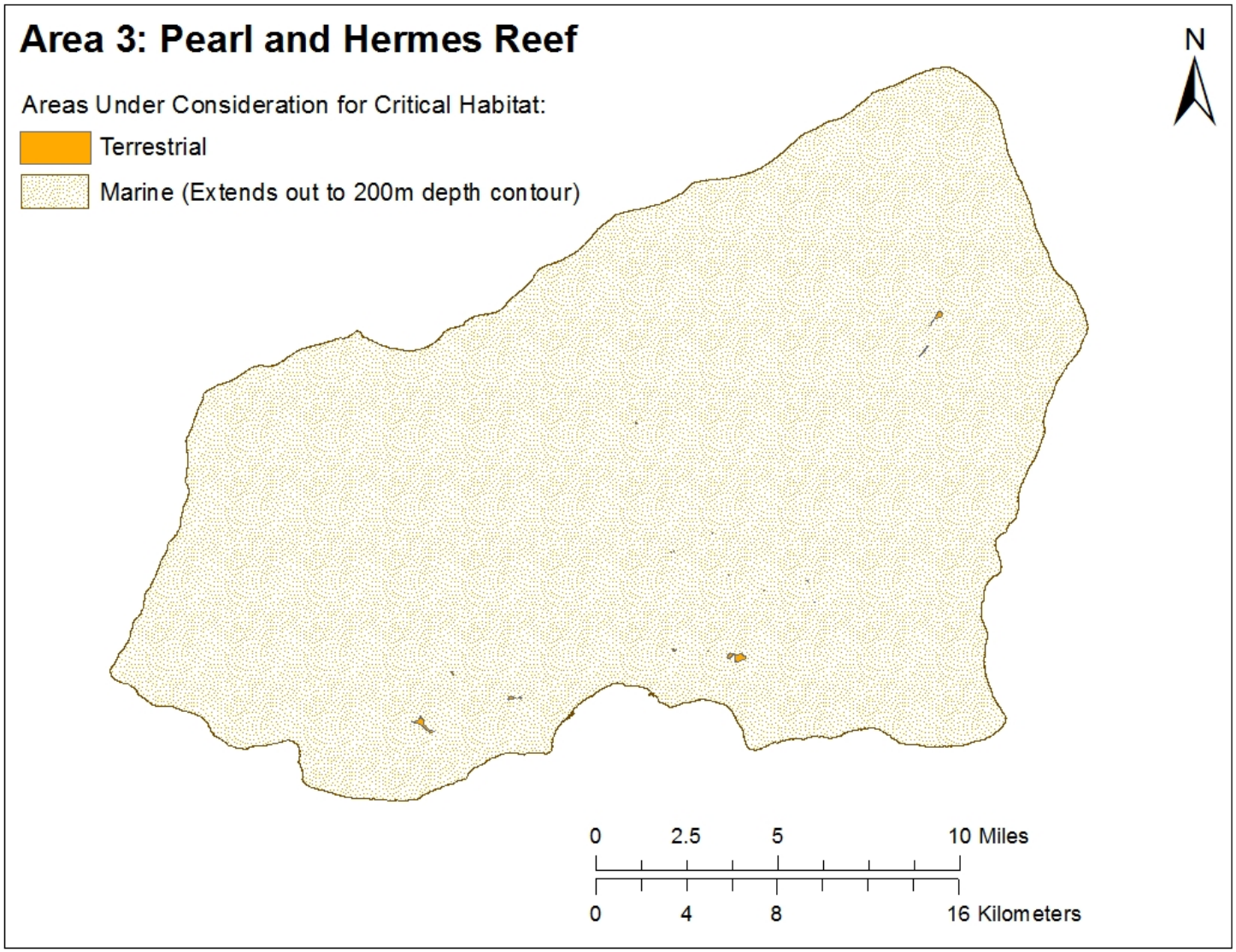

Figure 10. Pearl and Hermes Reef areas under consideration for critical habitat.

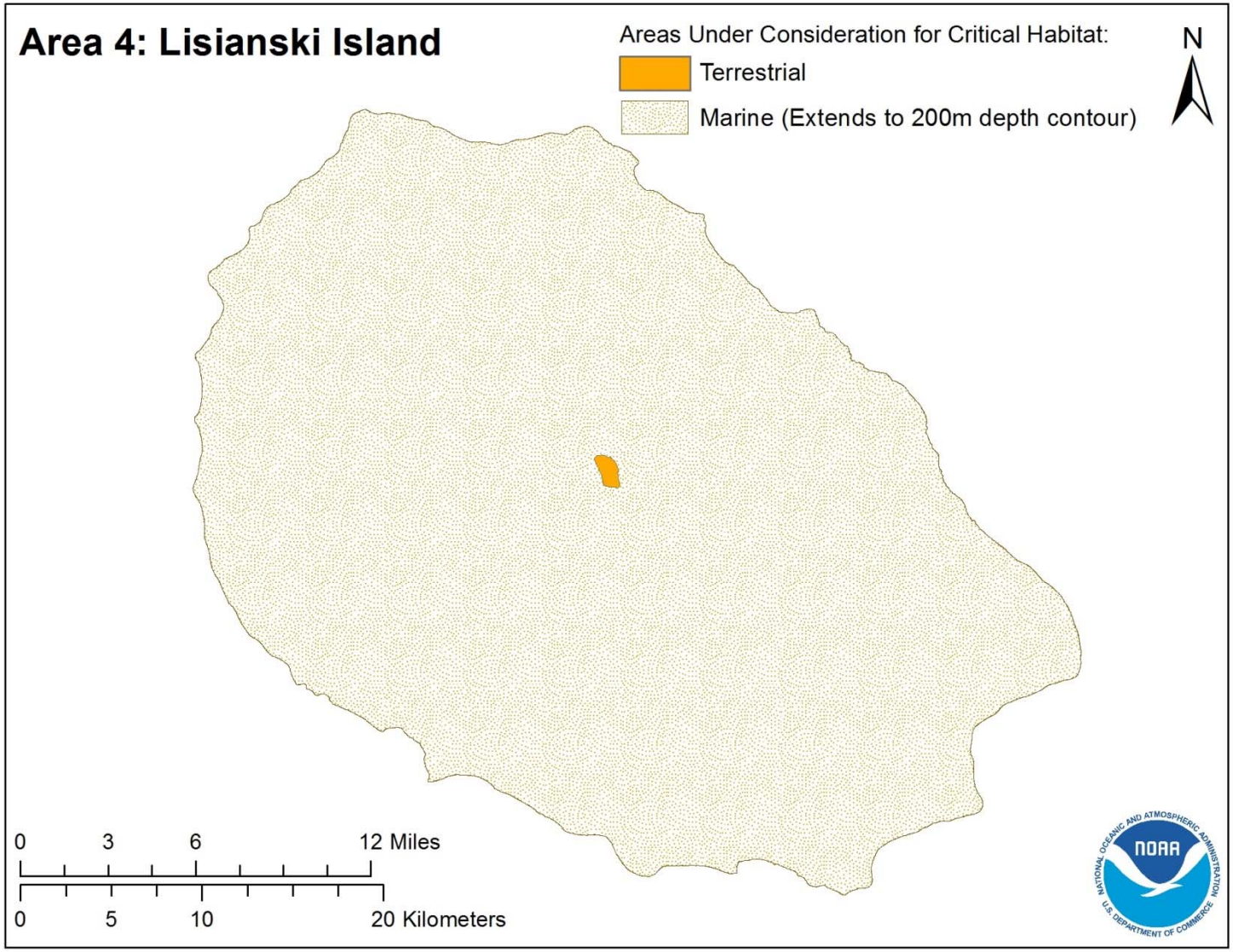

Figure 11. Lisianski Island areas under consideration for critical habitat.

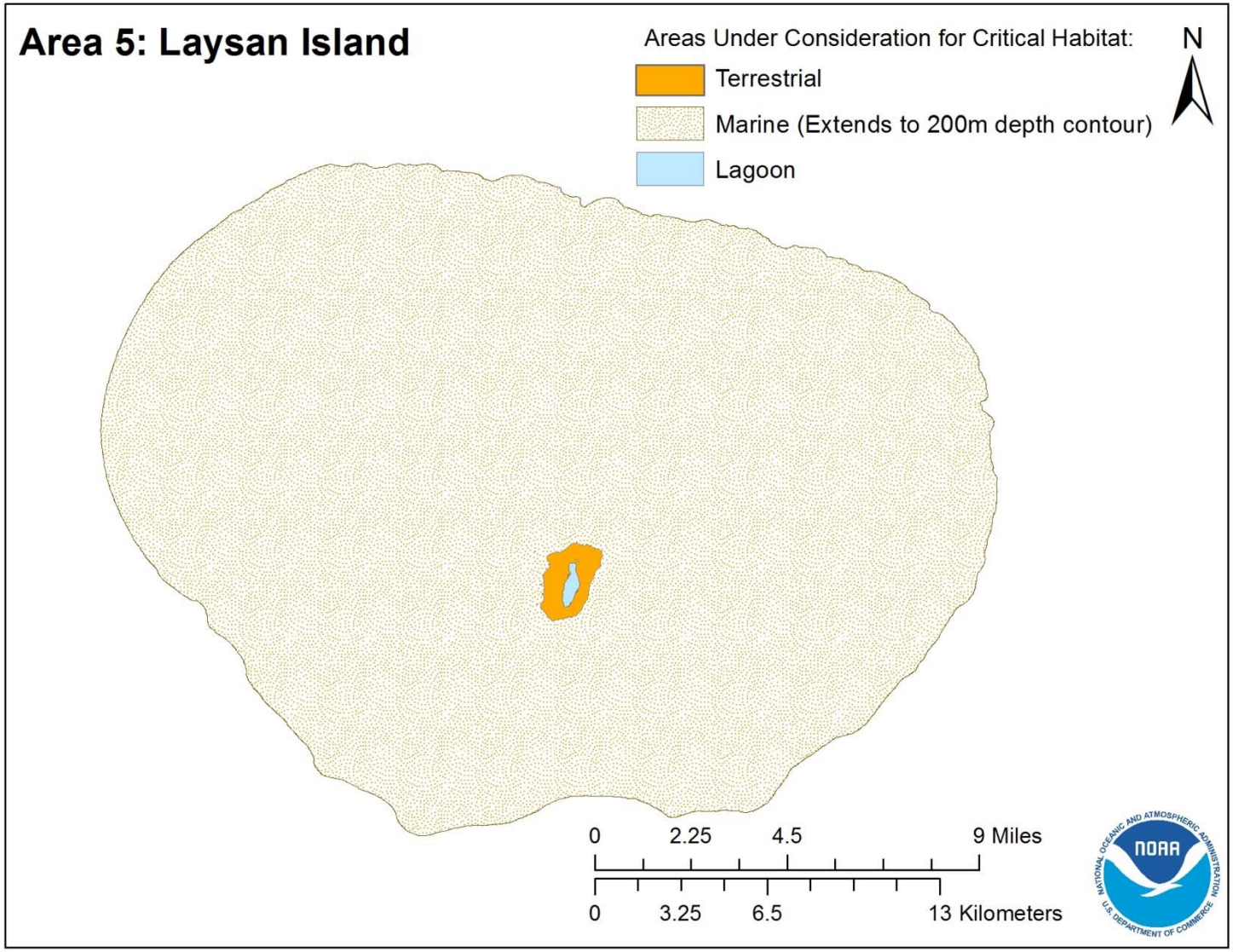

Figure 12. Laysan Island Areas under consideration for critical habitat.

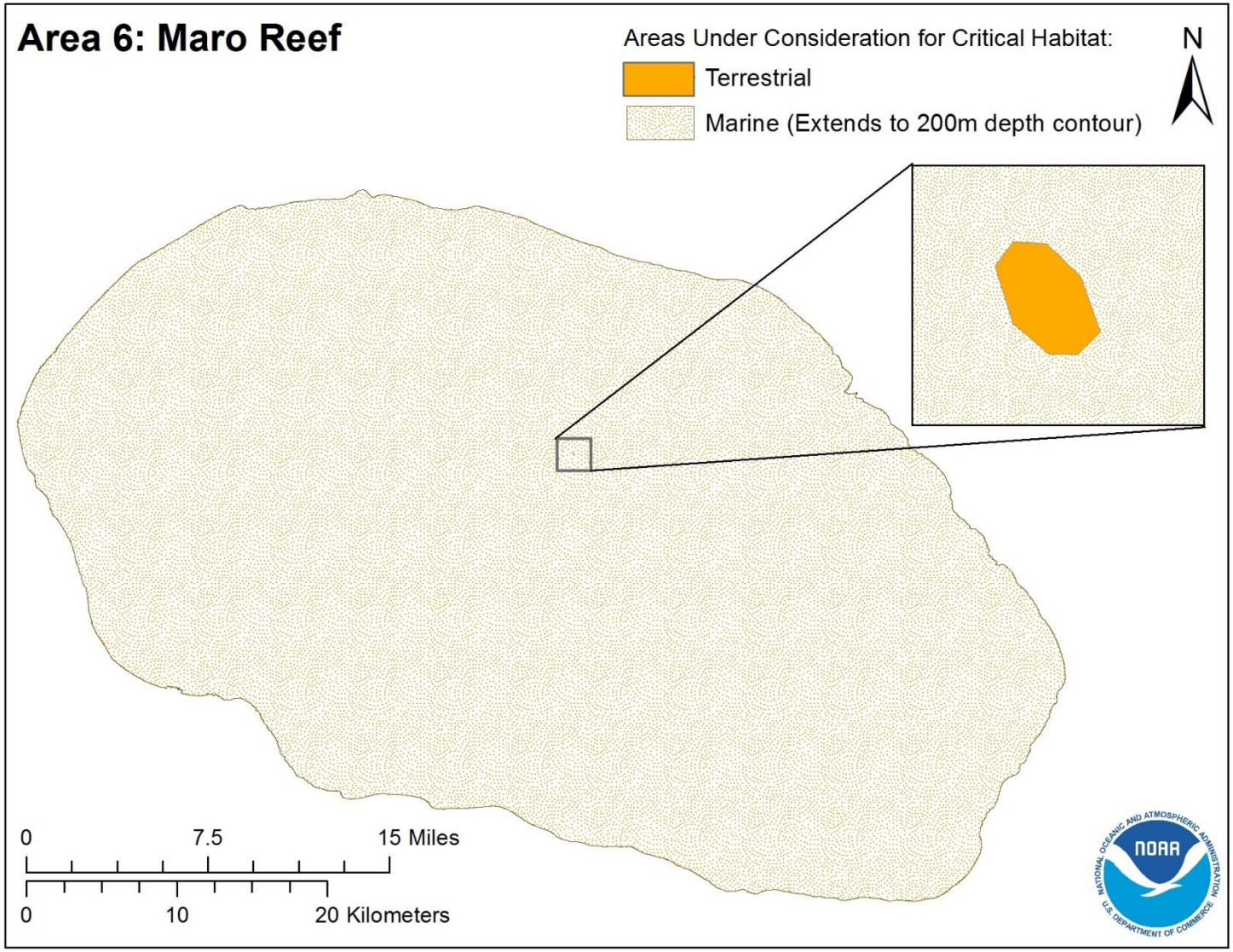

Figure 13. Maro Reef Areas under consideration for critical habitat.

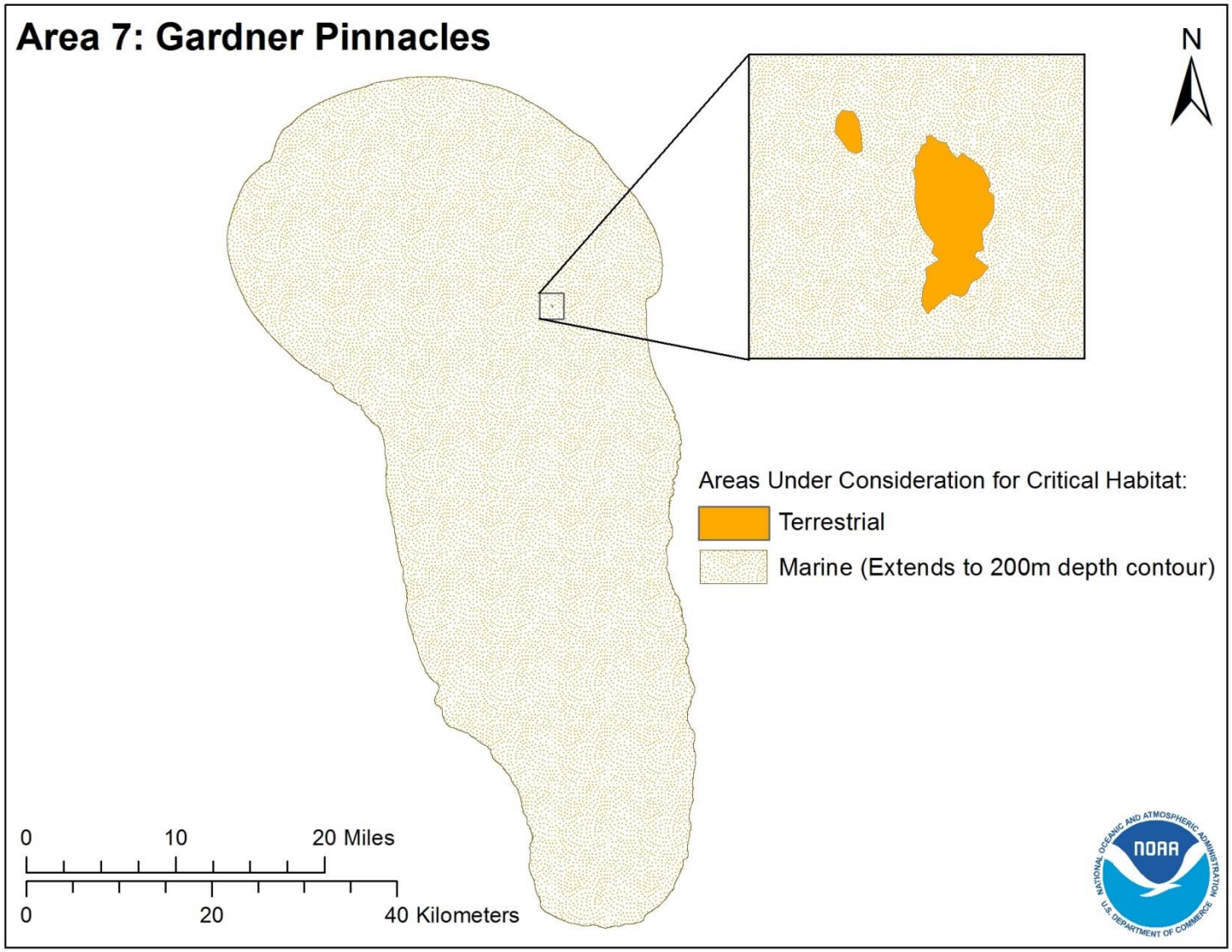

Figure 14. Gardner Pinnacles areas under consideration for critical habitat.

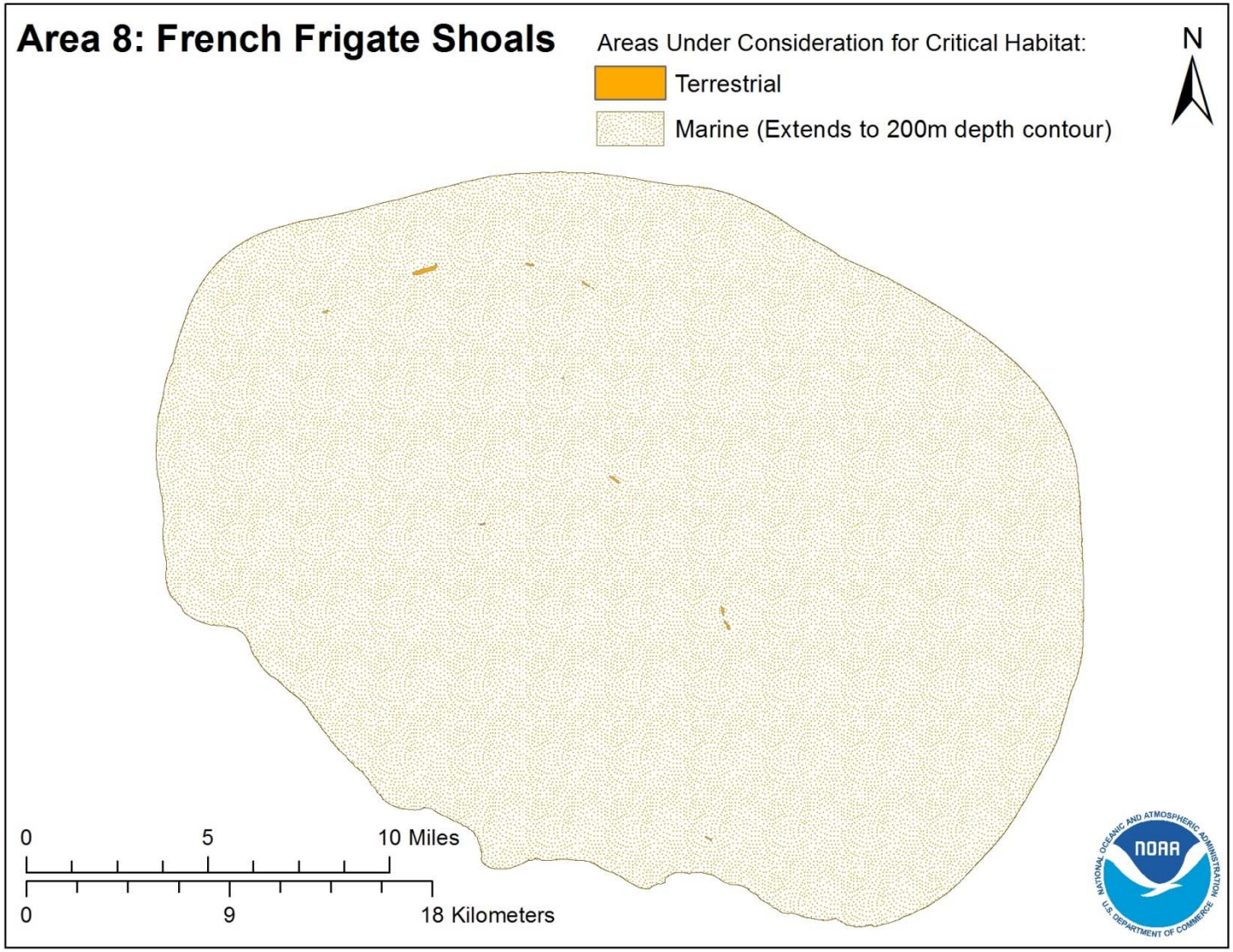

Figure 15. French Frigate Shoals areas under consideration for critical habitat.

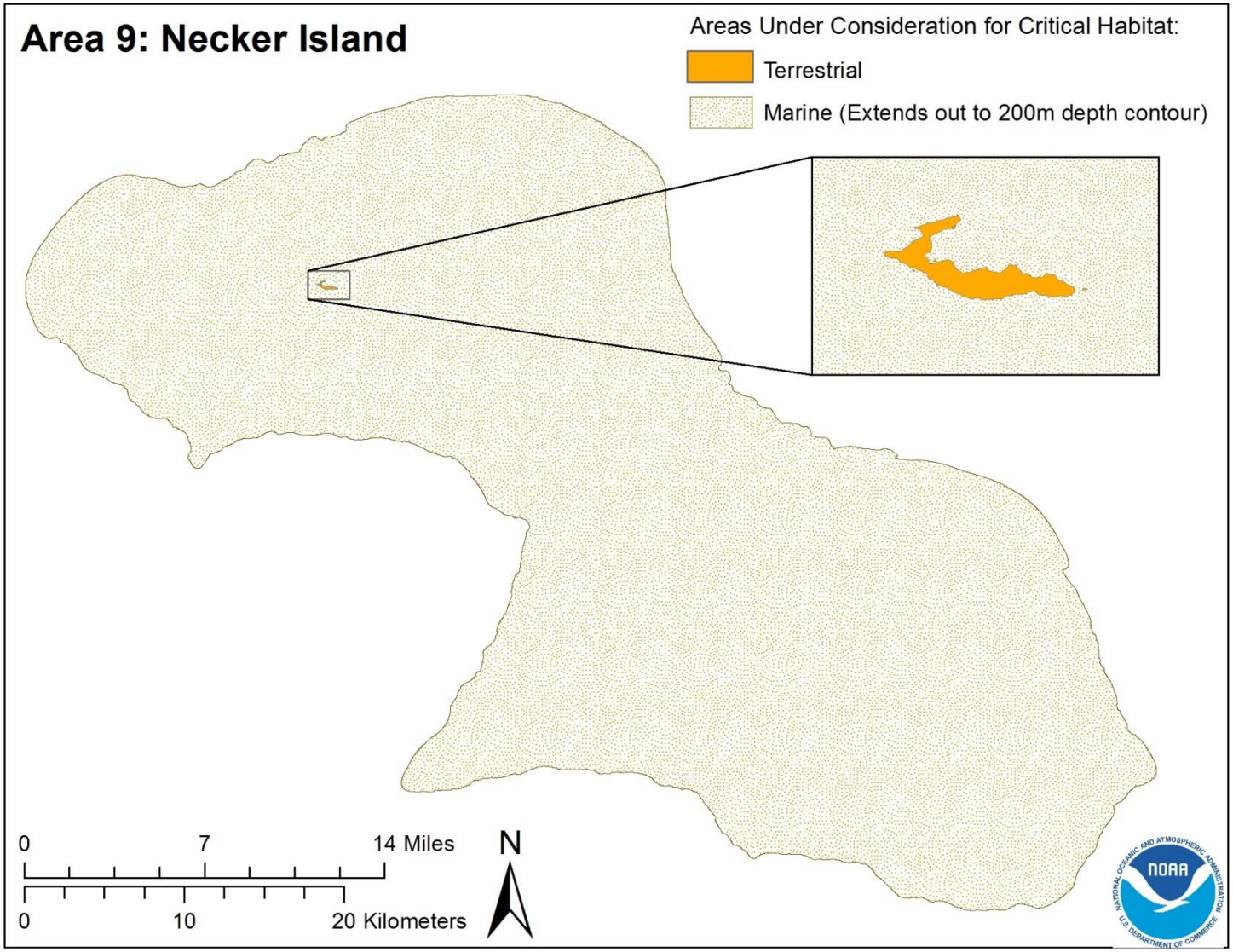

Figure 16. Necker Island areas under consideration for critical habitat.

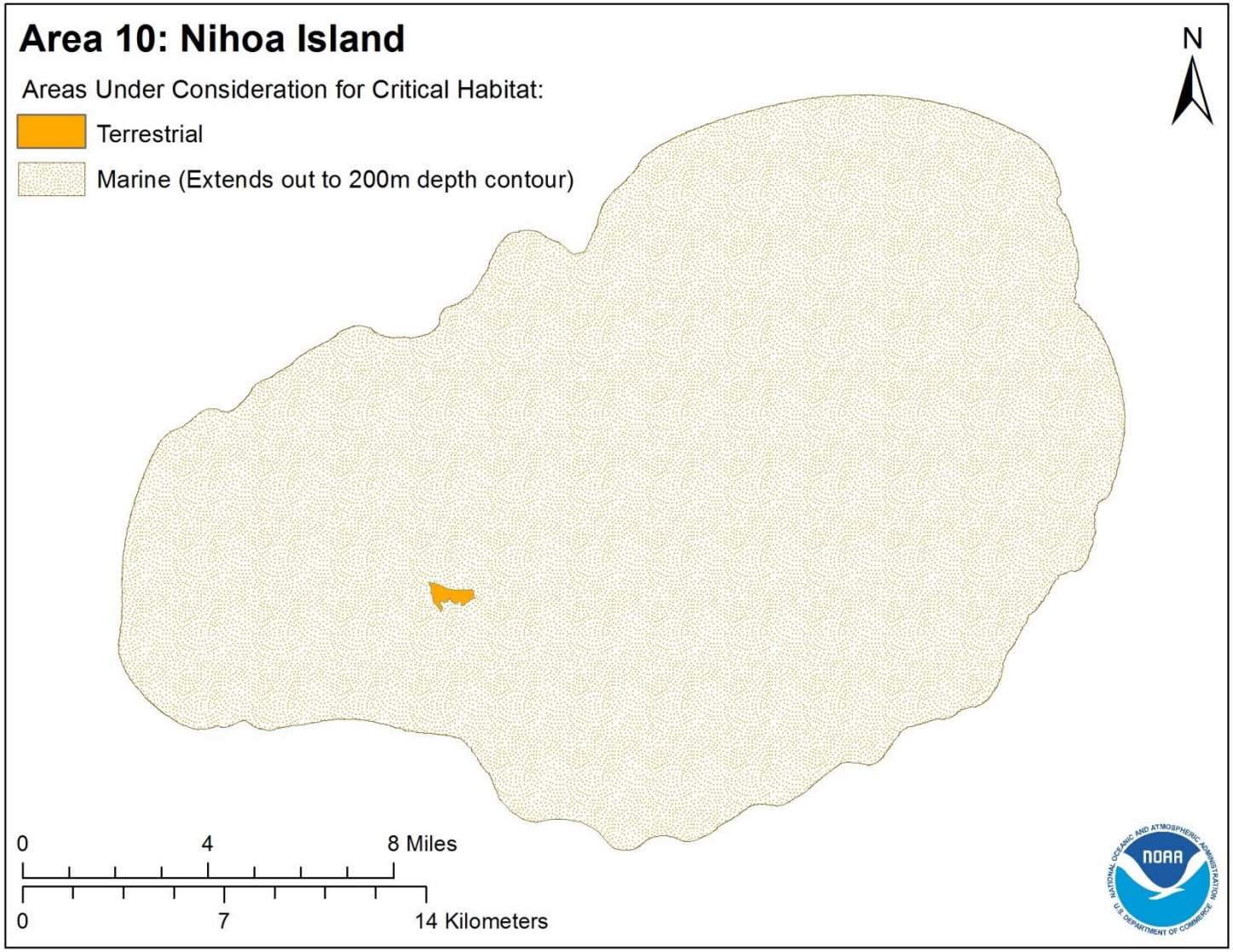

Figure 17. Nihoa Island areas under consideration for critical habitat.

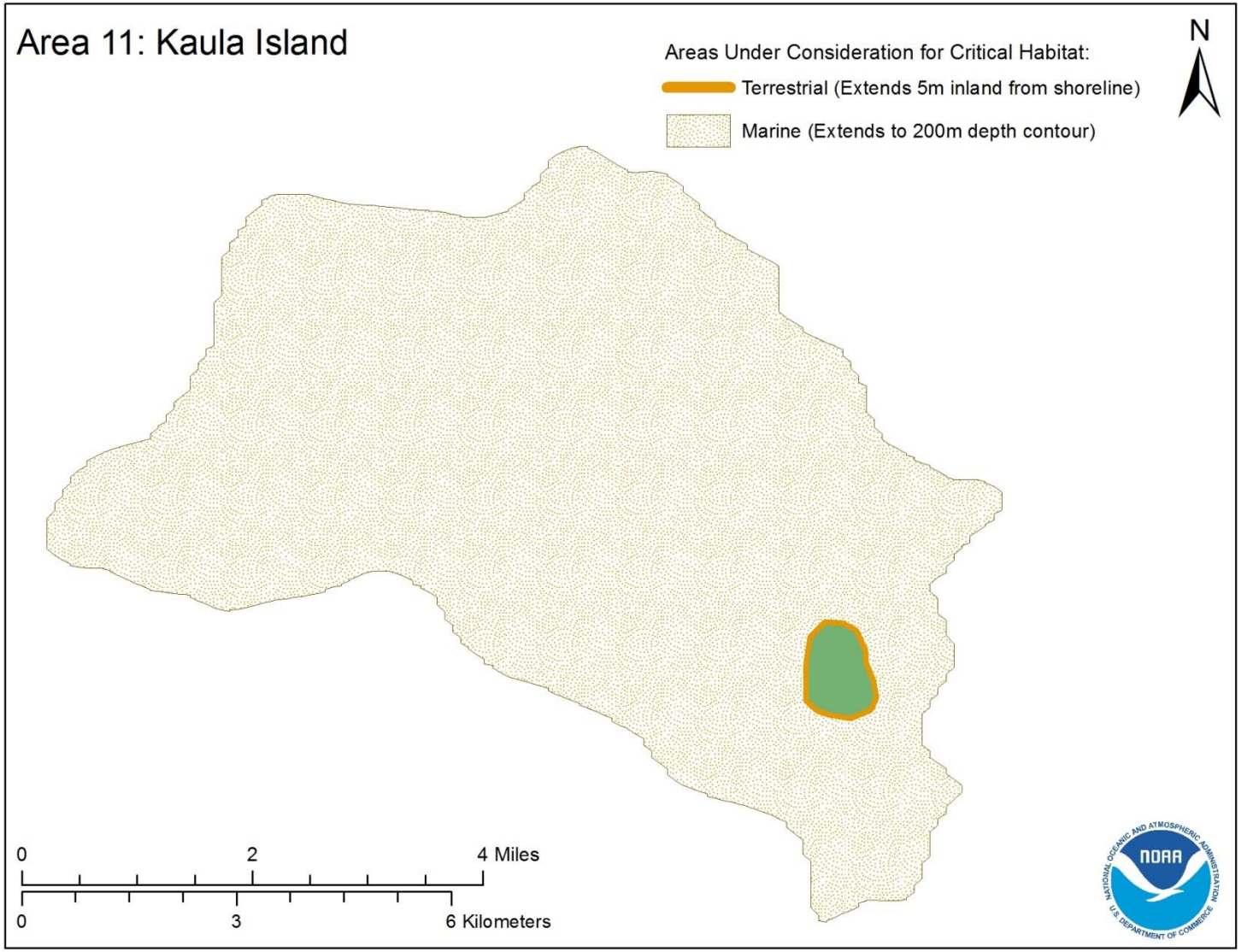

Figure 18. Kaula Island areas under consideration for critical habitat.

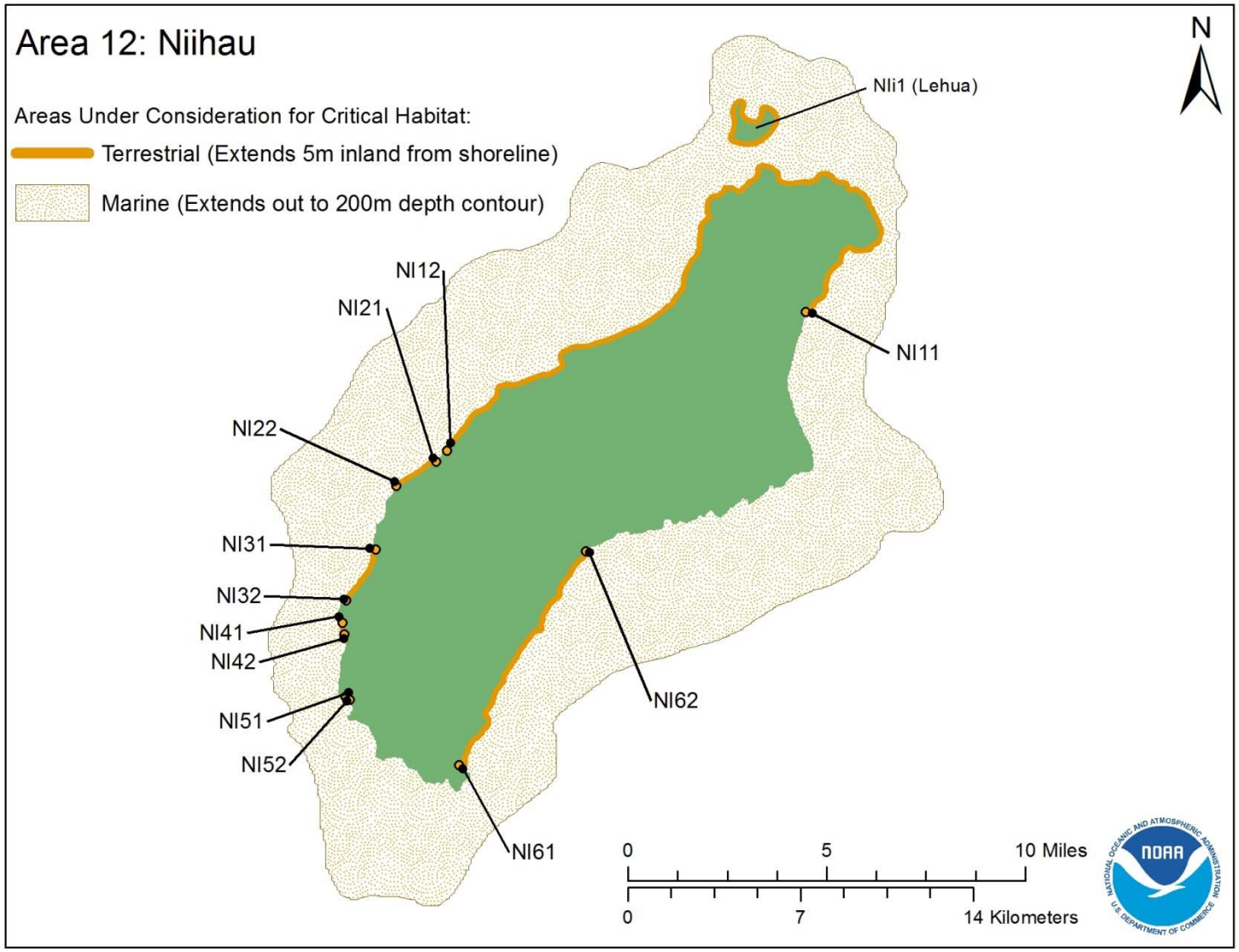

Figure 19. Niihau Island areas under consideration for critical habitat.
Reference Table 3 for Niihau coastal segments boundary points.

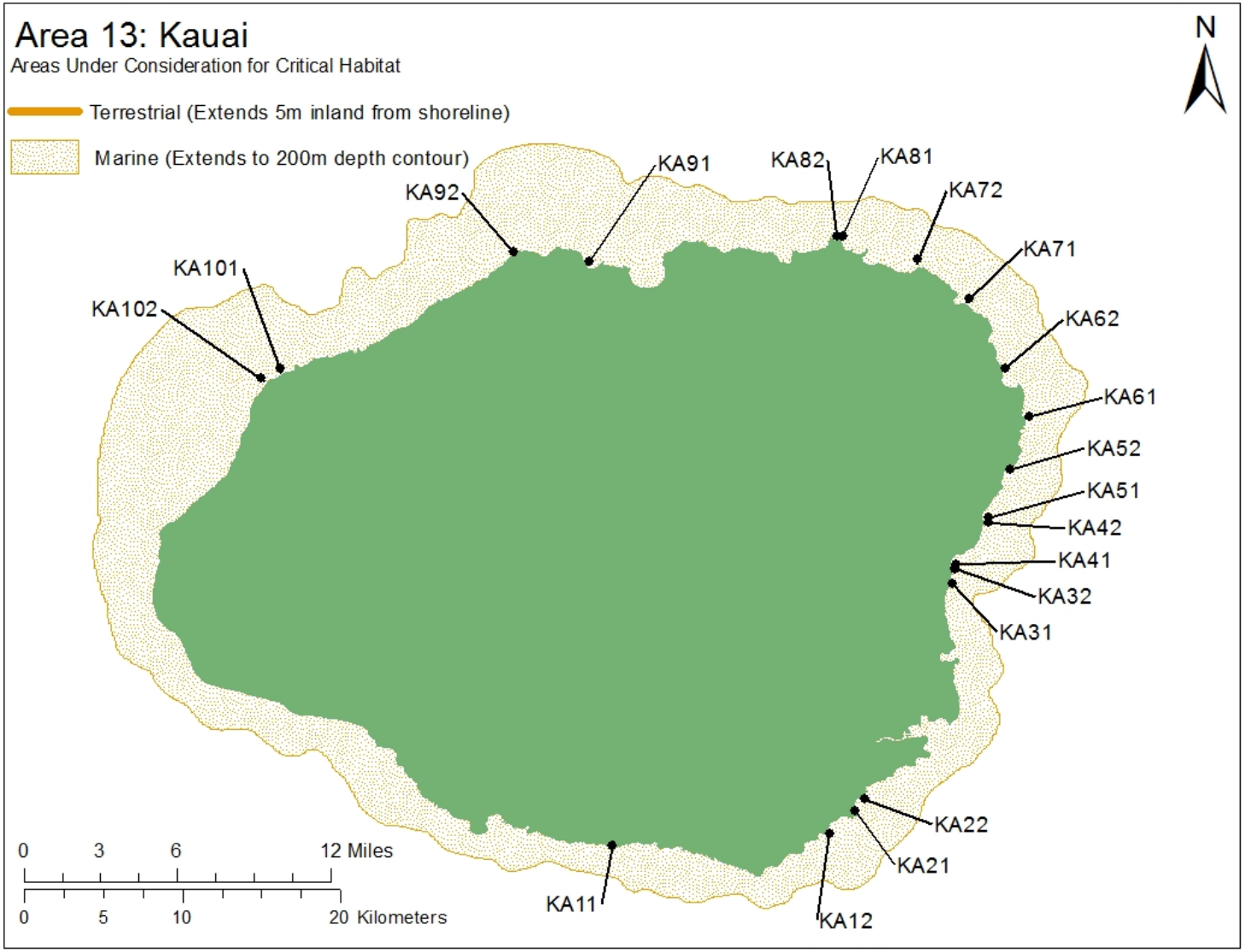

Figure 20. Kauai areas under consideration for critical habitat.
Reference Table 4 for Kauai coastal segments boundary points.

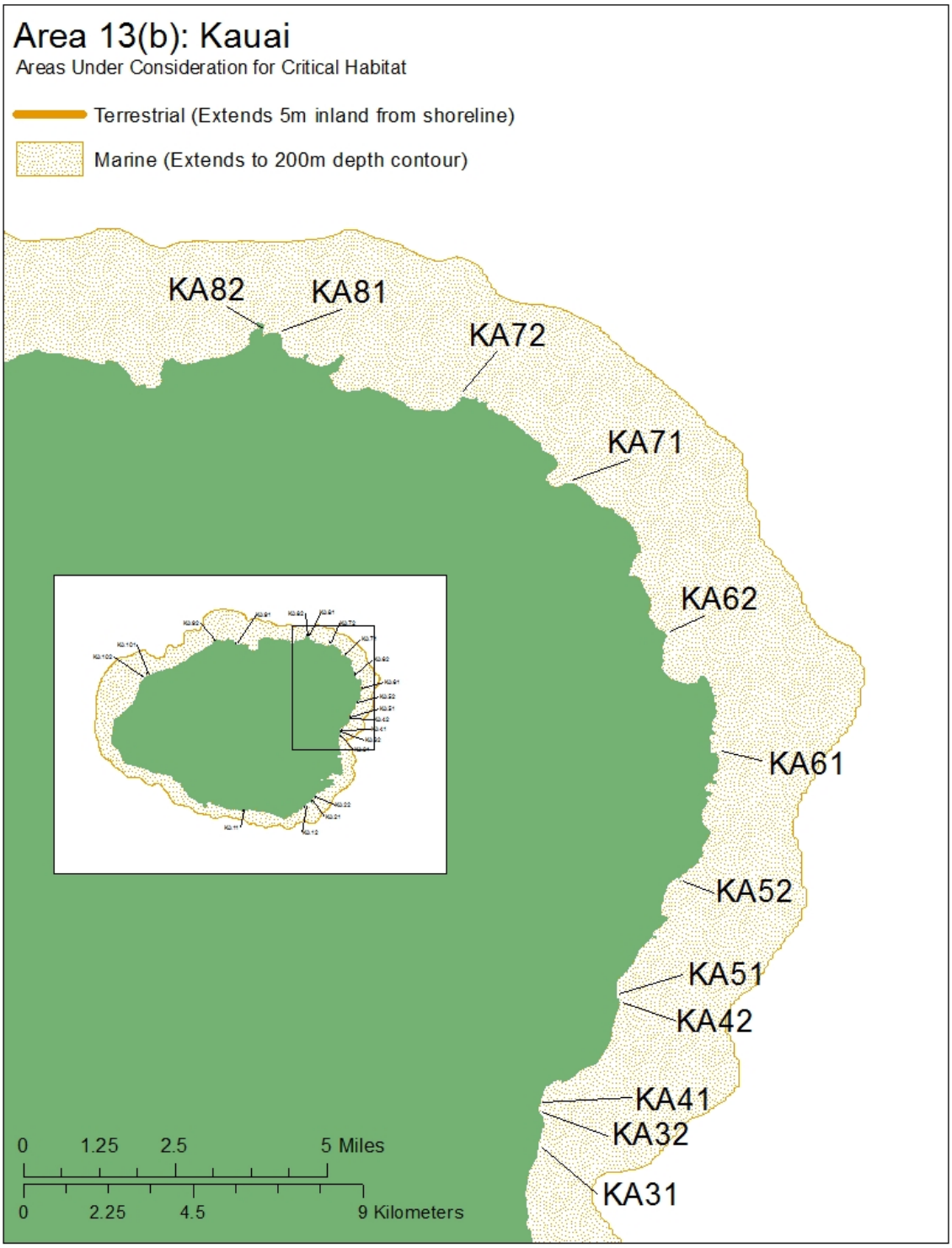

Figure 21. Northeast Kauai areas under consideration for critical habitat. Reference Table 4 for Kauai coastal segments boundary points.

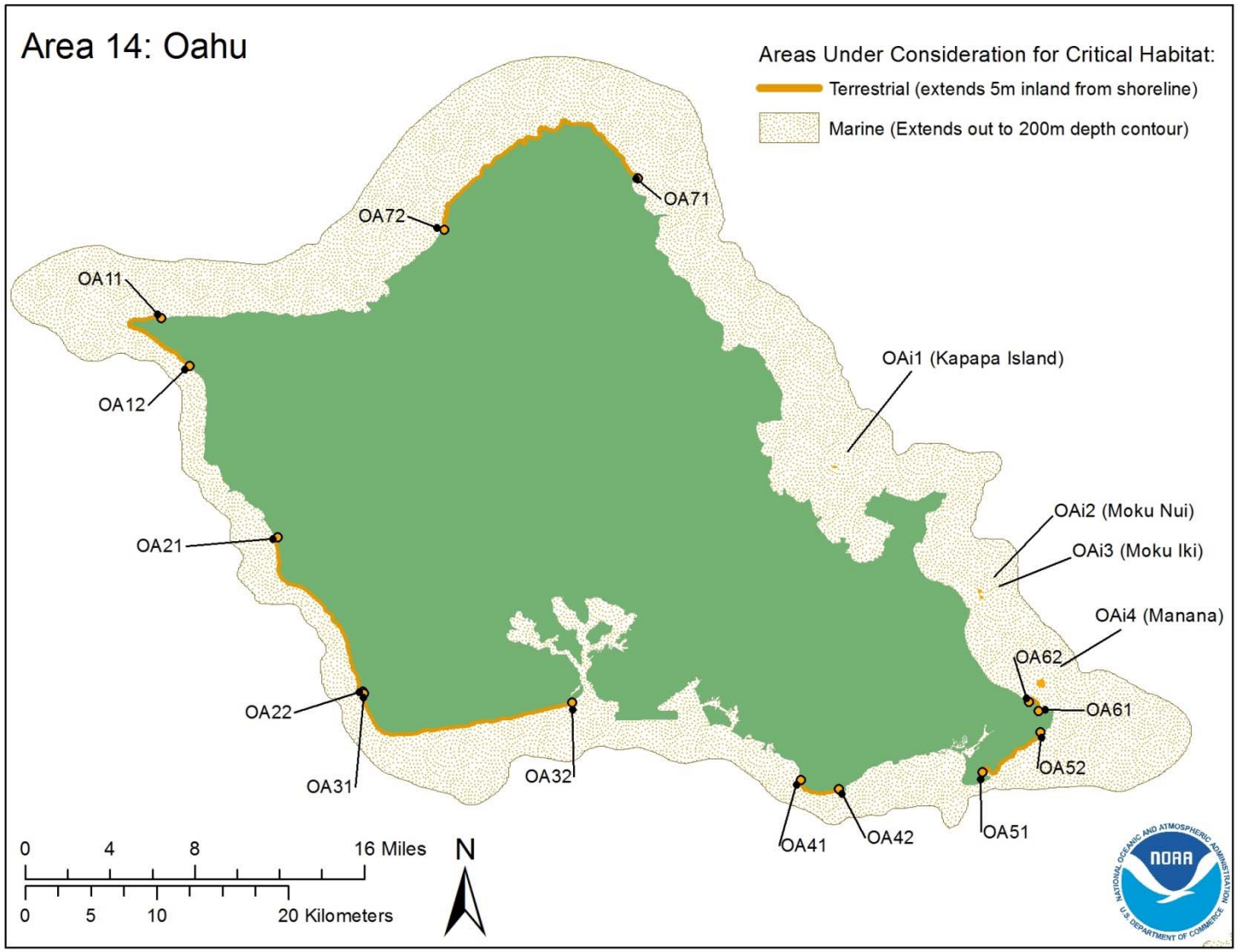

Figure 22. Oahu areas under consideration for critical habitat.
Reference Table 5 for Oahu coastal segments boundary points.

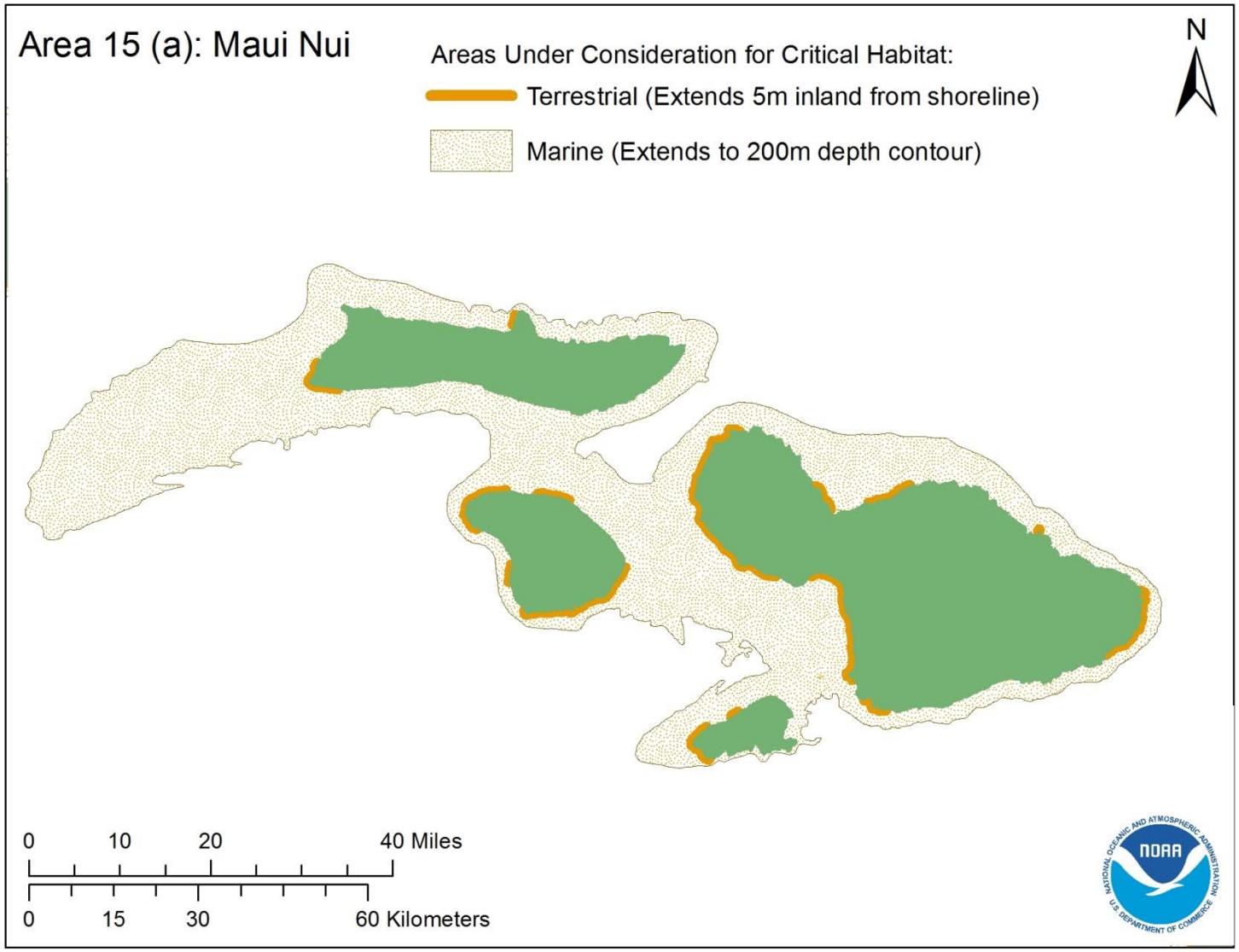

Figure 23. Maui Nui Area Areas under consideration for critical habitat.

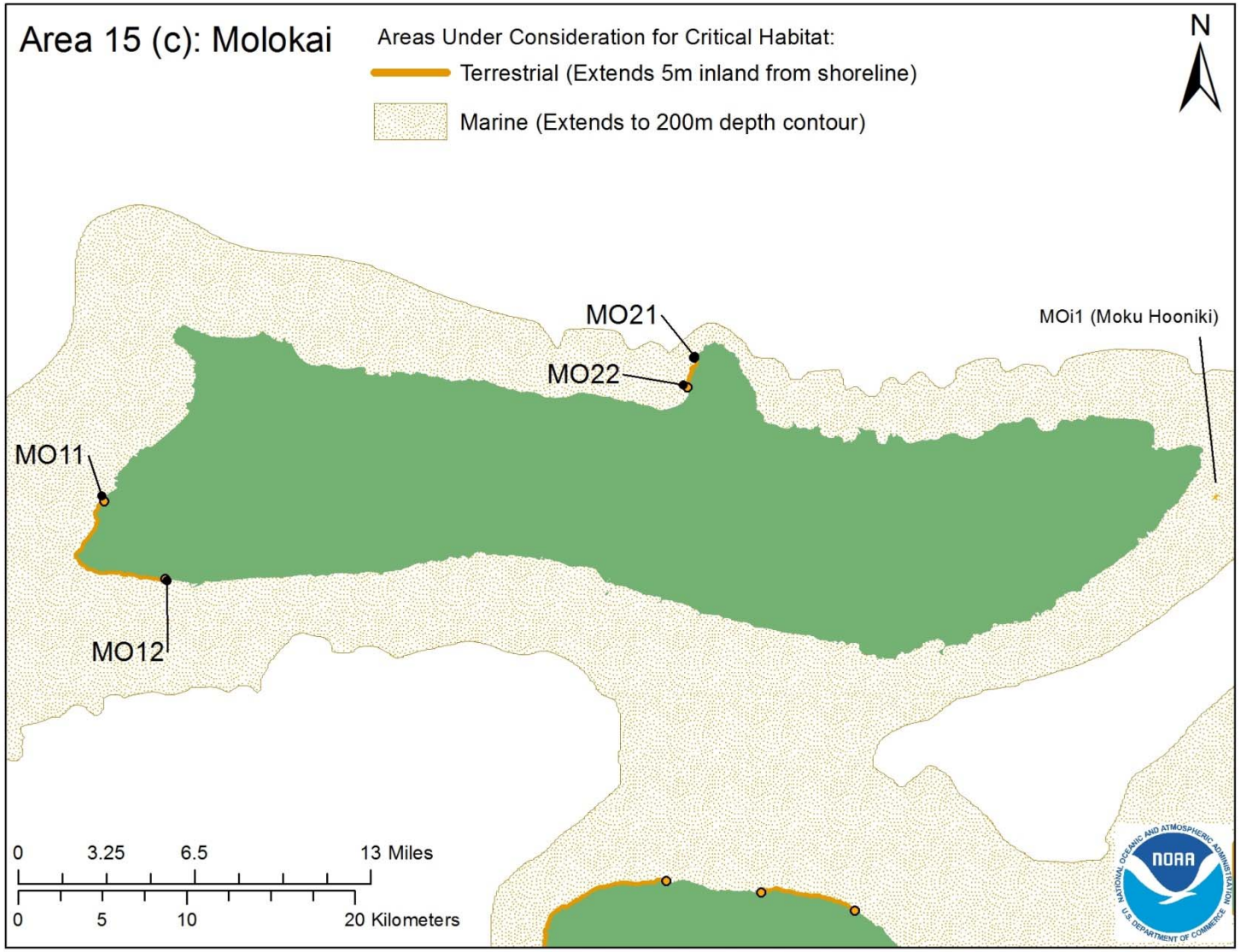

Figure 24. Molokai areas under consideration for critical habitat.
Reference Table 6 for Molokai coastal segments boundary points.

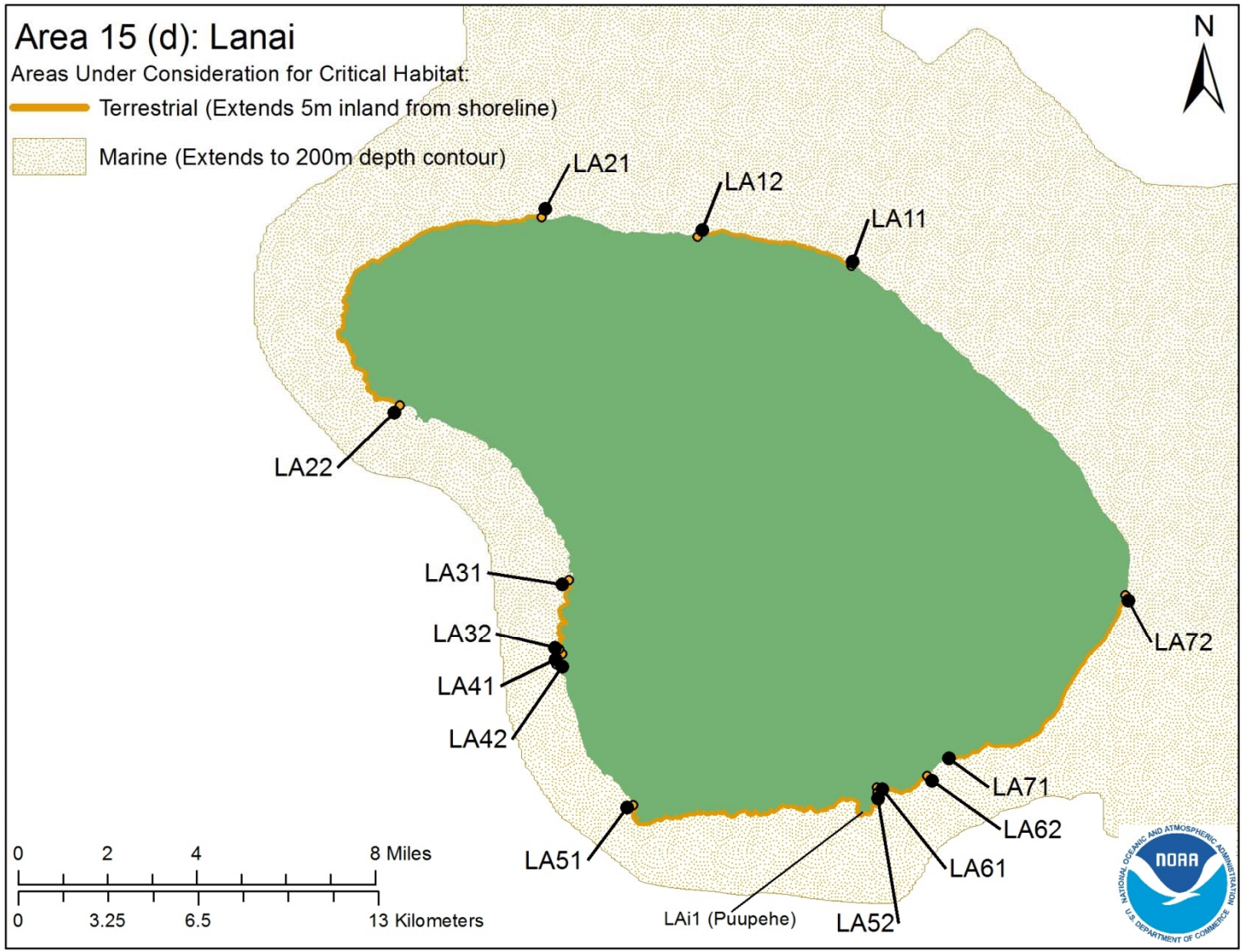

Figure 25. Lanai areas under consideration for critical habitat.
Reference Table 6 for Lanai coastal segments boundary points.

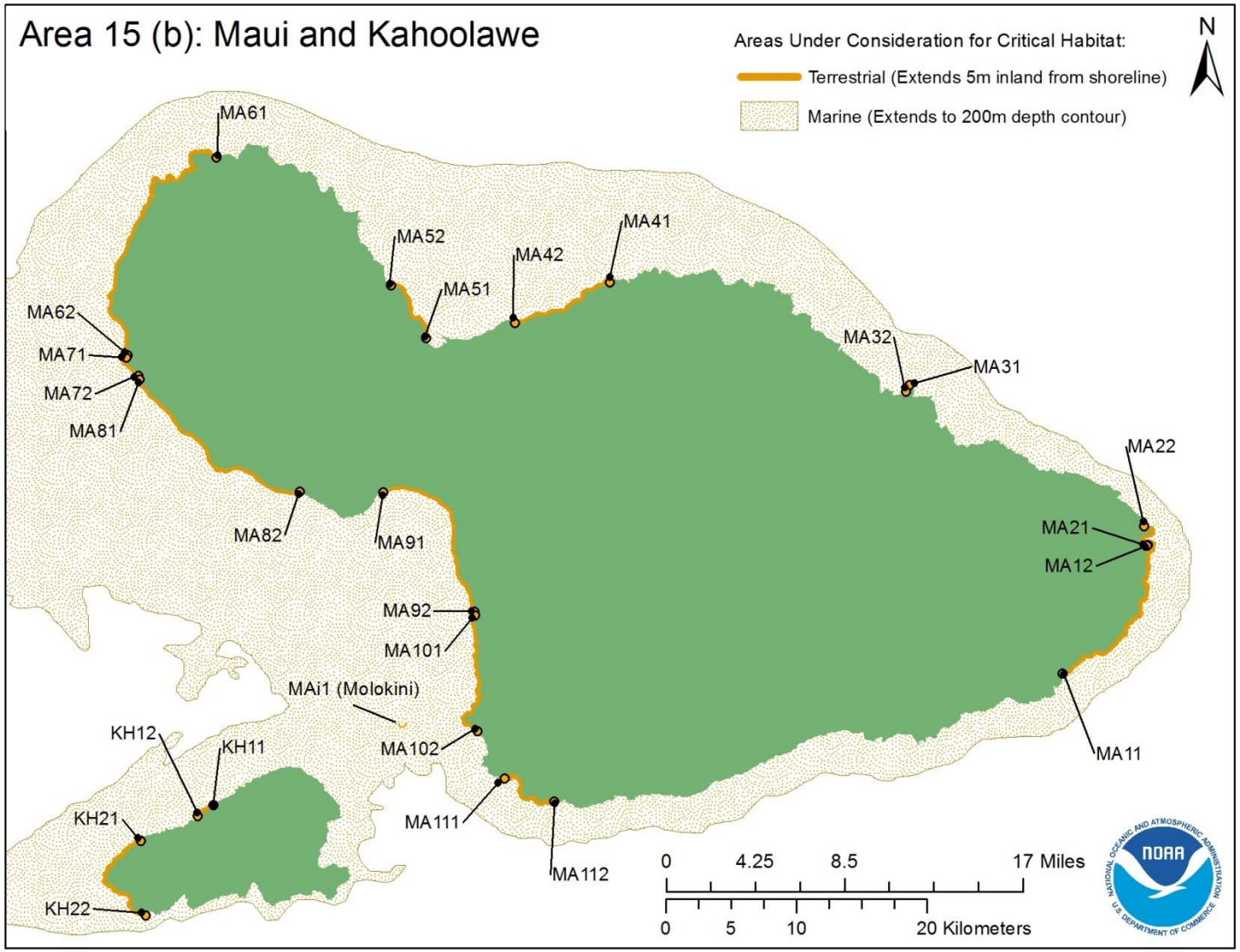

Figure 26. Maui and Kahoolawe areas under consideration for critical habitat. Reference Table 6 for Kahoolawe and Maui coastal segments boundary points.

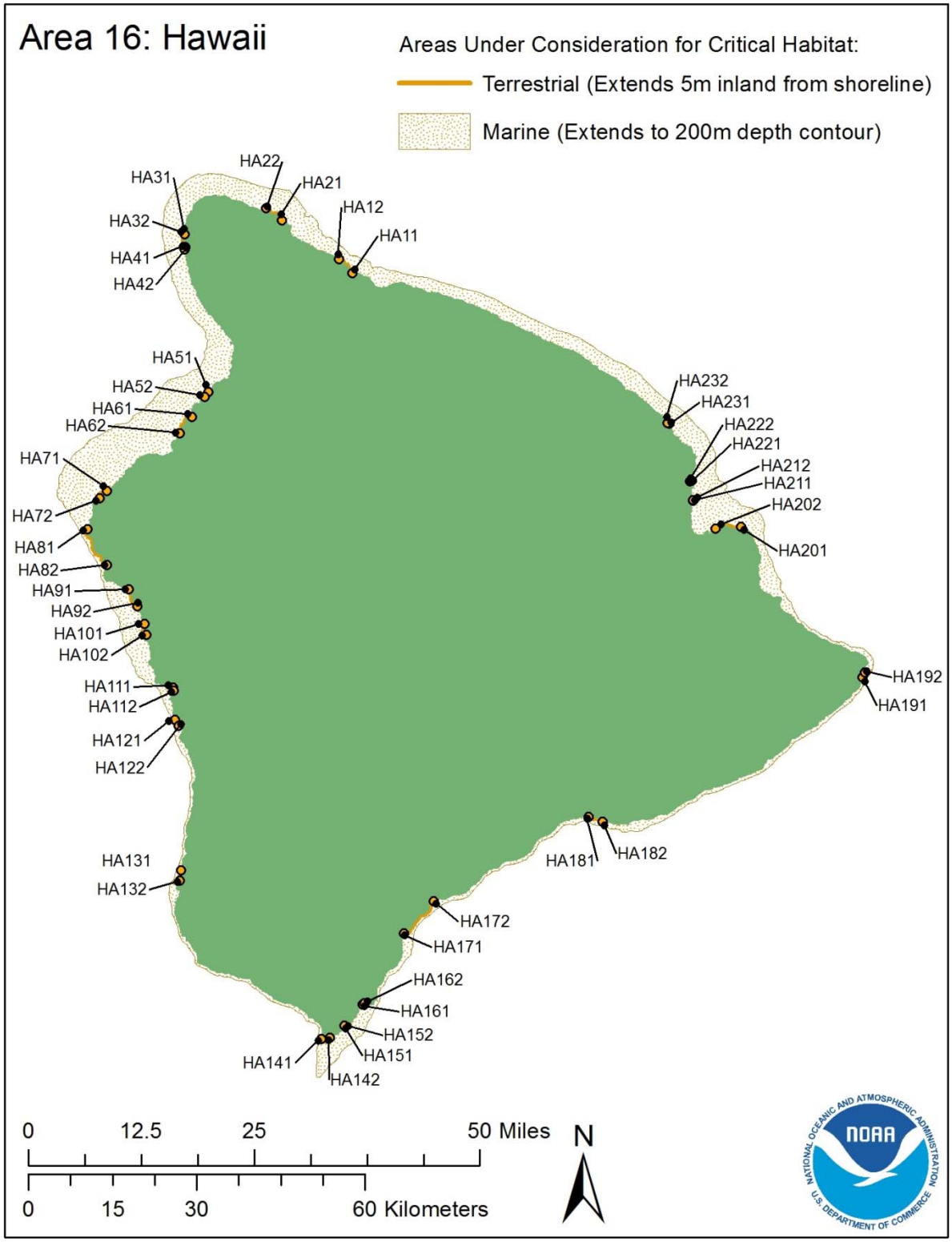

Figure 27. Hawaii Island areas under consideration for critical habitat. Reference Table 7 for Hawaii coastal segments boundary points.

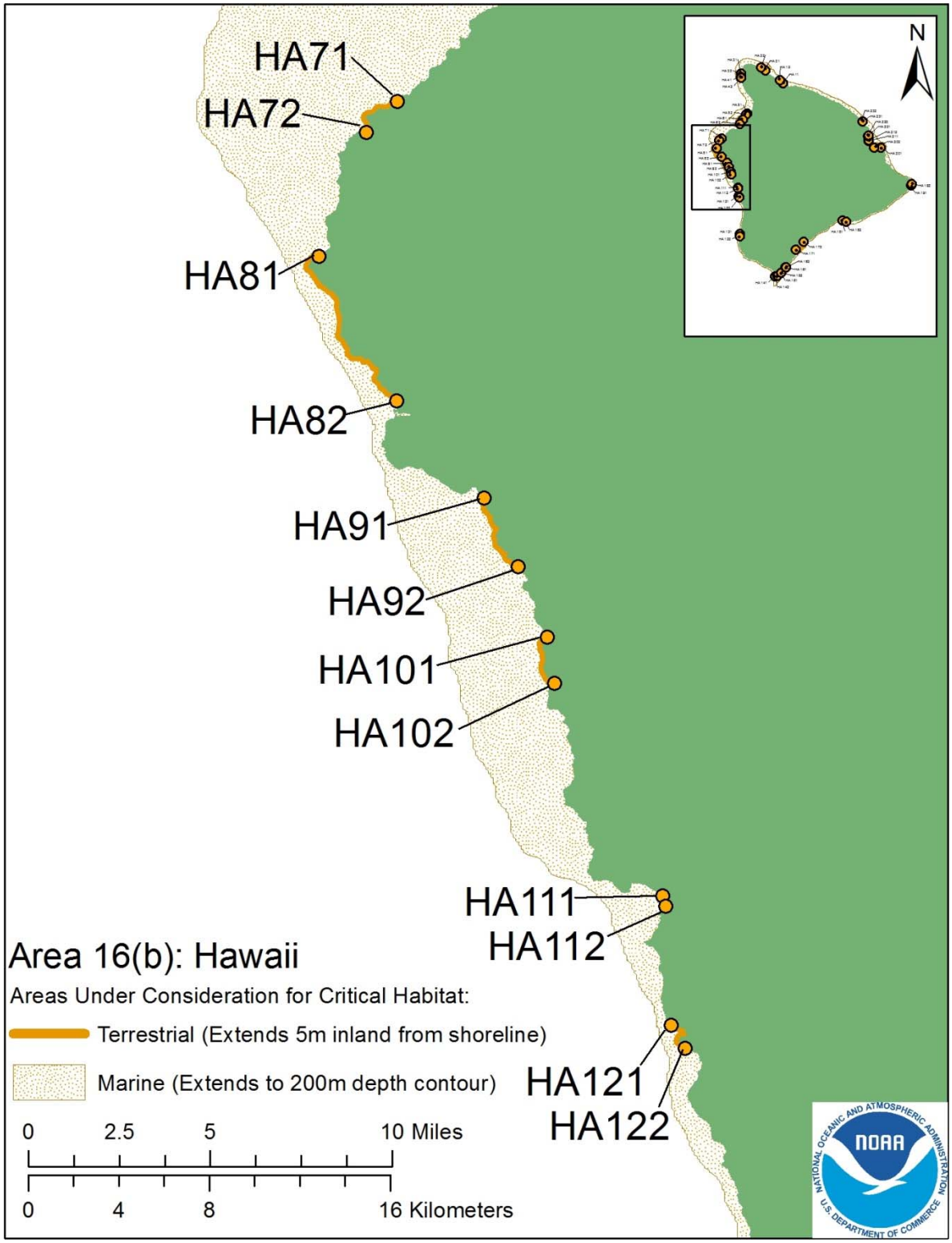

Figure 28. East coast Hawaii Island areas under consideration for critical habitat.
Reference **Table 7** for Hawaii coastal segment boundary points.

References Cited

Abernathy, K. (1999). *Foraging ecology of Hawaiian monk seals at French Frigate Shoals.* Master of Science, University of Minnesota.

Amerson, A. B., Jr., & Shelton, P. C. (1976). The Natural History of Johnston Atoll, Central Pacific Ocean: Hawaiian Monk Seal. *Atoll Research Bulletin, 192*(384).

Antonelis, G. A., Baker, J. D., Johanos, T. C., Braun, R. C., & Harting, a. A. L. (2006). Hawaiian Monk Seal (*Monachus schauinslandi*): Status and Conservation Issues. *Atoll Research Bulletin, 543*, 75-101.

Antonelis, G. A., Baker, J. D., & Polovina, J. J. (2003). Improved body condition of weaned Hawaiian monk seal pups associated with El Nino events: Potential benefits to an endangered species. *Marine Mammal Science, 19*(3), 590-598.

Arnason, U., Gullberg, A., Janke, A., Kullberg, M., Lehman, N., Petrov, E., & Väinölä, R. (2006). Pinniped phylogeny and a new hypothesis for their origin and dispersal. *Molecular phylogenetics and evolution, 41*(2), 345-354.

Athens, J., Tuggle, H., Ward, J., & Welch, D. (2002). Avifaunal Extinctions, Vegetation Change, and Polynesian Impacts in Prehistoric Hawai'i. *Archaeology in Oceania, 37*(2), 57-79.

Bailey, A. M. (1952). The Hawaiian monk seal. *Denver Museum of Natural History, Museum Pictorial, 7*, 1-32.

Baker, J. (2008). Variation in the relationship between offspring size and survival provides insight into causes of mortality in Hawaiian monk seals. *Endangered Species Research, 5*, 55-64.

Baker, J., Becker, B., Wurth, T., Johanos, T., Littnan, C., & Henderson, J. (2011). Translocation as a tool for conservation of the Hawaiian monk seal. *Biological Conservation, 144*(11), 2692-2701.

Baker, J., Harting, A., & Johanos, T. (2006). Use of discovery curves to assess abundance of Hawaiian monk seals. *Marine Mammal Science, 22*(4), 847-861.

Baker, J. D. (2004). Evaluation of closed capture-recapture methods to estimate abundance of Hawaiian monk seals. *Ecological Applications, 14*(4), 987-998.

Baker, J. D., Charles L. Littnan, David W. Johnston. (2006). Potential effects of sea level rise on the terrestrial habitats of endangered and endemic megafauna in the Northwestern Hawaiian Islands. *Endangered Species Research, 2*, 21-30.

Baker, J. D., Harting, A. L., Wurth, T. A., & Johanos, T. C. (2011). Dramatic shifts in Hawaiian monk seal distribution predicted from divergent regional trends. *Marine Mammal Science, 27*(1), 78-93.

Baker, J. D., Howell, E. A., & Polovina, J. J. (2012). Relative influence of climate variability and direct anthropogenic impact on a sub-tropical Pacific top predator, the Hawaiian monk seal. *Marine Ecology Progress Series, 469*, 175.

Baker, J. D., & Johanos, T. C. (2004). Abundance of the Hawaiian monk seal in the main Hawaiian Islands. *Biological Conservation, 116*(1), 103-110. doi: 10.1016/s0006-3207(03)00181-2

Baker, J. D., Polovina, J. J., & Howell, E. A. (2007). Effect of variable oceanic productivity on the survival of an upper trophic predator, the Hawaiian monk seal Monachus schauinslandi. *Marine Ecology-Progress Series, 346*, 277-283. doi: 10.3354/meps06968

Cahoon, M. (2011). *The Foraging Ecology of Monk Seals in the Main Hawaiian Islands.* Master of Science, University of Hawaii, Honolulu, Hawaii.

Carretta, J. V., Oleson, E., Weller, D. W., Lang, A. R., Forney, K., Baker, J., . . . Hill, M. (2007). *U.S. Pacific Marine Mammal Stock Assessments: 2007.* Southwest Fisheries Science Center.

Carretta, J. V., Oleson, E., Weller, D. W., Lang, A. R., Forney, K., Baker, J., . . . Hill, M. (2009). *U.S. Pacific Marine Mammal Stock Assessments: 2009* Southwest Fisheries Science Center.

Carretta, J. V., Oleson, E., Weller, D. W., Lang, A. R., Forney, K., Baker, J., . . . Hill, M. (2013). *U.S. Pacific Marine Mammal Stock Assessments: 2013* (NOAA-TM -NMFS-SWFSC-504). Southwest Fisheries Science Center.

Center for Biological Diversity, K., Ocean Conservancy. (2008). Petition to Revise Critical Habitat for the Hawaiian Monk Seal (*Monachus schauinslandi*) under the Endangered Species Act.

Commander U.S. Coast Guard, S. H. (2010). *Hawaii Area Contingency Plan*. Honolulu, HI: U.S. Coast Guard.

Craig, M. P., & Ragen, T. J. (1999). Body size, survival, and decline of juvenile Hawaiian monk seals, *Monachus schauinslandi*. *Marine Mammal Science, 15*(3), 786-809.

de Swart, R., Ross, P., Vos, J., & Osterhaus, A. (1996). Impaired immunity in harbour seals (*Phoca vitulina*) exposed to bioaccumulated environmental contaminants: review of a long-term feeding study. *Environmental Health Perspectives, 104*(Suppl 4), 823.

de Sylva, D. (1994). Distribution and ecology of ciguatera fish poisoning in Florida, with emphasis on the Florida Keys. *Bulletin of Marine Science, 54*(3), 944-954.

Defeo, O., McLachlan, A., Schoeman, D., Schlacher, T., Dugan, J., Jones, A., . . . Scapini, F. (2009). Threats to sandy beach ecosystems: A review. *Estuarine, Coastal and Shelf Science, 81*(1), 1-12.

Department of Energy, U. S. (2009). Report to Congress on the Potential Environmental Effects of Marine and Hydrokinetic Energy Technologies. (December 2009).

Diamond, J., Ashmole, N., & Purves, P. (1989). The Present, Past and Future of Human-Caused Extinctions [and Discussion]. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 325*(1228), 469-477.

Donohue, M. J., Boland, R. C., Sramek, C. M., & Antonelis, G. A. (2001). Derelict fishing gear in the Northwestern Hawaiian Islands: Diving surveys and debris removal in 1999 confirm threat to coral reef ecosystems. *Marine Pollution Bulletin, 42*(12), 1301-1312.

ECONorthwest. (2010). *Draft Economic Analysis of Critical Habitat Designation for the Hawaiian Monk Seal*. Eugene, OR: ECONorthwest.

Erftemeijer, P. L., Riegl, B., Hoeksema, B. W., & Todd, P. A. (2012). Environmental impacts of dredging and other sediment disturbances on corals: a review. *Marine Pollution Bulletin*.

Fleischer, R., McIntosh, C., & Tarr, C. (1998). Evolution on a volcanic conveyor belt: using phylogeographic reconstructions and K–Ar-based ages of the Hawaiian Islands to estimate molecular evolutionary rates. *Molecular Ecology, 7*(4), 533-545.

Fyler, C., Reeder, T., Berta, A., Antonelis, G., Aguilar, A., & Androukaki, E. (2005). Historical biogeography and phylogeny of monachine seals (Pinnipedia: Phocidae) based on mitochondrial and nuclear DNA data. *Journal of Biogeography, 32*(7), 1267-1279.

Goodman-Lowe, G., Carpenter, J., & Atkinson, S. (1999). Assimilation efficiency of prey in the Hawaiian monk seal (*Monachus schauinslandi*). *Canadian Journal of Zoology, 77*(4), 653-660.

Goodman-Lowe, G. D. (1998). Diet of the Hawaiian monk seal (*Monachus schaunislandi*) from the Northwestern Hawaiian Islands during 1991-1994. *Marine Biology, 132*, 535-546.

Harting, A. L., Baker, J. D., & Johanos, T. C. (2007). Reproductive patterns of the Hawaiian monk seal. *Marine Mammal Science, 23*(3), 553-573. doi: 10.1111/j.1748-7692.2007.00136.x

Harvell, C., Mitchell, C., Ward, J., Altizer, S., Dobson, A., Ostfeld, R., & Samuel, M. (2002). Climate warming and disease risks for terrestrial and marine biota. *Science, 296*(5576), 2158.

Henderson, J. R., and Johanos, T.C. (1988). Effects of tagging on weaned Hawaiian monk seal pups. *Wildlife Society Bulletin, 16*, 312-317.

Hoegh-Guldberg, O., Mumby, P., Hooten, A., Steneck, R., Greenfield, P., Gomez, E., . . . Caldeira, K. (2007). Coral reefs under rapid climate change and ocean acidification. *Science, 318*(5857), 1737.

Industrial Economics, I. (2014). Draft Economic Analysis of Critical Habitat Designation for the Hawaiian Monk Seal. *Prepared for National Marine Fisheries Service*.

IPCC. (2007). Climate Change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. *Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA*.

IPCC. (September 2013). Working Group I Contribution to the IPCC Fifth Assessment Report (AR5), Climate Change 2013: The Physical Science Basis. Chapter 13 - Sea Level Change - Final Draft Underlying Scientific-Technical Assessment.

Iverson, S., J. Piche, and W. Blanchard. (2006). Hawaiian monk seals and their prey in the Northwestern Hawaiian Islands: Assessing characteristics of prey species fatty acid signatures and consequences for estimating monk seal diets using quantitative fatty acid signature analysis (QFASA). *Unpublished report. Pacific Islands Fisheries Science Center, Honolulu, HI*, 134 p.

Job, D., Boness, D., & Francis, J. (1995). Individual variation in nursing vocalizations of Hawaiian monk seal pups, *Monachus schauinslandi* (Phocidae, Pinnipedia), and lack of maternal recognition. *Canadian Journal of Zoology, 73*(5), 975-983.

Johanos, T. C., and A. K. H. Kam. (1986). *The Hawaiian monk seal on Lisianski Island: 1983*.

Johanos, T. C., Becker, B. L., & Ragen, T. J. (1994). Annual reproductive cycle of the female Hawaiian monk seal (*Monachus schauislandi*). *Marine Mammal Science, 10*, 13-30.

Juvik, S., & Juvik, J. (1998). *Atlas of Hawaii*: University of Hawaii Press.

Kenyon, K. W. (1972). Man versus the monk seal. *Journal of Mammalogy, 53*(4), 687-&.

Kenyon, K. W., & Rice, D. W. (1959). Life history of the Hawaiian monk seal. *Pacific Science, 13*, 215-252.

Kirch, P., Hartshorn, A., Chadwick, O., Vitousek, P., Sherrod, D., Coil, J., . . . Sharp, W. (2004). Environment, agriculture, and settlement patterns in a marginal Polynesian landscape. *Proceedings of the National Academy of Sciences of the United States of America, 101*(26), 9936.

Lapointe, B. E., & Bedford, B. J. (2011). Stormwater nutrient inputs favor growth of non-native macroalgae (Rhodophyta) on O'ahu, Hawaiian Islands. *Harmful Algae, 10*(3), 310-318.

Littnan, C. L., Stewart, B. S., Yochem, P. K., & Braun, R. (2006). Survey for selected pathogens and evaluation of disease risk factors for endangered Hawaiian monk seals in the main Hawaiian Islands. *EcoHealth, 3*(4), 232-244. doi: 10.1007/s10393-006-0059-z

Longenecker, K., Dollar, R., & Cahoon, M. (2006). Increasing taxonomic resolution in dietary analysis of the Hawaiian monk seal. *Atoll Research Bulletin, 543,* 103-113.

Miller, E. H., & Job, D. A. (1992). Airborne acoustic communication in the Hawaiian monk seal, Monachus schauinslandi *Marine mammal sensory systems* (pp. 485-531): Springer.

Monument, P. M. N. (2008). Papahanaumokuakea Marine National Monument Management Plan. 1-411.

Naylor, R. L., Goldburg, R. J., Primavera, J. H., Kautsky, N., Beveridge, M. C. M., Clay, J., . . . Troell, M. (2000). Effect of aquaculture on world fish supplies. *Nature, 405*(6790), 1017-1024.

Newell, R., Seiderer, L., & Hitchcock, D. (1998). The impact of dredging works in coastal waters: a review of the sensitivity to disturbance and subsequent recovery of biological resources on the sea bed. *Oceanography and Marine Biology: An Annual Review, 36,* 127-178.

NMFS. (1983). *Recovery Plan for the Hawaiian Monk Seal (Monachus schauinslandi)*. NMFS, Office of Protected Resources, Silver Spring, MD.

NMFS. (2001). May 31, 1001, letter from Rebecca Lent, Regional Administrator, Southwest Region, and attachment "Johnston Atoll and Range of the Hawaiian Monk Seal.". 8 p.

NMFS. (2007). *Recovery Plan for the Hawaiian Monk Seal (Monachus schauinslandi) Revision*. NMFS, Office of Protected Resources, Silver Spring, MD.

NMFS. (2010a). Revision of Critical Habitat for Hawaiian Monk Seals Draft Biological Report. (September 2010), 1-58.

NMFS. (2010b). Revision of Critical Habitat for Hawaiian Monk Seals Draft ESA Section 4(b)(2) Report. 1-29.

NMFS. (2010c). Memo from Jean Higgins, Pacific Islands Regional Office, to the HMS Critical Habitat Proposed Rule File re: Unconfirmed Pacific Region Sightings of Hawaiian monk seals.

NMFS. (2010d). Memo from Jean Higgins, Pacific Islands Regional Office, to the HMS Critical Habitat Proposed Rule File re: Hawaiian monk seal Female breeding age range.

NMFS. (2010e). *PIFSC Internal Report IR-10-013*. NMFS Pacific Islands Fisheries Science Center, Honolulu, HI.

NMFS. (2010g). Memo from Jean Higgins, Pacific Islands Regional Office, to the HMS Critical Habitat Proposed Rule File re: Youngest known female Hawaiian monk seal pupping in the MHI.

NMFS. (2010i). Memo from Jean Higgins, Pacific Islands Regional Office, to the HMS Critical Habitat Proposed Rule File U.S. Census Bureau's State and County QuickFacts for Hawaii.

NMFS. (2010j). Memo from Jean Higgins, Pacific Islands Regional Office, to the HMS Critical Habitat Proposed Rule File re: RM34 Translocation from MHI to Johnston Atoll.

NMFS. (2010k). Memo from Jean Higgins, Pacific Islands Regional Office, to the HMS Critical Habitat Proposed Rule File re: Two Males Translocation from FFS to Johnston Atoll.

NMFS. (2010m). Memo from Jean Higgins, Pacific Islands Regional Office, to the HMS Critical Habitat Proposed Rule File re: Last Seal Sighted at Johnston Atoll.

NMFS. (2012). Memo from Jean Higgins, Pacific Islands Regional Office, to the HMS Critical Habitat Proposed Rule File re: Diving behavior.

Olson, S., & James, H. (1982). Fossil birds from the Hawaiian Islands: Evidence for wholesale extinction by man before western contact. *Science(Washington), 217*(4560), 633-635.

Parmesan, C. (2006a). Ecological and evolutionary responses to recent climate change.

Parmesan, C. (2006b). Ecological and evolutionary responses to recent climate change. *Annual Review of Ecology, Evolution, and Systematics, 37*(1), 637.

Parrish, F. A. (2004). *Foraging landscape of the Hawaiian monk seal.* P.h.D., University of Hawaii, Honolulu, Hawaii.

Parrish, F. A., & Abernathy, K. (2006). Movements of monk seals relative to ecological depth zones in the lower Northwestern Hawaiian Islands. *Atoll Research Bulletin, 543,* 115-130.

Parrish, F. A., Abernathy, K., Marshall, G. J., & Buhleier, B. M. (2002). Hawaiian monk seals (*Monachus schauinslandi*) foraging in deep-water coral beds. *Marine Mammal Science, 18*(1), 244-258.

Parrish, F. A., Craig, M. P., Ragen, T. J., Marshall, G. J., & Buhleier, B. M. (2000). Identifying diurnal foraging habitat of endangered Hawaiian monk seals using a seal-mounted video camera. *Marine Mammal Science, 16*(2), 392-412.

Parrish, F. A., G.J. Marshall, B. Buhleier, and G.A. Antonelis. (2008). Foraging interaction between monk seals and large predatory fish in the Northwestern Hawaiian Islands. *Endangered Species Research, 4,* 299-308.

Parrish, F. A., & Littnan, C. L. (2007). Changing perspectives in Hawaiian monk seal research using animal-borne imaging. *Marine Technology Society Journal, 41*(4), 30-34.

Parrish, F. A., Marshall, G. J., Littnan, C. L., Heithaus, M., Canja, S., Becker, B., . . . Antonelis, G. A. (2005). Foraging of juvenile monk seals at French Frigate Shoals, Hawaii. *Marine Mammal Science, 21*(1), 93-107.

PIFSC. (2010). 2008 Main Hawaiian Islands Derelict Fishing Gear Survey. *NOAA Fisheries Pacific Islands Fisheries Science Center, PIFSC Special Publication, SP-10-003.*

Polovina, J. J., & Haight, W. R. (1999). Climate variation, ecosystem dynamics, and fisheries management in the Northwestern Hawaiian Islands. *Age, 12*(3), 4-5.

Polovina, J. J., Haight, W. R., Moffitt, R. B., & Parrish, F. A. (1995). The role of benthic habitat, oceanography, and fishing on the population dynamics of the spiny lobster, Panulirus marginatus (Decapoda, Palinuridae), in the Hawaiian Archipelago. *Crustaceana*, 203-212.

Ragen, T. J. (1993). Status of the Hawaiian monk seal in 1992. Southwest Fisheries Science Center. *Administrative Report, H-93-05; 79p*.

Ragen, T. J. (1999). Human Activities Affecting the Population Trends of the Hawaiian Monk Seal. *American Fisheries Society Symposium, 23*, 183-194.

Repenning, C. A., & Ray, C. E. (1977). The origin of the Hawaiian monk seal. . *Proceedings of the Biological Society of Washington, 89*(58), 667-688.

Rosendahl, P. H. (1994). Aboriginal Hawaiian structural remains and settlement patterns in the upland archeological zone at Lapakahi, Island of Hawaii. *Journal of Hawaiian Archeology, 3*, 14-70.

Scheel, D.-M., Slater, G. J., Kolokotronis, S.-O., Potter, C. W., Rotstein, D. S., Tsangaras, K., . . . Helgen, K. M. (2014). Biogeography and taxonomy of extinct and endangered monk seals illuminated by ancient DNA and skull morphology. *ZooKeys*(409), 1.

Schreiber, R. W., & Kridler, E. (1969). Occurrence of a Hawaiian monk seal (*Monachus schauinslandi*) at Johnston Atoll, Pacific Ocean. *Journal of Mammalogy, 50*, 841-842.

Schultz, J. K., Baker, J. D., Toonen, R. J., & Bowen, B. W. (2009). Extremely Low Genetic Diversity in the Endangered Hawaiian Monk Seal (*Monachus schauinslandi*). *Journal of Heredity, 100*(1), 25-33. doi: 10.1093/jhered/esn077

Southall, B. L., Bowles, A. E., Ellison, W. T., Finneran, J. J., Gentry, R. L., Greene Jr., C. R., . . . Tyack, P. L. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals, 33*(4).

Sprague, R. S., Littnan, C. L., & Walters, J. S. (2013). Estimation of Hawaiian monk seal prey consumption in relation to ecosystem biomass and overlap with fisheries in the main

Hawaiian Islands. In N. O. A. A. U.S. Department of Commerce, National Marine Fisheries Service (Ed.). Honolulu, HI: Pacific Islands Fisheries Science Center.

State of Hawaii Department of Business, E. D. T. (2008). 2008 Annual Visitor Research Report.

Stewart, B. S., Antonelis, G. A., Baker, J. D., & Yochem, P. K. (2006). Foraging biogeography of Hawaiian monk seals in the Northwestern Hawaiian Islands. *Atoll Research Bulletin, 543,* 131-146.

Stewart, B. S., Ph.D., & Yochem, P. K., M.S., D.V.M. (2004). *Use of Marine Habitats by Hawaiian Monk Seals (Monachus schauinslandi) from Kure Atoll*. Pacific Islands Fisheries Science Center.

Stewart, B. S. P. D., & Yochem, P. K., M.S., D.V.M. (2004). *Use of Marine Habitats by Hawaiian Monk Seals (Monachus schauinslandi) From Laysan Island: Satellite-linked Monitoring in 2001-2002*. Pacific Islands Fisheries Science Center.

Thomas, J., Moore, P., Withrow, R., & Stoermer, M. (1990). Underwater audiogram of a Hawaiian monk seal (Monachusschauinslandi). *The Journal of the Acoustical Society of America, 87*(1), 417-420.

Westlake, R. L., & Gilmartin, W. G. (1990). Hawaiian monk seal pupping locations in the Northwestern Hawaiian Islands. *Pacific Science, 44,* 366-383.

Willcox, M., Woodward, L., Ylitalo, G., Buzitis, J., Atkinson, S., & Li, Q. (2004). Organochlorines in the free-ranging Hawaiian monk seal (*Monachus schauinslandi*) from French Frigate Shoals, North Pacific Ocean. *Science of the Total Environment, 322*(1-3), 81-93.

Williams, T. M., Richter, B., Kendall, T., & Dunkin, R. (2011). Metabolic Demands of a Tropical Marine Carnivore, the Hawaiian Monk Seal (Monachus schauinslandi): Implications for Fisheries Competition. *Aquatic Mammals, 37*(3), 372.